SAFETY OF PEDESTRIAN CROSSING FACILITIES

PUBLICATION 1974-2E

safety of pedestrian crossing facilities

An international comparative research on the effect of variously composed sets of pedestrian crossing facilities (zebra crossings, signal controlled crossings, grade separated crossings) on pedestrian safety in towns

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Introduction

Within the Organisation for Economic Co-operation and Development (OECD) there are a number of groups engaged on road safety. One of them concentrates on pedestrian safety. In 1970, this group published a literature study (Biehl, 1970), which reviews all the important aspects directly or indirectly affecting the safety of the pedestrian. In the section 'Future Research', the above mentioned OECD report states in paragraph 3.2.3.1. (p. 51), that supplementary research is required on the subject of 'a comparison of the use and safety of various crossing places, including pedestrian overpasses and underpasses'. In this context, the Netherlands have undertaken to conduct a comparative statistical survey.

In order to ensure maximum co-operation from other countries, a design was chosen in which the only requirement was the supply of statistical materia l which, in the opinion of the researchers, could be collected comparatively easily and quickly. Consequently, countries participating in the Dutch research were not obliged to spend a great deal of time and money on their co-operation. Apart from the Netherlands, the participating countries were the United Kingdom, the United States, Denmark, Sweden, Spain, Germany and Austria.

The research was carried out for the semi-independent OECD Working Group on Pedestrian Safety by J. H. Kraay (Institute for Road Safety Research SWOV) and M. Slop (Institute for Road Safety Research SWOV, now Utrecht Traffic Department), with the collaboration of S. Oppe (Institute for Road Safety Research SWOV).

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Summary

International comparative statistical research was undertaken to establish the relationship between the existence of pedestrian facilities (zebra crossings, signal controlled crossings and grade separated crossings) and the relative risk to pedestrians crossing urban roads.

In three of the six countries investigated it was found that the pedestrians' relative risk is reduced as more signal controlled crossings are provided. In two other countries this correlation was found only for zebra crossings. In only one country was no correlation at all found between pedestrian facilities and relative risk.

With the method used in this research it could not be demonstrated in the case of the Netherlands that increasing the number of zebra crossings promoted pedestrian safety. Making more signal controlled crossings does, however, have a favourable effect on pedestrian safety.

The criterion of exposure used in this research proved very sound and can be recommended for similar research.

1. Statement of the problem

Several researchers have investigated the risk of crossing a road on different kinds of (level) pedestrian crossings, compared with the risk of crossing at various distances away from these (e.g. Mackie, 1962; Jacobs and Wilson, 1967). Apart from grade separated crossings (footbridges and pedestrian subways), which of course are very safe indeed, the general finding is that signal controlled crossings are safer than zebra crossings, and the latter safer again than places where there are no facilities for pedestrians.

The consequence of this would be a policy of increasing the number of signal controlled crossings considerably, or, because only limited funds are likely to be available, at least an unrestricted extension of the number of additional zebra crossings, which are easy and inexpensive to install. What is actually happening is that all towns tend to limit their number of crossings, also of the zebra type, fearing that too many of them will reduce their individual favourable effect on the behaviour and safety of pedestrians as well as drivers. Taking this into account, it is reasonable to suppose that the relative risk of a certain type of crossing also depends on the number of these and other crossings in a town. This raises the question of how to determine the number of crossings of different types in a town that will create optimum overall pedestrian safety.

Before the investigation started it was held by the researchers that the excessive installing of zebra crossings in particular was likely to have an adverse effect, which would probably likewise exist in several towns. With regard to signal controlled crossings they did not expect the numbers of this kind of crossings in any one town to be large enough to verify the existence of such an effect. After the processing of the data of all countries it has turned out that neither the signal controlled crossings nor the zebra crossings were numerous enough to justify the assumption of an U-shape relationship in the mathematical treatment (see paragraph 5.1.).

2. Research method

One way of studying the problem stated is comparing the levels of pedestrian safety in towns distinguished by variously composed sets of pedestrian crossing facilities.
Assume a situation in which pedestrians cross roads and motorists drive their vehicles in such a way as if the other category did not exist, i.e. both without paying attention at all to each other. This behaviour would undoubtedly result in a certain number of collisions per unit of time. An estimate can be made of this number of potential accidents.
The method of calculation is set out in Appendix I. It shows that the following formula can be used:

$P = I.i.T_0$

in which:
P = the number of potential accidents (per unit of time);
I = the average flow of motor traffic per road (per unit of time) in the town;
i = the average number of pedestrians crossing throughout the town (per unit of time);
T_0 = a time factor to take into account the time during which there is a chance of collision when one pedestrian crosses the path of one vehicle.

I is calculated by dividing the estimated number of motor vehicle kilometres driven within the town limits, by the total length of the street network.
i is calculated by multiplying the population by an estimated average number of times a particular pedestrian crosses any road in the particular town. (The influence of the age distribution and the amount of commuters of the different towns has not been taken into account.)
T_0 equals an average of about 2.5 sec, and has been treated as a constant.

In reality, there will be fewer accidents than the calculated number of potential vehicle vs. pedestrian accidents, which is due to the attentiveness and care both kinds of road users jointly take whilst driving and crossing respectively. The number of actual pedestrian accidents in a town can be derived from accident statistics. Having estimated the number of potential accidents one can easily figure out how this number has apparently been reduced as a result of the interaction in behaviour mentioned.
The solicitous behaviour in each specific town can be considered to be built up of a kind of basic solicitude, noticeable in a town without any pedestrian crossing at all, modified (improved) by the particular set of facilities in the town in question. This set of crossing facilities is to be considered as an aid for both motorists and pedestrians in their combined efforts to avoid collisions taking place between them. The presence of a crossing facility, for instance a zebra, will especially affect the behaviour of drivers and pedestrians on the spot where it is situated, but the point is that its effect will also depend on the presence of the same or other facilities throughout the town.

In this study the composition of the sets of facilities has been expressed only by the *numbers* of de different types of crossings in the respective towns. The researchers were aware of the fact that the *situation* of the crossings in the street network might be of as much importance as just their number. For reasons of efficiency mentioned in the introduction, the former way of investigating has been chosen.

The hypothesis now is that differences between *towns* in the reduction of the number of potential accidents to the actual number, are to a certain extent due to differences in the composition of the pedestrian crossing facility sets.

To test this hypothesis three sets of data are required, viz.:
a. figures for I, i and T_0 to determine the number of potential accidents;
b. figures for the number of actual vehicle vs. pedestrian accidents;
c. figures describing the sets of pedestrian crossing facilities.

With the data mentioned in a. and b., the accident reduction ratio can be calculated. An explanation of the differences between towns must be sought with c., while it must be realised that as stated above a large number of accidents are already prevented without any facilities. The ratio can be regarded as a measure of relative risk.
The model used for calculating the relative risk, with the basic argument, is given as Appendix II.

After some simple calculations, the relative risk so formulated can be written:

$$(26) = 33800 \cdot \frac{(9)}{(16)} \cdot \frac{(14a)}{(5)} \cdot \frac{(3)}{(5)}$$

the figures in brackets corresponding to the answers in the completed questionnaires:
(26) = the relative risk (ratio between actual and potential numbers of pedestrian accidents)
(9) = total number of inhabitants in all built-up areas in the country in question
(16) = total number of motor vehicle kilometres per annum in all built-up areas in the country in question
(14a) = number of vehicle vs. pedestrian accidents per annum in the built-up area of the town in question
(5) = number of inhabitants in the built-up area of the town in question
(3) = built-up area of the town in question
The factor of 33800 is determined by the average distance covered per annum by an inhabitant of the town as a pedestrian and by the value taken for T_0.
The ratio (9) : (16) is constant for each country in question and is the reciprocal value of the average amount of traffic in the built-up areas of that country expressed as motor vehicle kilometres per annum per inhabitant.
The ratio (14a) : (5) gives the actual number of vehicle vs. pedestrian accidents per annum per inhabitant for the town in question.
The ratio (3) : (5), lastly, forms the reciprocal value of the town's population density.

It is found that the criterion of relative risk, apart from a coefficient, is the number of pedestrian accidents per annum per inhabitant *divided by population density*.

An uncertain factor that remained was yielded by the differences in statutory regulations for pedestrians in the various countries (Kraay, 1971). For instance, in the Netherlands it is forbidden to cross when the pedestrian-crossing lights are red, but not in Britain. Despite these differences there is no particularly great discrepancy in behaviour (Older, 1972), probably because the level of enforcement of the regulations is generally low where pedestrians are concerned (Kraay, 1972).

3. Collection of the material

From November 1969 on, the required data were collected by asking the delegates of the semi-independent OECD Working Group on Pedestrian Safety to provide relevant details for their own countries. Each delegate was sent a questionnaire, which is attached as Appendix III.
On August 1st, 1973, completed questionnaires for this investigation had been received from the following countries:

The Netherlands : 14 towns
United States : 11 towns
United Kingdom : 9 towns
Spain : 9 towns
Germany : 6 towns
Denmark : 3 towns
Sweden : 3 towns
Austria : 1 town

In spite of the fact that each participating country had been asked to give the figures for every town over 100,000 inhabitants, none of the countries has provided data of all towns suggested. The lower limit of 100,000 had been chosen to avoid that the number of actual pedestrian accidents would turn out to be too small for statistical processing.

4. Evaluation of the material

After studying the information obtained it proved necessary to depart from the original research plan on a number of points.

In the first place, it was almost invariably impossible to obtain a figure for the average number of kilometres per pedestrian per annum. The calculations were therefore all based on the same 750 km (Zabel, 1968).

For calculating the number of motor vehicle kilometres in a town in one year there are various methods, most of them derived from traffic planning practice. This information was asked for under question (18) on the questionnaire. Because it was feared that many towns would not be able to answer this question and, if they could, the reliability or at least the comparability of the individual figures would not be adequate, there was a second question (17) on this subject. In this, the number of motor vehicle kilometres per year was approximated by multiplying the total number of motor vehicle kilometres per year in all towns of the country, by the fraction represented by the population of the relevant town within the total population living in towns in that country. In this way at least a uniform calculation method was used. Moreover, it agreed reasonably well with the answers to question (18) whenever these could be provided (see Table 1 and 2). Only in some U.S. towns it was not the case (see paragraph 5.3.).

In processing the figures, and after considering the answers to question (18) (if received), allowance was always made for the answers to question (17).

In spite of these deviations, the original research design could be reasonably approximated as far as the Netherlands, the United Kingdom, the United States, Denmark and Sweden are concerned.

