EPIDEMIOLOGY OF CYCLIST AND MOPED RIDER'S CASUALTIES

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The accident pattern for the unprotected road users varies with the construction of the traffic and its density. Dense two-wheeled traffic is characteristic for countries like Denmark and Holland, and therefore these countries are especially suitable areas, when it comes to the study of these particular accidents.

Development and size of problem.

During the last 15 years, Denmark has seen a gradual turn from bicycle accidents to moped accidents. Figure 1. (The numbers derive from the Central Bureau of Statistics). However the light two-wheeler's total number of accidents has been relatively stable, apart from a distinctive increase in the number of moped accidents in connection with lowering of the permitted age to ride from 16 to 15 years in 1971 (6) without proportional decrease in the number of bicycle accidents.

It is remarkable, that the number of deaths after bicycle accidents as well as after moped accidents has been almost stable through 15 years. It is possible, that the phenomenon can be ascribed to a modified age distribution with more young moped riders, in as much as the mortality in the young is only around 1/4 of the mortality of the old (2).

Epidemiological problems.

The pattern of lesions at traffic accidents is well known. New knowledge can only be established by comparing the pattern of accidents and lesions with causative factors (3). Accidents can be related to general human patterns of behaviour which are susceptible to pedagogical and legislative measures. But traffic accidents are at the same time always local phenomenons which must be studied in relation to the environmental factors where momentary or permanent accident factors may appear, which can only be recognized by stable supervision and knowledge of the locality.

The co-ordinated analysis of accidents in the Odense University Hospital's population of 230.000 with approximately 3.000 traffic injuries per year has been described in previous reports (5). Co-operation with other authorities has through the last

five years proved to be decisive in order to benefit from the analyses. By analysis of the epidemiology of the unprotected road user, there is a particular need for co-operation with the road authorities and the police, in order to get information about a number of background factors.

At cost-benefit analyses one should not normally take exposure into account, but this is necessary by evaluation of the level of risk in an area of traffic. Here exposure can be described as the number of encounters between the examined parties. Unfortunately however this phenomenon cannot be measured and consequently one must normally settle for simple counting of the occurrence of parties. As a rule only measurements of the car traffic is available, and not of the traffic of the unprotected. However an estimate of the product of their activity and fitness may be reached by studying their single accidents in that particular area.

Another essential problem in the study of accidents consist in the verification of whether the areas in which the traffic is counted are representative for the normally far larger area in which accidents are registered. This is particularly a problem in the city traffic. In reality this problem cannot be solved. However representativity can be verified if the observations remain stable even if the material is dispersed into smaller selections.

Correlation between car traffic and unprotected road user's casualties.

By now the Odense registration has taken place for so long, that it is possible to compare the 24-hour variation for car traffic and collisions between unprotected and cars for particular roads, where traffic counting has taken place, and where many accidents happen as well.

Figure 2 shows this connection for a densely crowded narrow shopping street, and figure 3 shows the connection for a large exit road which function as a major road in some parts with international traffic. In both places there seems to be good accordance with the traffic intensity and the frequency of accidents.

Figure 4 - 7 show the same connection for the whole area, but after a dispersion into four age groups, which might be expected internally to have relatively uniform patterns of behaviour, but which might differ essentially from each other. The material has also been divided according to type of conflict into single accidents and weak/strong, that is all unprotected who collide with cars (2). Motorcycles might also be represented as "strong counterparts" or "weak offer" - but the motorcycle accidents represent only a very small part of the material.

Figure 4 shows a very high number of single accidents for children with a very high and five hours long afternoon plateau from 2 p.m. to 7 p.m. In the collision situation with cars the plateau is narrowed down to a top point at 5 p.m., probably a reflection of the culmination of the car traffic. It is striking, that the children almost lack a top point at the time, when the school traffic is confronted with the morning rush-hour.

Figure 5 shows, that the teen-agers have a peculiar single accident pattern with a graduate increase during the afternoon hours and with culmination at 10 p.m. The pattern is found again in their collision accidents, where also the characteristic reflection of the afternoon rush-hour appears.

Figure 6 shows, that the well-known, two-bulged 24-hour distribution is found in the 18 - 49 year old in single accidents and in collision situations as well. Specific for these ages is a high frequency of nocturnal single accidents.