For Spain and Germany the replies to the questions about number of inhabitants in all built-up areas (9) and about the total number of motor vehicle kilometres driven in built-up areas (16), needed for approximating the number of motor vehicle kilometres driven in the various towns (17), could not be obtained. But this did not prevent a comparative study being made within these countries. It was not, however, possible to compare the towns in the latter two countries with those in the others.

Concerning the last aspect, in evaluating the material it was soon discovered that it would be difficult to compare towns in different countries. The main reason was that a number of definitions, such as for 'built-up area' and 'casualty', are not the same in different countries. In most countries the difference between built-up and non built-up areas, as upheld in every Dutch municipality, does not even exist in statistics. Therefore, the researchers had to focus their attention on the individual countries successively as a direct comparison was difficult. Consequently, the collected data have not been digested together, but the various countries have been dealt with separately. For a totally different reason, of a statistical nature, in two cases (Denmark and Sweden; Germany and Vienna) the researchers have taken the liberty of combining the data.

As to the accidents, since in many cases the number of vehicle vs. pedestrian accidents involving property damage only could not be given and in other instances could not be considered reliable, researchers decided to consider as the number of actual accidents (14a) the sum of (11) and (12), i.e. the number of reported accidents involving injuries, and to omit (13) whenever possible.

With regard to the signal controlled crossings there appeared to be no purpose in maintaining the distinction between full-time, day-time and rush-hour control. This is why the answers to questions (28), (29) and (30) of the questionnaire have not been processed separately, but answers (31) have been used throughout. In most towns the number of grade separated crossings proved to be so small that separate statistical processing was not possible. In view of these considerations two new figures have been introduced:

A = the number of signal controlled crossings plus twice the number of grade separated crossings, all per km of road; the factor 2 has been chosen, assuming that it reflects broadly the relatively larger attractivity of this type of crossing.

B = the number of zebra crossings per km of road.

5. Results

5.1. The Netherlands

Relevant figures from the completed questionnaires of fourteen Dutch towns have been collected in Table 1.
First of all, an attempt was made at roughly characterising the policy with regard to installing the two main types of crossings (signal controlled and zebra crossings) in Dutch towns, by establishing the relationship between the figures A and B on the one hand, and on the other hand:

1. the average flow of motor traffic per road (answer (20) of the questionnaire);
2. the average flow of pedestrians crossing per width of normal crossing (= 4 m) (answer (24) of the questionnaire, divided by answer (19), times 4);
3. the product of 1 and 2.

The results are set out in Figure 1. Of the three possibilities, A appears to correlate best with the pedestrian flow and B better still with the motor traffic flow. This means that in Dutch towns there is a tendency towards accordingly installing *more zebra crossings when there is more motor traffic, and more signal controlled crossings when there are more crossing pedestrians.*
After that a relationship was primarily sought between the total number of pedestrian facilities (grade separated, signal controlled and zebra crossings) per km of road, and the relative risk. There was no demonstrable relationship.
On the basis of data from the literature, according to which signal controlled crossings, and certainly grade separated crossings, have a greater influence on pedestrian safety than zebra crossings, it was then investigated whether a relationship with the relative risk could be demonstrated when an other description of the total of pedestrian facilities was used as independent variable. When roughly inspecting the figures calculated in this way, a decreasing relative risk was found when it was plotted against the number of signal controlled and grade separated crossings per km of road. (Since grade separated crossings were not numerous in any Dutch town, their numbers did not influence the calculations fundamentally).

If the assumption in Chapter 2 that the presence of a very large number of signal controlled crossings again leads to an increase of the relative risk is correct, the only conclusion to be drawn from the available figures is that this applies only where the number of signal controlled crossings per km of road is larger than in the towns involved in the investigation. That is why a higher-degree curve based on a U-form correlation did not apply satisfactorily to the numerical material.
It was therefore decided to abandon the hypothesis that the risk increases again if there are very large numbers of signal controlled crossings.
In that case it is likely however that the reduction in the relative risk with an increasing number of facilities is always proportional to the extent of that risk. This means, inter alia, that when the relative risk is more and more reduced, each further reduction of it

Question no.	(3)	(5) 10^3	(11)	(12)	(14a)	(17) 10^6	(18) 10^6	(19)	(26) 10^{-6}	(27)	(31)	(32)	A	B
Amsterdam	88	823	31	981	1012	1130	1200	1220	3.3	8	440	549	0.37	0.45
Rotterdam	68	687	20	748	804	940	939	1057	2.9	9	269	1083	0.27	1.03
The Hague	65	560	21	236*	257*	770	—	750	1.4	0	353	291	0.47	0.39
Utrecht	25	276	11	249	260	380	—	520	2.1	1	219	93	0.43	0.18
Eindhoven	22	187	4	135	139	256	—	615	2.2	3	191	27	0.32	0.04
Haarlem	30	173	8	132	140	237	—	345	3.5	1	81	27	0.24	0.08
Groningen	28	167	4	158	162	229		255	4.1	3	23	225	0.11	0.88
Tilburg	29	152	5	115	120	208	—	340	3.7	0	25	42	0.08	0.12
Breda	21	117	3	54	57	161	71	272	2.2	3	85	45	0.33	0.17
Arnhem	16	110	5	90	95	151	—	322	3.1	5	85	16	0.29	0.05
Apeldoorn	30	102	5	60	65	140	—	411	4.7	0	65	10	0.16	0.02
Leiden	10	100	4	122	126	137	—	174	3.3	5	30	107	0.23	0.62
Hilversum	15	98	4	90	94	134	150	205	3.6	1	25	38	0.13	0.18
Maastricht	15	94	3	100*	103*	129	—	215	4.5	2	51	50	0.26	0.23

Table 1. *The Netherlands:* Summary of figures from the questionnaires and some figures calculated from these.
Question (9) — 11.7×10^6; Question (16) = 16×10^9
*Damage only accidents included; no separated figures available.

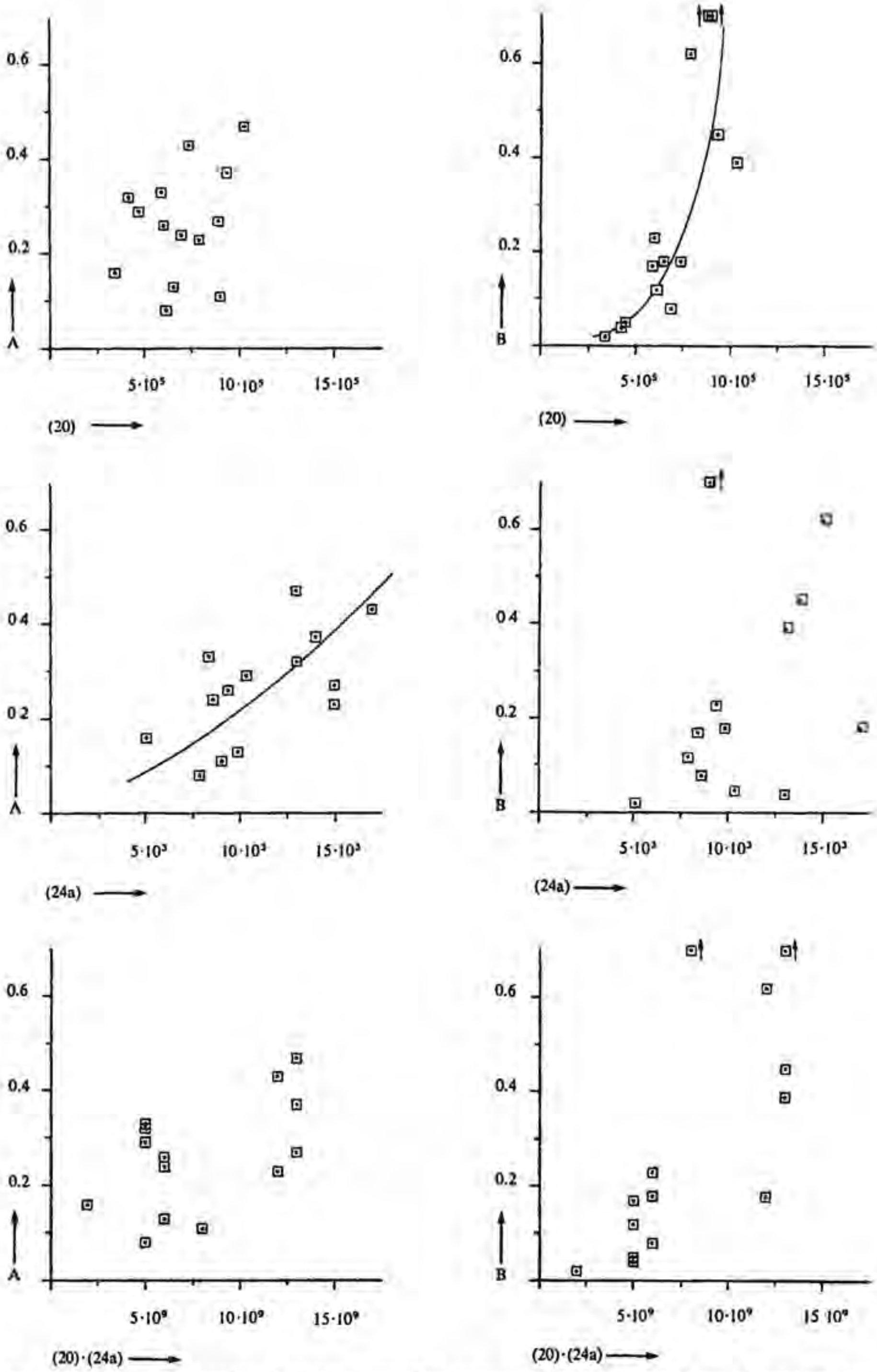

Figure 1. *The Netherlands:* Relationships between the average flow of motor traffic (20) and the average flow of pedestrians crossing per width of a normal crossing (24a), and the numbers of signal controlled crossings etc. (A) and zebra crossings per km of road (B).

will be increasingly difficult to realise. The result of the above assumption is an exponential relationship between the relative risk (y) and the number of pedestrian facilities per km of road (x). This leads to fitting the regression curve: $y = b.e^{ax}$, in which parameter a is an index of the effectiveness of installing pedestrian crossings: the more negative the value of a the more effective the action taken. Parameter b indicates the level of the relative risk if there are no pedestrian crossings.
This function can also be written:

$y = e^{ax+b'}$, in which $b' = \ln b$, or: $\ln y = ax+b'$.

The question thus boils down to fitting a linear regression curve between ln y and x. If y is expressed in terms of 10^{-6} the least-squares solution gives the following parameters for the relationship between relative risk on the one hand and the number of signal controlled crossings and twice that of the grade separated crossings per km of road (A) on the other hand: $a = -2.4369$ and $b = 5.5527$. The product-moment correlation coefficient is $r = -0.8385$, which means that the relationship is significant at the 1% level (see Figure 2, page 22). It is found that an increase in the number of signal controlled crossings etc. is accompanied by a decreasing relative risk.
If the same procedure is maintained in establishing the relationship between the relative risk and the number of zebra crossings per km of road (B), the following parameters are found: $a = 0.0282$ and $b = 3.0082$. The product-moment correlation coefficient is $r = 0.0268$. This relationship is not significant (see Figure 3, page 23).

Although the significance of the relationship between the number of signal controlled crossings etc. and the relative risk is already rather satisfactory, attempts have been made at further improvement of the relationship. Since car-ownership in some towns differs more than 20% from the national average, one supposition was that differences in car-ownership between the various towns should be taken into account. Although from an investigation into this aspect the impression was obtained that this supposition is correct, no substantial improvement of the significance level could be reached.

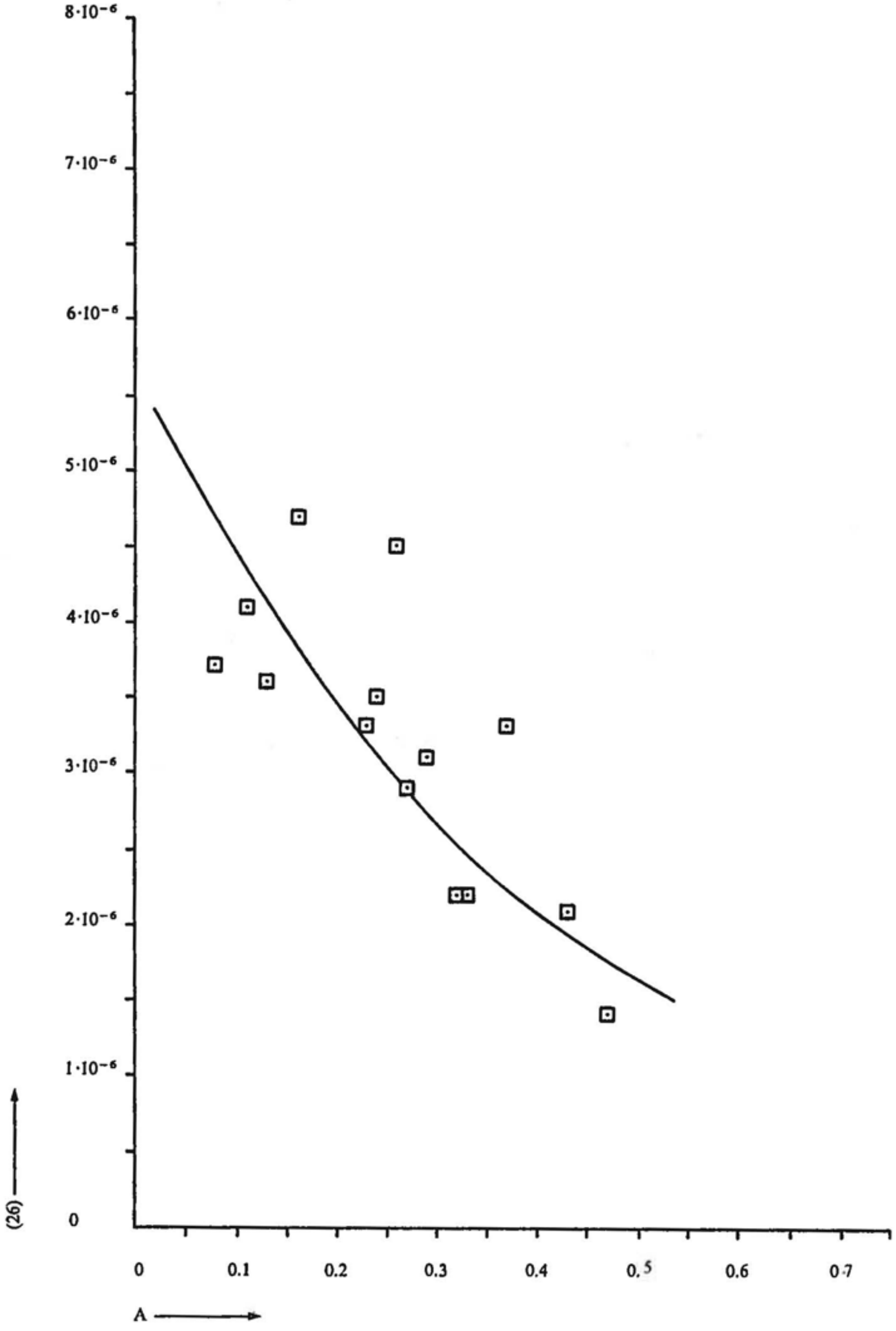

Figure 2. *The Netherlands:* Relationship between the numbers of signal controlled crossings etc. per km of road (A) and the relative risk (26).

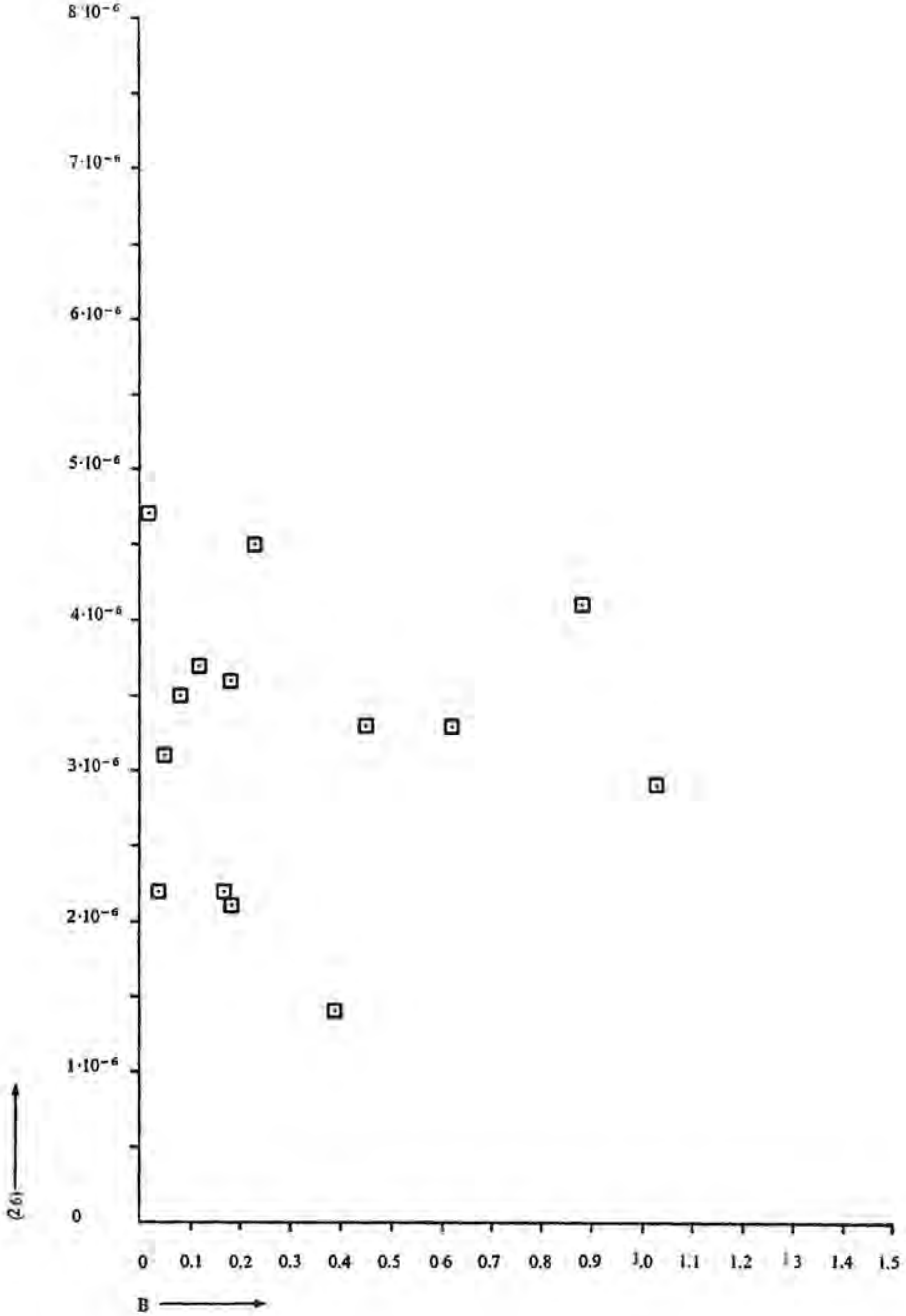

Figure 3. *The Netherlands:* Relationship between the numbers of zebra crossings per km of road (B) and the relative risk (26).

5.2. United Kingdom

The principal figures from the completed questionnaires for nine British towns are set out in Table 2.

For the five towns with over 100,000 inhabitants a distinction could be made between inside and outside built-up areas. The other four, all with a population of 70,000 or less, where no distinction was possible between inside and outside built-up areas, were therefore disregarded.

The number of inhabitants and the length of the street network each time apply to the whole municipality, since the figures for the built-up areas only were not available. It is estimated that this irregularity has resulted in figures for A and B that are 5 to 10% too low.

As for the Netherlands, an attempt was made at characterising the policy regarding the installing of pedestrian crossings. The results, set out in Figure 6, page 28, point to a clear tendency to install *more zebra crossings according as the average number of pedestrians crossing is larger and — less clearly — to more signal controlled crossings in denser motor traffic flow*. This is quite the reverse of the situation in the Netherlands.

In the case of the United Kingdom, too, a study was first made of the total pedestrian facilities and the relative risk. As for the Dutch towns there was no evidence of any relationship.

In looking for a relationship between the number of signal controlled crossings etc. per km of road, and the relative risk (when using the same calculation method as for the Netherlands), the parameters found were: $a = 0.3178$ and $b = 3.8919$. In a product-moment correlation coefficient $r = 0.0484$ no significant relationship can be found (see Figure 4, page 26).

If the same procedure is followed for the relationship between the number of zebra crossings per km of road and the relative risk the parameters found are: $a = -1.9702$ and $b = 5.1535$. Here, the product-moment correlation coefficient $r = 0.8220$, which means that this relationship was found to be significant at the 10% level (see Figure 5, page 27).