Figure 7 shows, that the 24-hour curve for persons over 50 years of age has a rather even course during the day hours, with a moderate 4 p.m. top point in the collision situation. In this situation there is also a top point between 10 a.m. and 12 a.m., which is not explainable right off.

Distribution and severity of lesions.

Figure 8 demonstrates a percentuated distribution of the total number of lesions in pedestrians, cyclists and moped riders respectively. The numbers are given as percentage of the patients who have the lesions in question. Furthermore the appearance of characteristic fractures has been demonstrated. The figure shows the well-known regional distribution with the largest number of lesions in the head followed by lesions in the legs, arms and trunc. The relative redistribution of lesions from the head towards the legs in moped riders might be due to the effect of the helmet. This will be exposed to a closer examination.

It is clear, that there is a higher incidence of femoral and crural fractures in pedestrians that in the two-wheelers. Children and old people are overrepresented in the group of pedestrians, but correlation between age phenomenons and lesions is very complex and depending upon several variables such as friction, mass tardiness, speed, place of center of gravity and fragility.

Furthermore the material has been examined for differences in the degree of severity of the lesions, according to the Odense method's 7-point scale. No differences in this could be pointed out in the various categories of road users.

The purpose of the transportation of the injured at the time of accident is of considerable interest for traffic- and city planners, legislators and educationists.

Table 1 shows all traffic injured, regardless of ways of transportation, who have been treated after accidents on the road between their home and school and place of work respectively, during work or in their leisure time. The information is given in absolute numbers and in percentages. Furthermore information is given as to how many of the patients have been reported by the police to the Central Bureau of Statistics. The low number of reports of school accidents (significantly different from home/place of work, $p < 0{,}001$) can be explained by the overrepresentation of cyclist accidents, which notoriously are reported only rarely (4). When it comes to leisure time accidents the low frequency of reporting (significantly different from home/place of work, $p < 0{,}001$) cannot be explained from the means of transportation or the distribution of age, but must also be sought for in other behavioural patterns, i.e. relatively high occurrence of intoxicated road users, who deliberately tries to withdraw from the police registration (1).

Table 2 shows, that the area has a very high occurrence of two-wheeler's accidents, especially during the leisure time. Second largest group is the carrider's injuries, also in leisure time. In this material the number of schoolroad accidents only represent 4,5% of the total number of accidents, and far the majority of accidents have taken place during bicycling.

Table 3 shows what counterparts the injured has had in connection with different errands. The single accidents is the largest group with 46% while 39% have had an automobile as counterpart, 5% two-wheelers and 4% heavy-goods vehicles.

As to degree of severity the two-wheeler's collisions with cars is the most serious safety problem of the area.

Geographical distribution of accidents.

Since September the 1st 1972 an attempt has been made to localize the accidents in which a registered vehicle has been involved. Table 4 shows the size of this material for the unprotected road users as victims.

Table 4.

Unprotected/cars (February 1st 1972 - January 31st 1976)

	Name of street			
	Available	Not available	Total	Not available/Total %
Pedestrians	495	146	641	23
Cyclists	548	162	710	23
Moped riders	602	237	839	28

The material is programmed in such a way, that it is possible to transcripe the number of casualties on each road for selected groups. From these transcriptions we have chosen the ten most heavily loaded roads in regard to casualties in pedestrians, cyclists and moped riders. There is good accordance between the preferred locations of these groups in as much as 17 street names cover the "top ten" list for all three categories. At the same time it is demonstrated, that there are roads where only one category of road users have many accidents. These will be pointed out to the road technicians in anticipation of a closer examination.

The 17 most heavily loaded roads have 618 accidents out of a total number of 2190 or 28%. There are about 1340 roads and streets in the area.

The concentration of accidents for the three categories appears in table 5.

Table 5.

	Total number of accidents	Of these on the "top ten" (percentage)	Number of roads with accidents	Mean accident number per road
Pedestrians	641	25	175	3,7
Cyclists	710	22	206	3,4
Moped riders	839	23	213	3,9

Table 5 shows a uniform tendency for the three groups.

Thus security-wise there seems to be a good reason to concentrate the preventive effort in the most accident loaded places.

In order to get a hint as to whether the carriders have a realistic notion about where the unprotected run the greatest risk, we asked some commercial drivers about their idea of the level of accidents for a number of streets. They disapproved four of the eight most dangerous streets and characterized those streets as "less dangerous". This indicates a limited value of "common sense" as well as of "local knowledge" which is not based on methodic observations.