Question no.	(2)	(3)	(4) 10^3	(11)	(12)	(14a)	(17) 10^6	(18) 10^6	(19)	(26) 10^{-6}	(27)	(28)* =(31)	(32)	A	B
Leeds	164	67	508	33	897	930	1167	1248	1416	3.6	8	220	150	0.17	0.11
Nottingham	74	33	310	23	709	732	712	—	620	3.7	9	156	125	0.28	0.20
Luton	43	26	154	1	298	299	354	256	296	4.8	0	97	19	0.33	0.06
Reading	37	17	126	7	254	261	290	293	233	4.1	1	68	20	0.30	0.09
Oxford	36	21	109	7	189	196	251	—	230	5.1	5	34	8	0.19	0.03
Worcester	25	—	70	2	80	82	—	—	172	—	1	34	10	0.21	0.06
Wakefield	23	—	60	5	108	113	—	—	139	—	0	7	14	0.05	0.10
Gt. Yarmouth	18	—	52	3	99	102	—	—	150	—	0	42	12	0.28	0.08
Canterbury	19	—	33	3	75	78	—	—	87	—	2	22	7	0.30	0.08

Table 2. *United Kingdom.* Summary of figures from the questionnaires and some figures calculated from these.

Question (9) = 41.9×10^6; Question (16) = 96×10^9

* Crossings with only part-time signal control were not reported from the English towns.

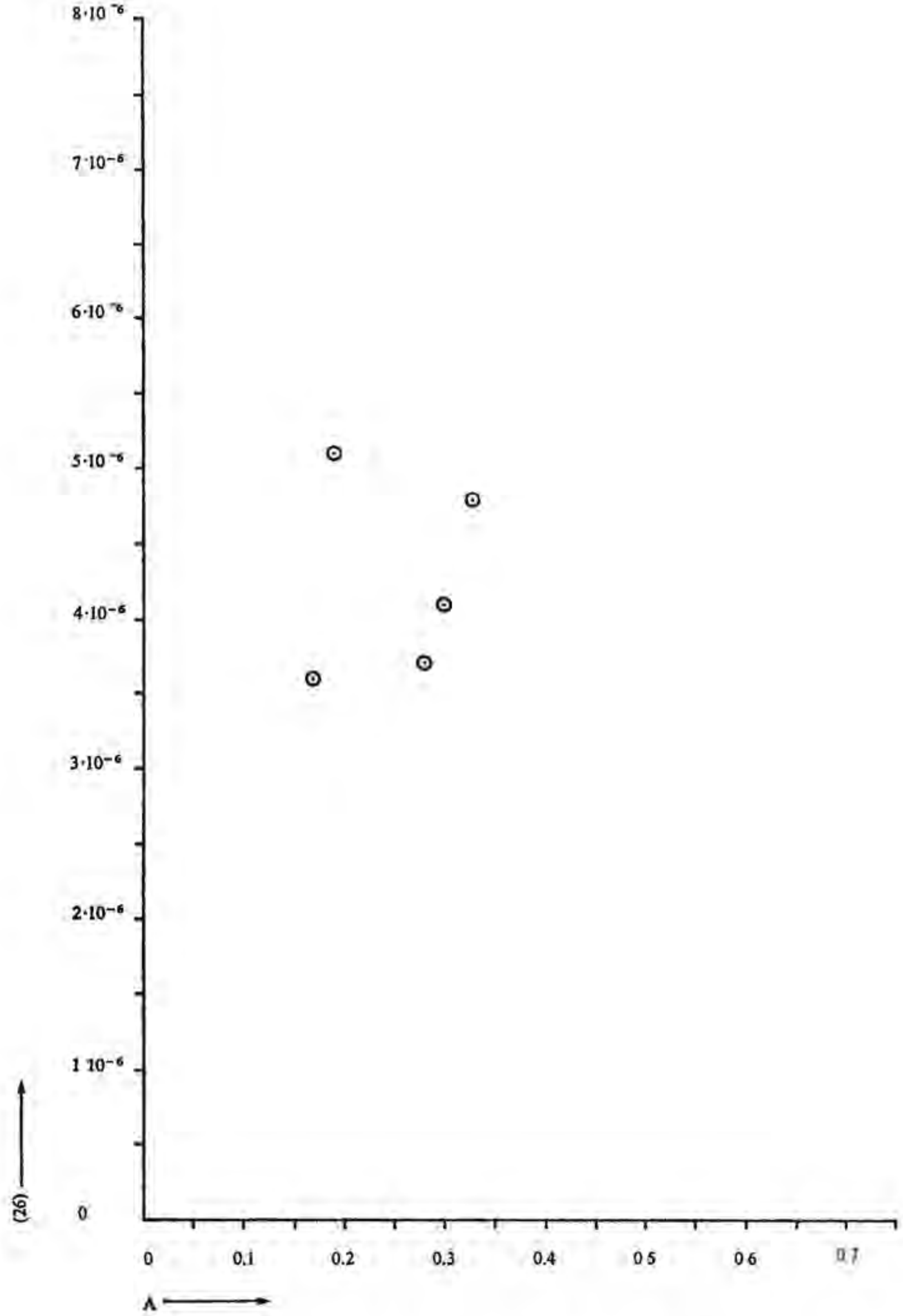

Figure 4. *United Kingdom:* Relationship between the numbers of signal controlled crossings etc. per km of road (A) and the relative risk (26).

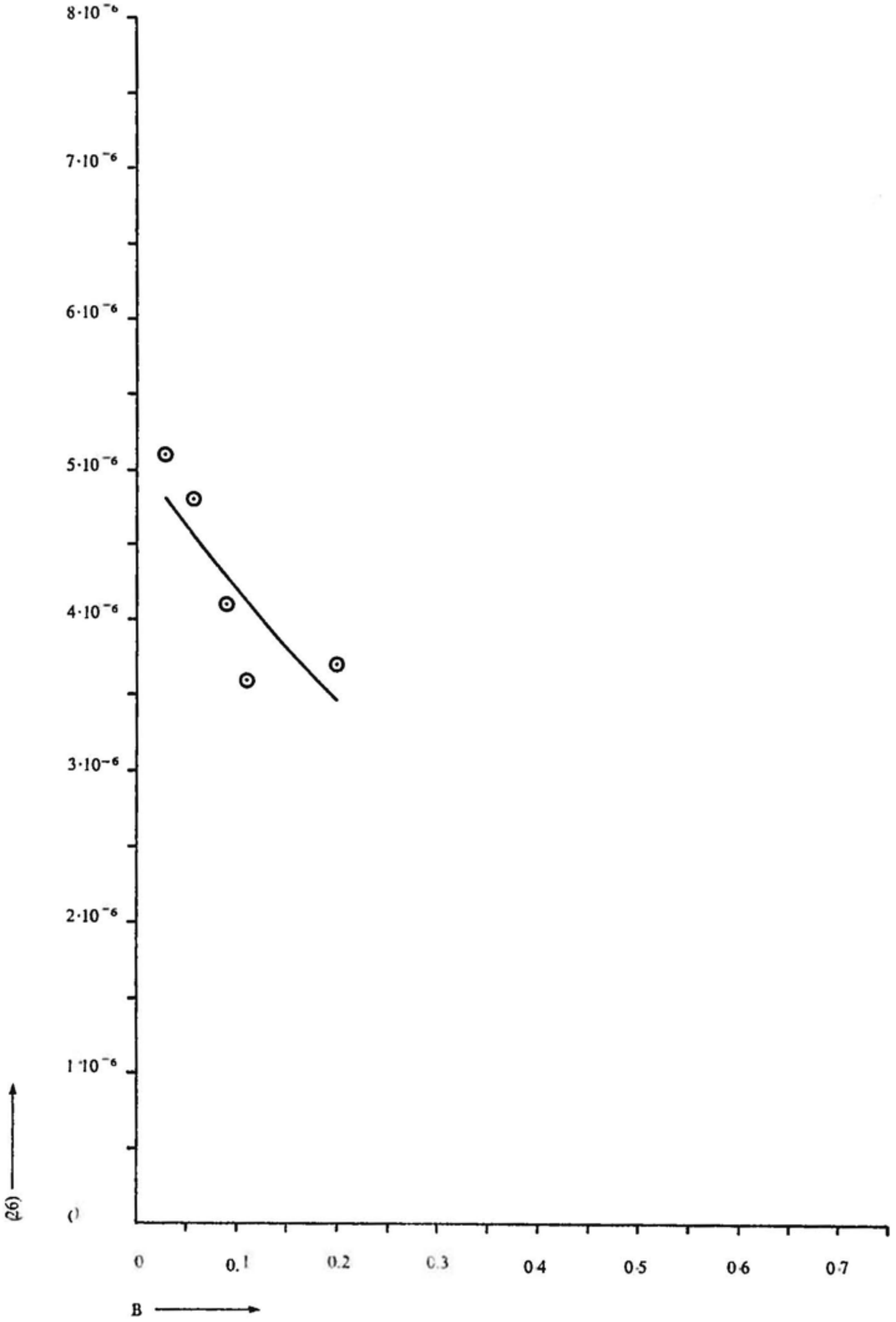

Figure 5. *United Kingdom:* Relationship between the number of zebra crossings per km of road (B) and the relative risk (26).

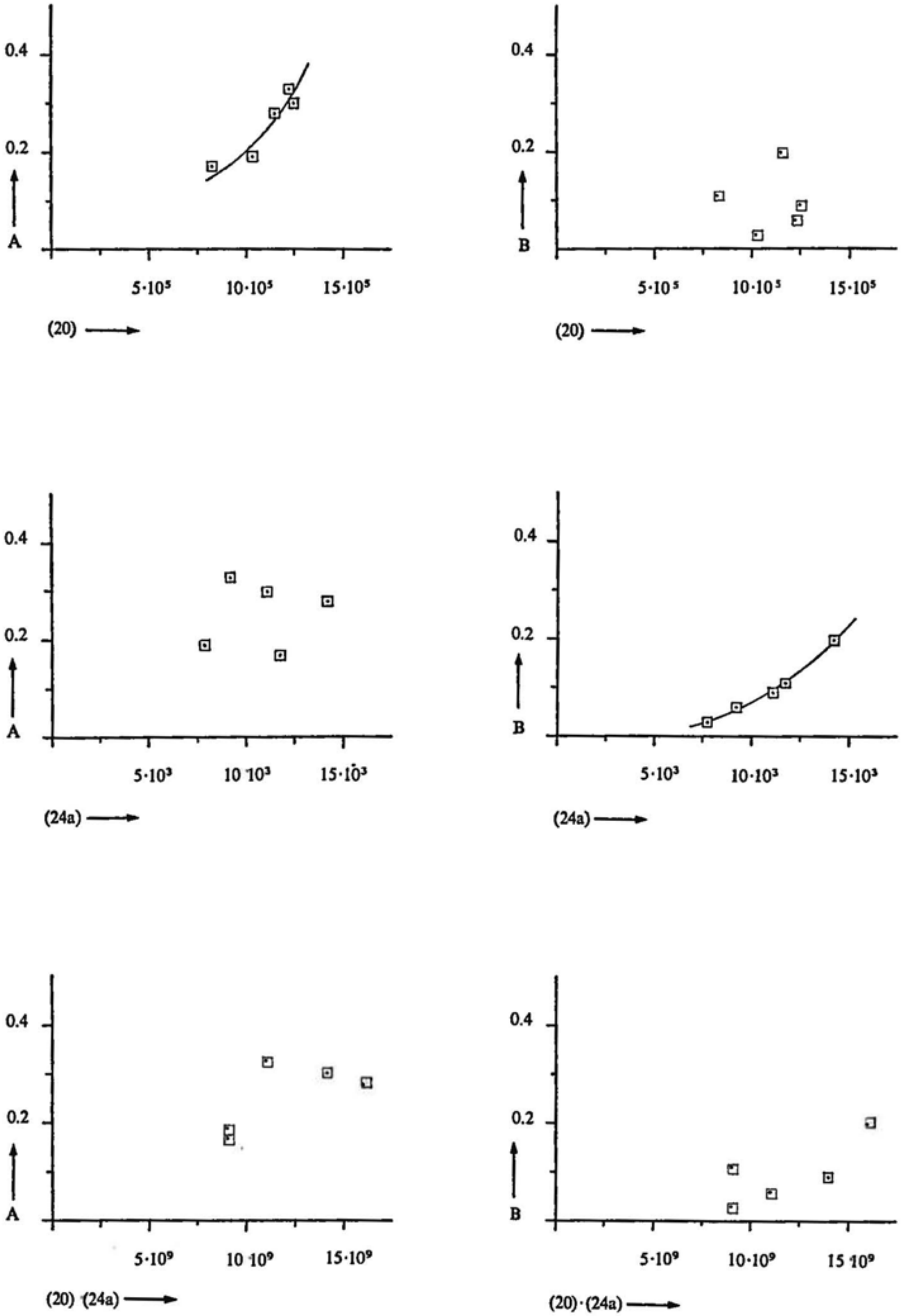

Figure 6. *United Kingdom:* Relationships between the average flow of motor traffic (20) and the average flow of pedestrians crossing per width of a normal crossing (24a), and the numbers of signal controlled crossings etc. (A) and zebra crossings per km of road (B).

5.3. **United States**

A selection of relevant figures from the questionnaires received from eleven American towns is collected in Table 3, page 30.

Some difficulties were encountered in transferring the Dutch meanings of 'area within administrative limits' and 'built-up area' to American conditions. Whereas in most European towns the former area is larger leaving within the administrative limits a rural area which was kept out of the investigation, it appears that the reported American towns all consist of built-up areas, and even have suburbs closely around them, constituting what is called a metropolitan area of sometimes considerable dimensions, fully 'built-up'. Although the research in its original design aimed at complete urban areas, in processing the U.S. data it was necessary to change over to the 'city' of the town, i.e. exclusively the central parts of the metropolitan areas, because these were the only places of which accident figures were known.

Regarding the answers, the impression prevails that one or more sets of figures are not correct. The figure of only 11 accidents involving at least injuries in Des Moines seems to be far too low when compared with the population. As to Albany the number of signal controlled crossings appears too large since this implies that almost every intersection in the whole city area would be signalised.

As already noted in Chapter 4, big differences were found between the results with the method used by the researchers for calculating the number of motor vehicle kilometres driven in built-up areas (17), and figures from specific research (18). This contrasted with the findings in other countries.

Since the presence of zebra crossings was reported from only a few American towns, the study has concentrated on the relationship between the number of signal controlled crossings etc. per km of road, and the relative risk.

Following the same procedure as before, the relationship between the number of signal controlled crossings etc. per km of road and the relative risk (without Albany and Des Moines) yields the parameters $a = -0.5039$ and $b = 4.3913$. The product-moment correlation coefficient $r = -0.8826$ reveals a significant relationship at the 5% level (see Figure 7, page 31).

Question no.	(3)	(5) 10^3	(11)	(12)	(14a)	(17) 10^6	(18) 10^6	(19)	(26) 10^{-6}	(27)	(31)	(32)	A
Houston/Texas	1166	1250	41	819	860	8100	30169	8367	3.3	36	2451	0	0.30
San Francisco/California	127	730	34	1100	1134	4700	3900	1384	1.4	10	3220	0	2.31
Phoenix/Arizona	668	660	23	—	—	4300	12	3556	—	1	1764	1296	0.50
St. Louis/Missouri	159	662	40	1040	1080	4000	17	2003	2.3	16	2260	0	1.15
Seattle/Washington	238	525	21	512	533	3400	2300	2507	2.4	50	1500	180	0.64
Birmingham/Alabama	207	300	11	343	354	1950	—	2574	4.2	7	1860	0	0.73
Dayton/Ohio	99	244	6	—	—	1580	1468	924	—	2	1070	0	1.16
Des Moines/Iowa	168	201	0	11	11	1300	2064	1236	0.2	8	468	20	0.39
Bridgeport/Connecticut	41	157	4	132	136	1020	0.46	461	1.2	—	—	—	—
Greensboro/N. Carolina	154	148	7	125	132	960	5	1154	4.8	5	108	1227	0.10
Albany/New York	49	115	7	261	268	750	1	373	5.2	0	1360	0	3.60

Table 3. *United States:* Summary of figures from the questionnaires and some figure calculated from these.
Question (9) $= 143 \times 10^6$; Question (16) $= 929 \times 10^9$

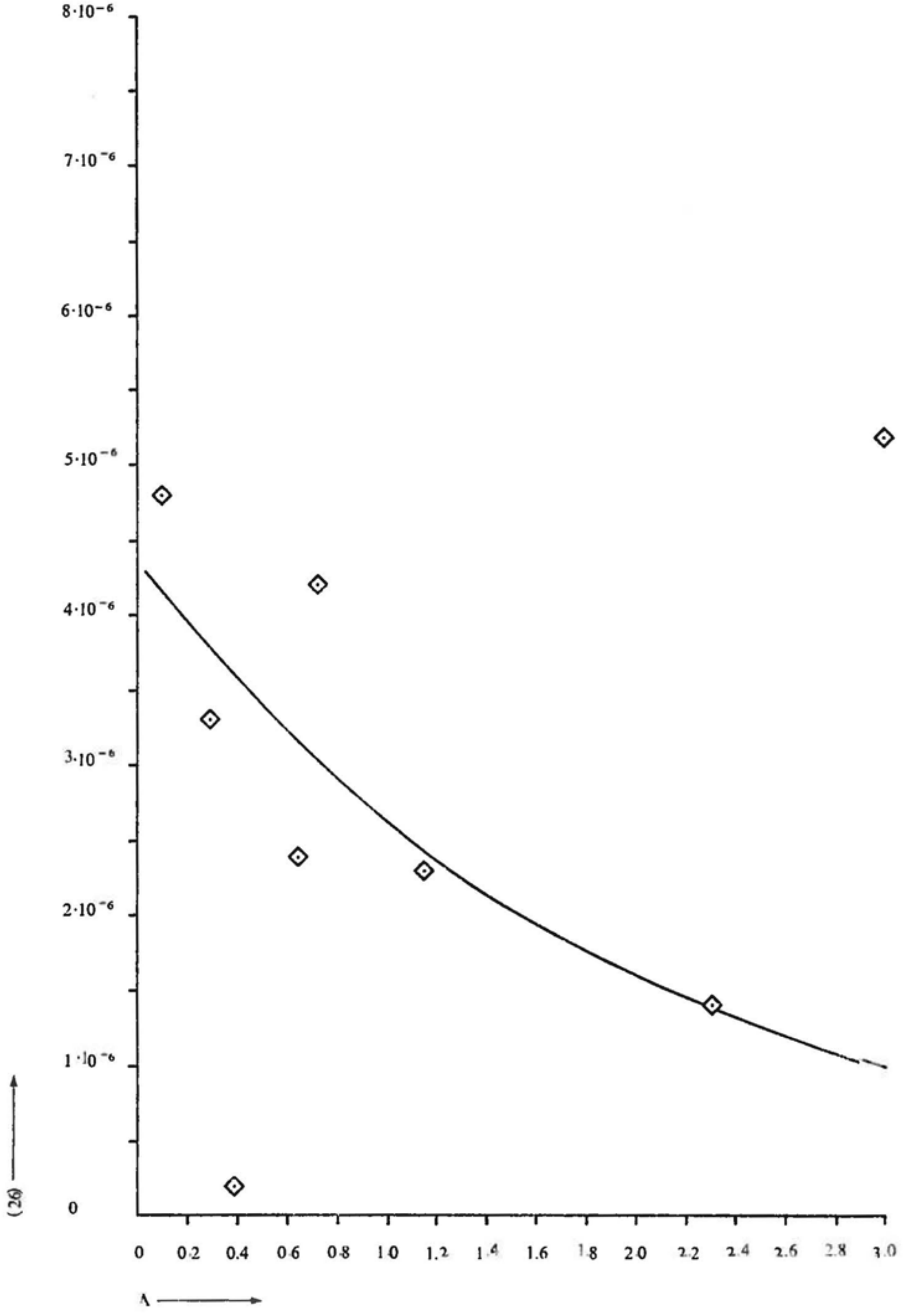

Figure 7. *United States:* Relationship between the numbers of signal controlled crossings etc. per km of road (A) and the relative risk (26).

5.4. Denmark and Sweden

As the data received from Denmark and Sweden cover only three towns each, there is not much point in giving hard and fast rulings concerning these countries on the basis of the relationships found for the separate countries. It is supposed, however, that the traffic characteristics of these countries are similar enough to permit a combined processing. An additional handicap consisted in that of Århus only the old part of the town had been considered instead of the entire built-up area.
The relevant Danish and Swedish figures are combined in Table 4.

The relationship between the number of signal controlled crossings etc. per km of road and the relative risk appears to yield the following parameters: $a = -0.6932$ and $b = 5.3018$. The product-moment correlation coefficient $r = -0.3580$ fails to produce any significant relationship (see Figure 8, page 34).
The relationship between the number of zebra crossings per km of road and the relative risk yields the following parameters: $a = -0.6295$ and $b = 7.0967$. The product-moment correlation coefficient $r = -0.9538$ means that this relationship is found to be significant at the 1% level (see Figure 9, page 35).

Similar to the situation in the United Kingdom, these conditions indicate a relationship which suggests that the relative risk falls according as more zebra crossings are installed. Denmark has for some years been using the 'Copenhagen system' to improve the visibility of zebra crossings and of the pedestrians on them. According to Jørgensen and Rabani (1971) this has reduced the number of night-time accidents involving pedestrians by one third. If this Copenhagen system (using special equipment) has been introduced in the Danish towns concerned, this could account for the relationship found. But for the situation in Sweden no cause can be given for the relationship found.