Accident situations.

Table 6.

Situation	Moped	Bicycle	Collision situation (∘ = victim)
1	54	79	
2	23	11	
3	119	108	
4	124	65	
5	110	80	
6	107	83	
7	54	11	
Total no.	591	437	

Table 6 shows moped- and bicycle accident situations for police registered accidents from September 1st 1972 to January 31st 1976 (Danish Central Bureau of Statistics). There does not seem to be any difference in their accident patterns. The degree of severity of the lesions (the 1 - 7 graduation) has been compared with the accident situation as well as with the means of transportation. The only difference which could be pointed out in the degree of

severity was a tendency towards a more severe degree of injury in the bicycle riders than in the moped riders, when they are hit from behind (situation 1) ($0{,}1 > p > 0{,}05$).

At the moment the bicycle rider's safety in the Odense area is undergoing a closer examination. However the effect of bicycle tracks cannot yet be evaluated with certainty.

From table 4 it appears, that 162 out of 710 (23%) of the bicycle accidents could not be localized. Therefore the localization of the remaining accidents has been the object of a closer investigation, partly in the police registers and partly through letter inquiry. The accidents which were localized in this way showed the same geographical distribution as those primarily localized, with 70% accordance on the "top ten" list. After this only 94 bicyclist accidents lack localization or 13% of the total material.

There is no reason to assume, that distribution of the lacking 94 cases differ geographically from the rest.

The time of inability as a result of the bicycle rider's collision with cars has been investigated through a letter inquiry in which 57 answers are available till now. The 57 answers are distributed as shown in table 7.

Table 7.

Severity group	1 - 3 (0- 14 days)	4 (15-90 days)	5 (91-180 days)	6 (> 181 days)
Number	40	15	1	1

A further investigation into the social consequences is still taking place, and the material is a part of a larger analysis which is aiming at converting "severity group" into days of inability.

Summary. Purpose: Investigation of the unprotected road user's collisions with cars.

From the Odense material's approximately 15.000 traffic casualties registered since February the 1st 1971 a material has been selected of 1106 cyclists and 1377 moped riders, whose lesions are compared with those of 981 pedestrians. It was not possible to point out any difference between cyclists and moped riders with

regard to distribution of lesions or severity. However, there was an obvious overweight of femoral and crural fractures in pedestrians. The 24-hour pattern of accidents was examined and compared to the car traffic in specific roads and in different age groups which showed certain characteristics.

From september the 1st 1972 information is available as to the errand of the road user at the moment of accident as well as the place of accident, comprising 710 cyclists and 589 moped riders. Far the most accidents occur during leisure time. From this material "top ten" lists of accident loaded streets have been set up and compared in regard to pedestrians, cyclists and moped riders.

It appeared, that there was a uniform localization and tendency of concentration for the accidents, but there were certain localities, where only one category of road users collided with cars. The accident situation and the lesions as a result were the same for the cyclists and the moped riders apart from a little more severe pattern of lesions in the cyclists who had been hit from behind.

References:

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2. Damholt, W., Nielsen, H. Victor and Nordentoft, Erik L. Correlations between Accident Circumstances and the Type and Grade of Injuries in Traffic Accidents. IRCOBI Conference Proceedings, Birmingham 1975, 40-49.
3. Mackay, G. M. The Practical Application of Epidemiological Methods upon the Enterpretation of Effects of Traffic Regulations. Traffic Speed and Casualties, Editor: Erik L. Nordentoft, Odense University Press, 1975 p. 9 - 23.
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5. Nordentoft, Erik L., Dalby, T. and Petersen, E. A. Traffic Accidents and Injury Evaluation Based upon a Coordinated Data Collecting System. IRCOBI Conference Proceedings, Amsterdam 1973, p. 43 - 48.
6. Pedersen, P. K. Moped Accidents. I: Epidemiological Aspects. II: Lesions, Duration of Treatment, Social and Economical Aspects. Ugeskr. Læg.1973: 135: 2761 - 2770.