Question no.	(3)	(5) 10^3	(11)	(12)	(14a)	(17) 10^6	(18) 10^6	(19)	(26) 10^{-6}	(27)	(31)	(32)	A	B
Stockholm/S	165	745	34	386	420	2400	—	1370	1.3	400	650	3350	1.06	2.44
Göteborg/S	125	445	21	296	317	1430	—	850	2.1	139	749	2000	1.21	2.35
Malmö/S	50	253	4	209	213	820	—	500	1.7	33	159	1116	0.45	2.23
Ålborg/DK	58	115	12	132	144	310	—	240	8.0	5	56	40	0.28	0.17
Odense/DK	42	102	5	114	119	270	—	250	6.1	1	265	42	1.07	0.17
Århus*/DK	16	100	5	196	201	290	—	180	3.4	3	135	136	0.78	0.76

Table 4. *Denmark and Sweden:* Summary of figures from the questionnaires and some figures calculated from these.

Denmark: Question (9) = 3×10^6; Question (16) = 8×10^9

Sweden: Question (9) = 6.2×10^6; Question (16) = 20×10^9

*The former town of Århus only

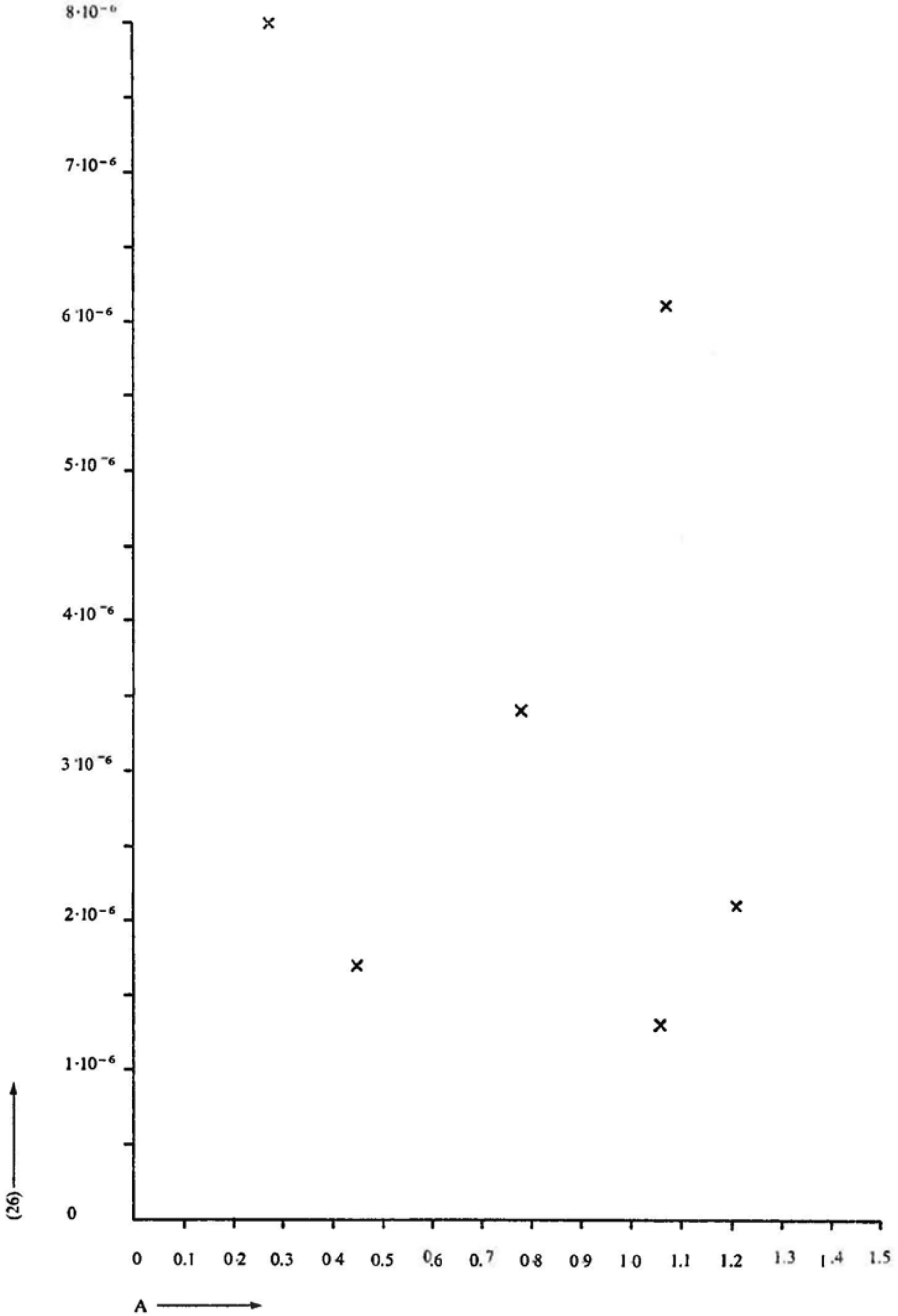

Figure 8. *Denmark and Sweden:* Relationship between the numbers of signal controlled crossings etc. per km of road (A) and the relative risk (26).

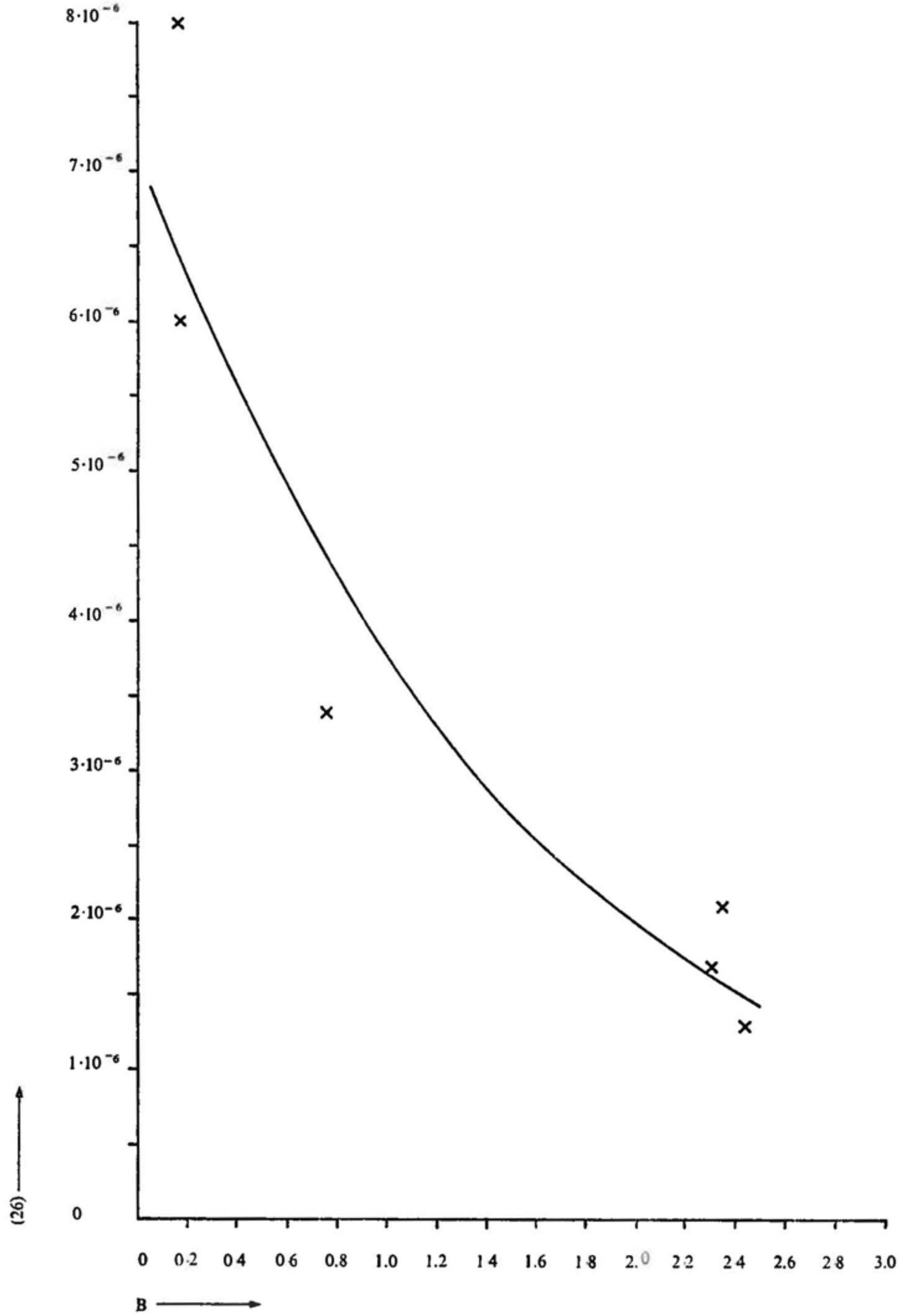

Figure 9. *Denmark and Sweden.* Relationship between the numbers of zebra crossings per km of road (B) and the relative risk (26).

5.5. Spain

Spain is one of the countries which could not answer question (17) in the assumed manner, because the answers to questions (9) and (16) were not available. The description of question (17) of the questionnaire shows that answers (9) and (16) are actually used as a quotient (16) : (9), thus forming a (national) measure of the average amount of traffic in the built-up areas, expressed as motor vehicle kilometres per inhabitant per year. If, because the necessary data are not available, any arbitrary value is chosen for this quotient, the towns within one country concerned can yet be compared with each other. For reasons of easy computation the arbitrary value of $33.8 \cdot 10^3$ was chosen.

A summary of the relevant figures from the completed questionnaires of the nine Spanish towns is given in Table 5. In all of these towns a distinction could be made between the built-up and non built-up areas by means of urbanistic photogrammetric studies.

According to the used statistical method the relationship between the number of signal controlled crossings etc. per km of road, and the relative risk is such that the parameters found are: $a = -0.0789$ and $b = 0.0478$, which yields a product-moment correlation coefficient $r = -0.0488$. This relation is not significant (see Figure 10, page 38).

The relationship between the number of zebra crossings per km of road and the relative risk produces the parameters $a = 0.3918$ and $b = 0.0357$, resulting in a product-moment correlation coefficient $r = 0.4572$, which indicates no significance (see Figure 11, page 39).