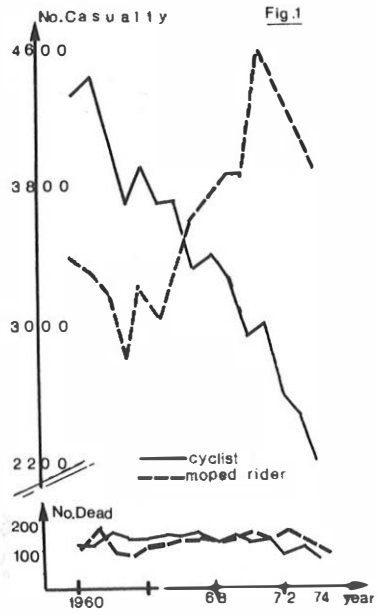


FIG.2

CASUALITIES/TRAFFIC INTENSITY

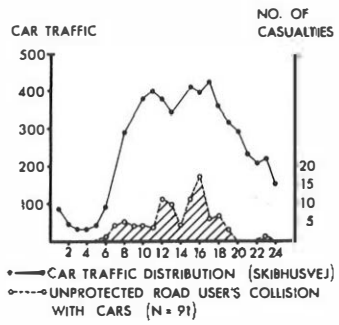


FIG.3

CASUALITIES/TRAFFIC INTENSITY

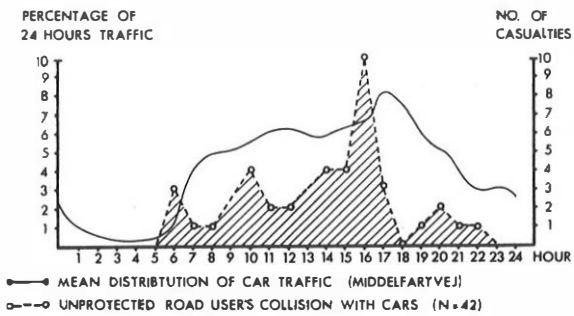


FIG.4

CASUALITIES/HOUR OF DAY.

AGE GROUP: 0-14 YEARS

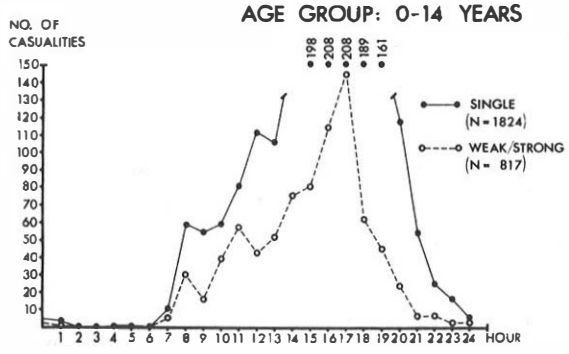


FIG.5

CASUALITIES/HOUR OF DAY.

AGE GROUP: 15 - 17 YEARS

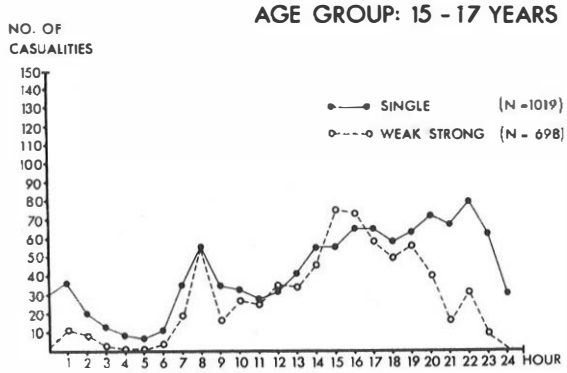


FIG. 6

CASUALITIES/HOUR OF DAY.

AGE GROUP: 18-49 YEARS

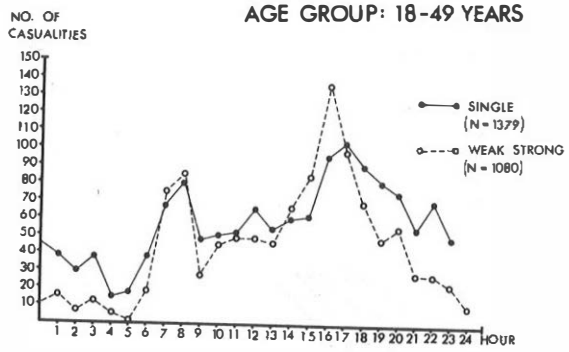


FIG. 7

CASUALITIES/HOUR OF DAY.