Question no.	(3)	(5) 10^3	(11)	(12)	(14a)	(19)	(26)* 10^{-6}	(27)	(31)	(32)	A	B
Barcelona	60	1776	36	2819	2855	1000	0.054	17	1700	57	1.73	0.06
Bilbao	25	413	16	777	793	206	0.116	2	99	156	0.48	0.75
Malaga	17	374	7	95	102	220	0.012	2	116	45	0.54	0.20
Valladolid	14	247	7	139	146	150	0.033	5	85	21	0.63	0.14
Vigo	10	212	10	106	116	92	0.026	0	60	17	0.65	0.18
Pamplona	9	153	7	152	159	76	0.061	0	39	39	0.51	0.51
Vitoria	6	141	4	136	140	91	0.042	2	74	112	0.85	1.23
Salamanca	7	126	4	124	128	62	0.056	0	25	0	0.40	0
Burgos	10	119	11	112	123	70	0.087	0	26	170	0.37	2.43

Table 5. *Spain:* Summary of figures from the questionnaires and some figures calculated from these.

The questions (9) and (16) could not be answered.

*Since in the computation an arbitrary value for the quotient (16) : (9) had to be introduced, these figures have no real meaning.

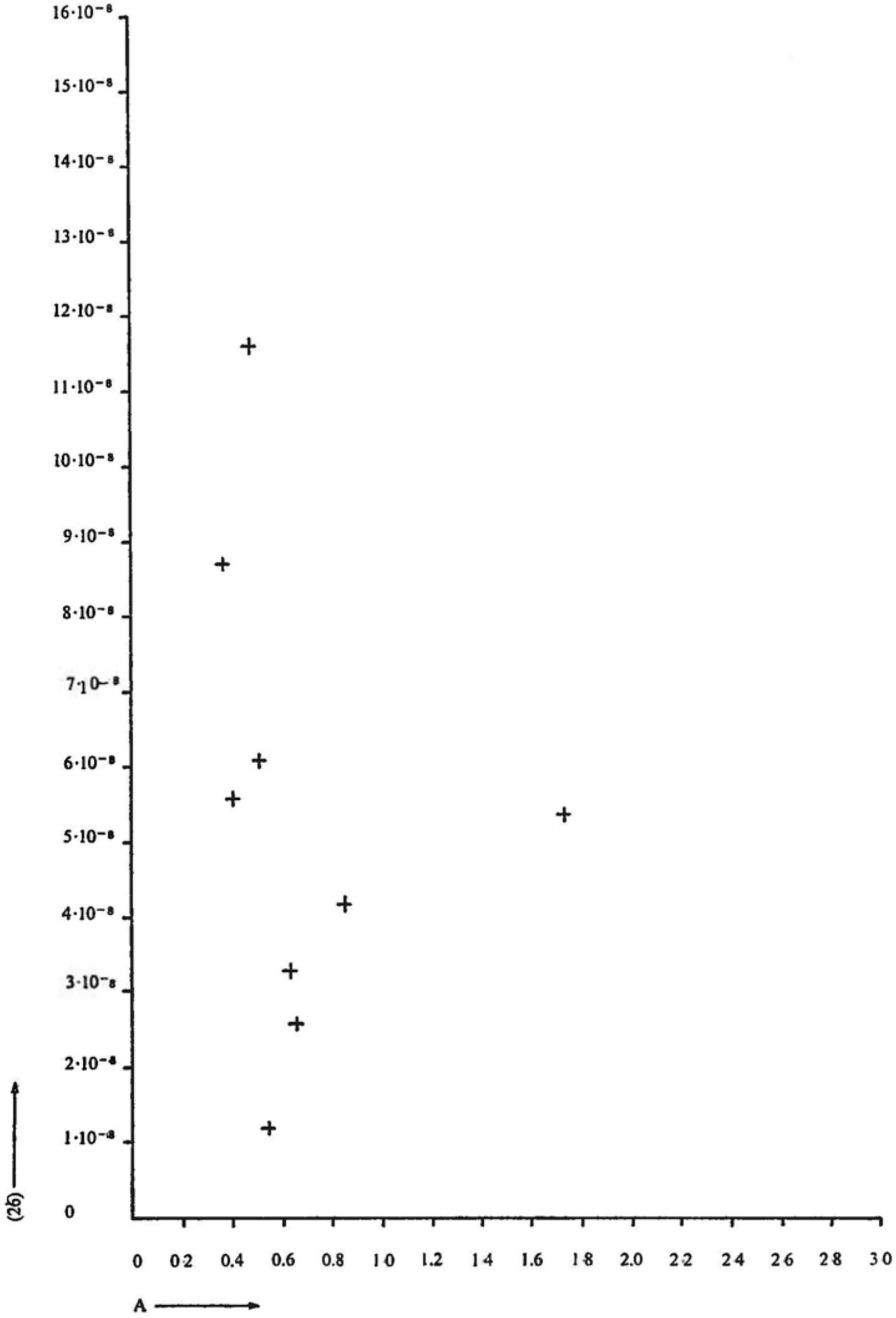

Figure 10. *Spain:* Relationship between the numbers of signal controlled crossings etc. per km of road (A) and the relative risk (26).

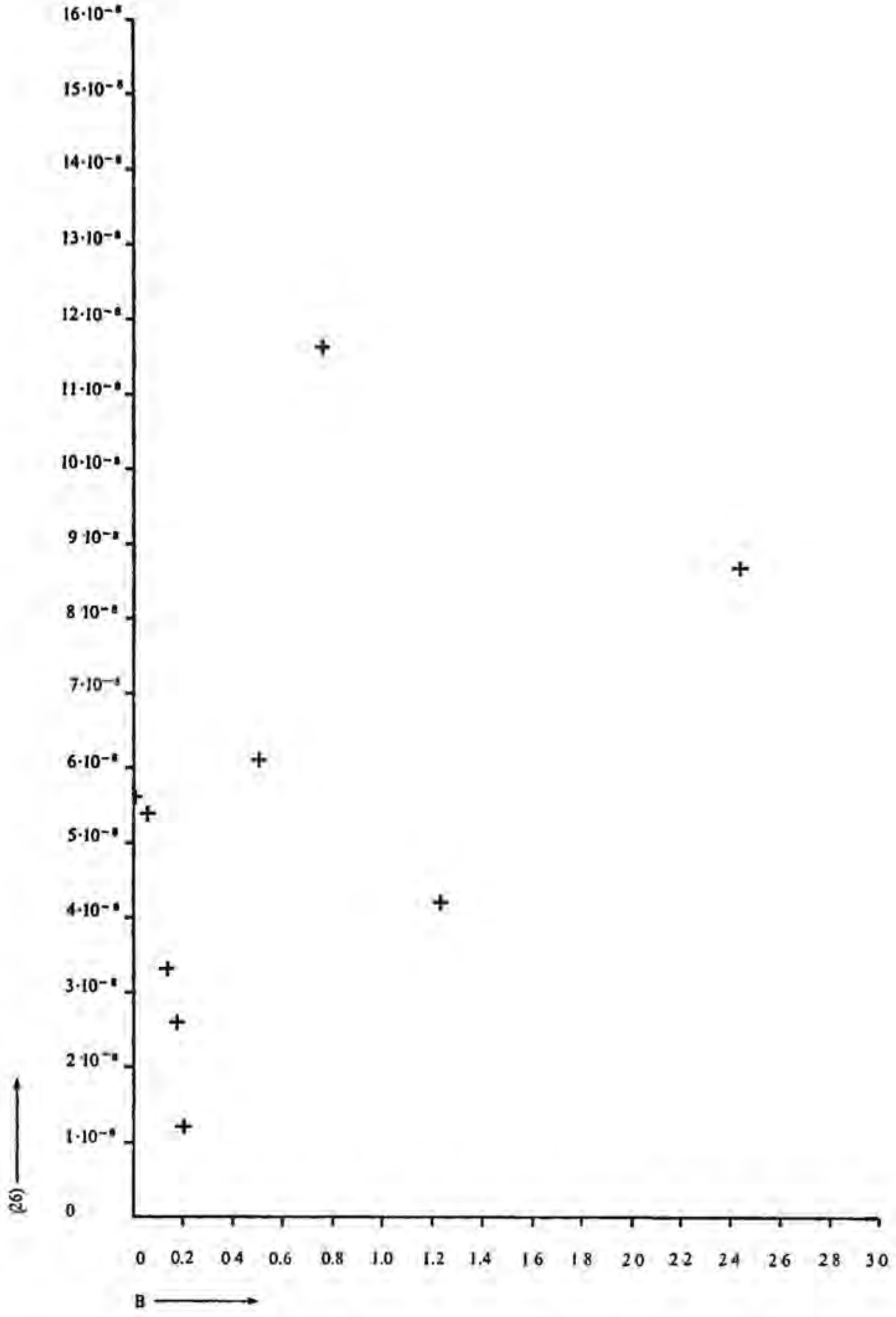

Figure 11. *Spain.* Relationship between the numbers of zebra crossings per km of road (B) and the relative risk (26).

5.6. Germany (and Vienna)

Since for Germany, as for Spain, no answers to questions (9) and (16) could be obtained, again the arbitrary value of $33.8 \cdot 10^3$ has been chosen for the quotient, to be able to compare the towns within this country with each other. There would even be no objection to taking a town in another country into consideration as well, provided the traffic situation matches sufficiently. As the researchers held the view that for Vienna the last-mentioned condition was met when compared with German towns, and since no other Austrian towns were able to supply the required data, Vienna was considered in conjunction with the German towns.
A review of the relevant German figures, together with those for Vienna, is shown in Table 6.

According to the consistently used statistical method the relationship between the number of signal controlled crossings etc. per km of road and the relative risk is such that the parameters are $a = -2.0939$ and $b = 2.1966$, which yields a product-moment correlation coefficient $r = -0.7878$. This relationship is significant at the 10% level (see Figure 12, page 42). In the calculation Heidelberg was disregarded because there existed justifiable doubt as to the reliability of the accident figures received.
The relationship between the number of zebra crossings per km of road and the relative risk produces the parameters $a = 2.3128$ and $b = 0.3193$, resulting in a product-moment correlation coefficient $r = 0.4765$, which indicates no significance (see Figure 13, page 43).

Question no.	(3)	(5) 10^3	(11)	(12)	(14a)	(19)	(26)* 10^{-6}	(27)	(31)	(32)	A	B
Wien/A	368	1615	114	2876	2990	2423	0.42	22	2024	500	0.86	0.21
Darmstadt/D	29	142	18	211	229	251	0.33	0	272	25	1.08	0.10
Recklinghausen/D	16	126	16	161	177	279	0.18	0	236	68	0.85	0.24
Heidelberg/D	15	123	1	18	19	326	0.02	9	101	21	0.37	0.06
Wiesbaden/D	37	122	19	464	483	578	1.20	5	270	72	0.48	0.12
Würzburg/D	24	115	12	298	310	407	0.56	13	134	70	0.39	0.17
Trier/D	58	85	9	191	200	250	1.61	9	61	139	0.32	0.56

Table 6. *Germany* (*and Vienna*): Summary of figures from the questionnaires and some figures calculated from these.
The questions (9) and (16) could not be answered.
*See note Table 5.