AGE GROUP: 50-99 YEARS

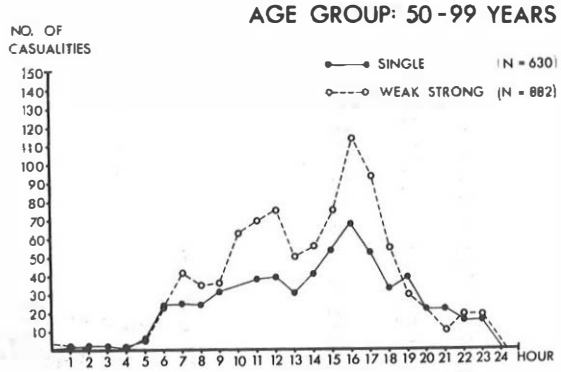


Table 1

VICTIM'S TRAFFIC ERRAND	NUMBER OF PATIENTS	PERCEN - TAGE OF TOTAL	POLICE RE- PORTED IN PERCENTAGES
TO AND FROM SCHOOL	411	5	26
TO AND FROM WORK	1066	12	37
AT WORK	314	3	45
IN LEISURE TIME	6685	73	31
UNKNOWN	690	8	45
TOTAL	9166	101	

O.S. 1976 1.9.72 - 31.1.76 (N = 9166)

Table 2

VICTIM'S TRAFFIC ERRAND	VICTIM'S TRANSPORT PEDES - STRIANS	TWO - WHEELERS	CARS	LORRIES & BUSSES	OTHER OR UNKNOWN
TO AND FROM SCHOOL	6	38	1	0	0
TO AND FROM WORK	4	75	36	1	0
AT WORK	3	12	16	3	1
IN LEISURE TIME	66	448	209	4	2
UNKNOWN	11	43	19	1	2
TOTAL	89	616	281	10	5

O.S. 1976 1.9.72-31.1.76. CIPHER'S PER THOUSAND (N=9166)

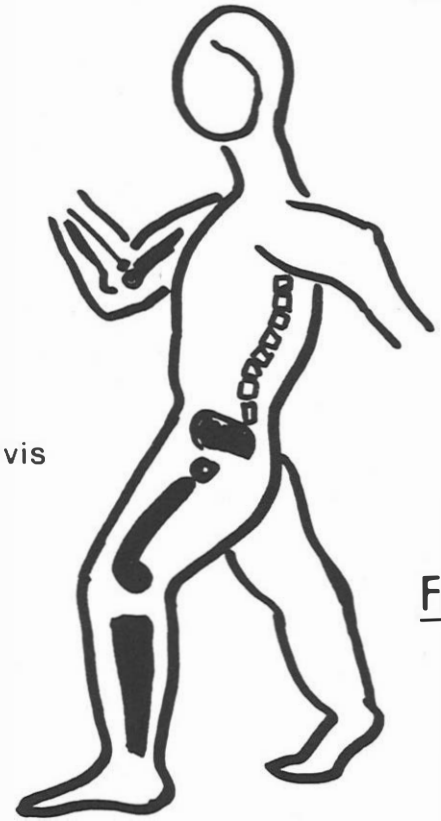
Table 3

VICTIM'S TRA FIC ERRAND	VICTIM'S COUNTERPART TWO - WHEELERS	CARS	LORRIES & BUSSES	SINGLE	OTHER OR UNKNOWN
TO AND FROM SCHOOL	5	16	2	20	2
TO AND FROM WORK	5	58	6	45	3
AT WORK	1	16	5	11	1
IN LEISURE TIME	40	267	21	358	42
UNKNOWN	3	28	6	31	7
TOTAL	54	385	41	464	56

O.S. 1976 1.9.72 - 31.1.76 CIPHERS'S PER THOUSAN (N= 9166)

Fig.8

Fractures:



I: arm

II: columna

III: hip + pelvis

IV: femur

V: crus

Pattern of lesions unprotected versus cars.

(No.lesions/No.patients x 100)

Total lesions: no.lesions / no.patients	Pedestrian 1825 / 981	cyclist 1891 / 1106	moped rider 2203 / 1317
head	73.1	66.9	53.6
neck	1.6	1.5	1.2
arm	26.6	33.5	31.6
thorax	7.8	7.7	6.2
abdomen	4.6	2.3	2.0
leg	60.4	50.3	66.6
Fractures:			
I :	7.5	6.8	5.1
II :	0.8	1.4	0.2
III :	4.4	4.6	4.0
IV :	7.1	2.5	3.4
V :	13.3	6.1	7.8
total:	33.1	21.4	20.5