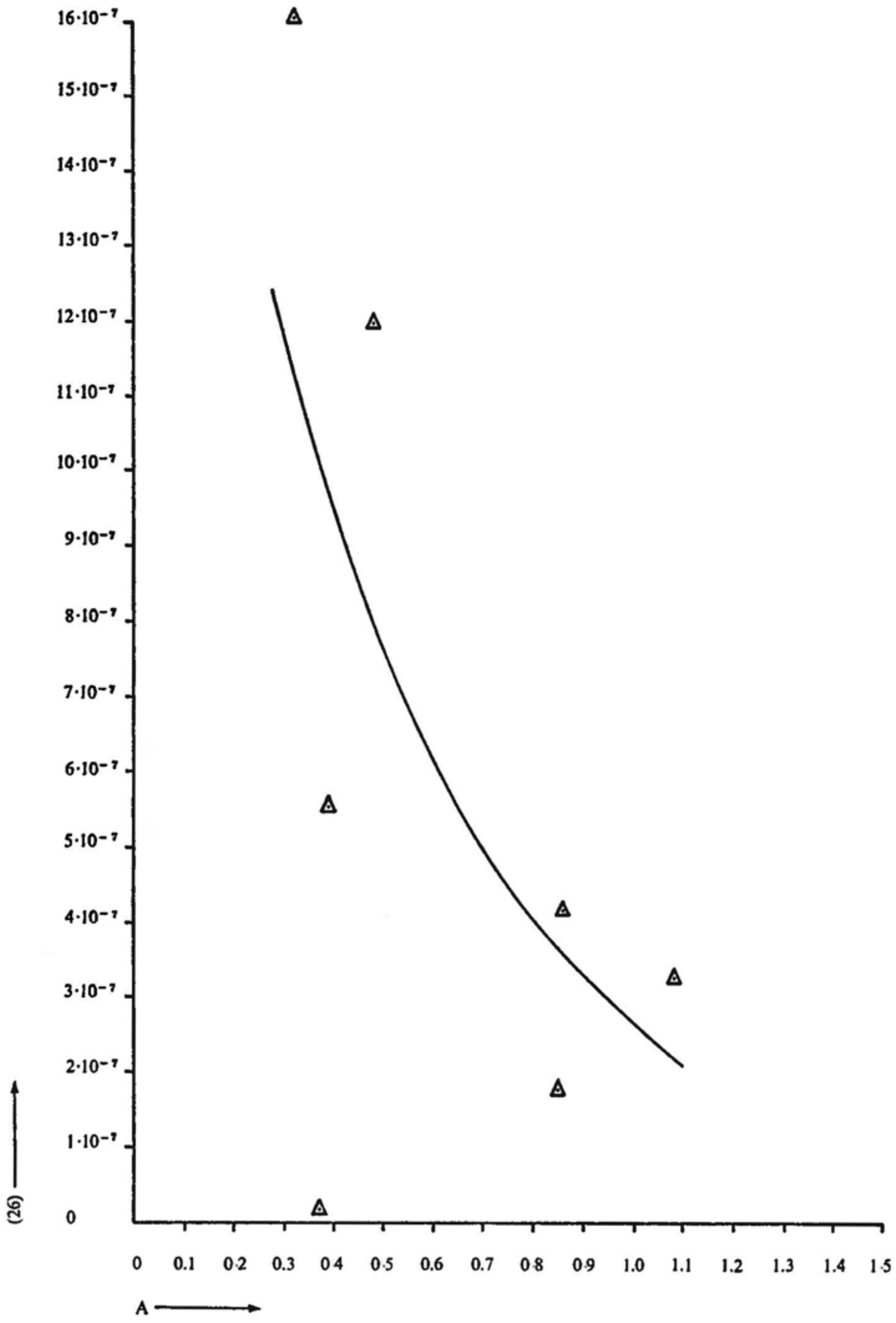

Figure 12. *Germany (and Vienna)*: Relationship between the numbers of signal controlled crossings etc. per km of road (A) and the relative risk (26).

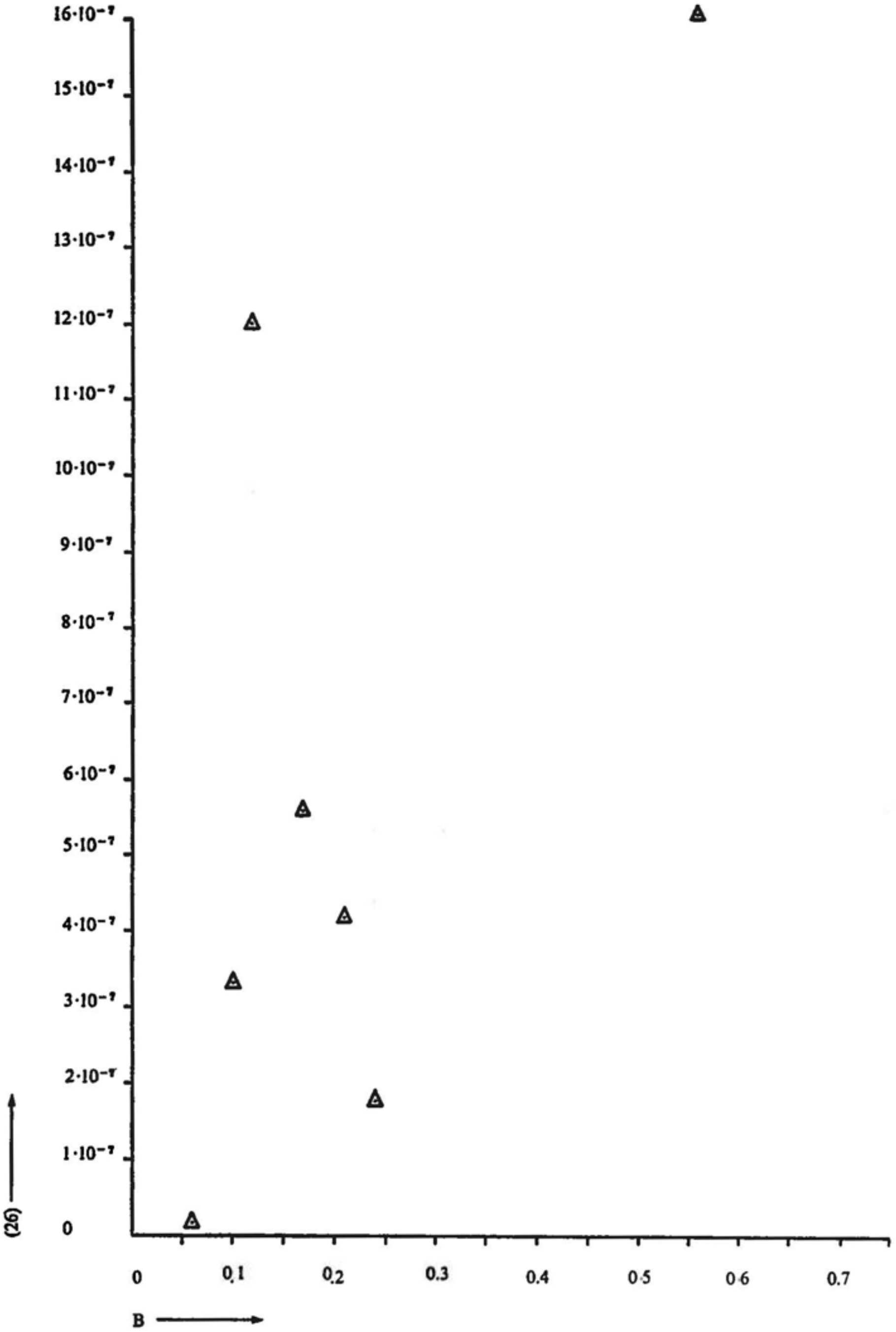

Figure 13. *Germany (and Vienna)*: Relationship between the numbers of zebra crossings per km of road (B) and the relative risk (26).

6. Discussion

As already indicated in the previous chapters, relationships between the number of crossing facilities (per km of road) and the relative risk could be demonstrated in some, not in all cases. With the use of significance calculations one may at least conclude to the existance of a relationship between:

1. The numbers of signal controlled and grade separated crossings per km of road, and the relative risk for the Dutch towns (1 % level), the American towns (5 % level) and the German towns (10 % level); in all countries studied, except the United Kingdom, the product-moment correlation is negative.
2. The number of zebra crossings per km of road, and the relative risk for the combination of Danish and Swedish towns (1 % level) and the English towns (10 % level).

The data are summarised in Table 7. But it should be noted that for various reasons some reserve must be made regarding the correlations found for the United States and Germany (signal controlled crossings) and for Denmark and Sweden (zebra crossings).

The circumstance that in this study, which was conducted by Dutch researchers, the Dutch figures happen to display the best correlation, can be explained by the following aspects:

a. In drawing up the study design and the questionnaire the Dutch situation has involuntarily been taken for a basis.
b. The closer contact made it possible to gather information about more towns in the Netherlands than in any other country.
c. The same cause was responsible for more accurate verification of the information.

The most striking feature is that in the Dutch towns the number of signal controlled crossings rather than the number of zebra crossings correlates with the relative risk while the situation in the United Kingdom is quite the reverse. There are several causes which can account for this phenomenon.

1. The two countries differ as regards design of crossings, both controlled and zebra ones. Signal controlled crossings in the United Kingdom are nowhere provided with zebra markings. In the Netherlands they usually are. Dutch zebra crossings within built-up areas never have lighted beacons, whereas English crossings are equipped with these.
2. The rules governing the two types of crossings differ. As mentioned before, crossing against a red pedestrian signal is allowed in the United Kingdom, but not in the Netherlands.
3. There are also differences as regards the location of the crossings. There are many cases in the United Kingdom of zebra crossings being situated half-way between intersections. This is rare in the Netherlands.
4. In this context, a very remarkable fact is the difference in policy with regard to the installation of crossings. In extreme terms, it might be said that in the United Kingdom

Country	Signal controlled crossings etc. a-param.	b-param.	Pearsons r_{xlny}	Level of significance
The Netherlands	−2.4369	5.5527	−0.8385	1%
United Kingdom	0.3178	3.8919	0.0484	—
U.S.A.	−0.5039	4.3913	−0.8826	5%
Spain	−0.0789	0.0478	−0.0488	—
Denmark - Sweden	−0.6932	5.3018	−0.3580	—
Germany (& Vienna)	−2.0939	2.1966	−0.7878	10%

Country	Zebra crossings a-param.	b-param.	Pearsons r_{xlny}	Level of significance
The Netherlands	0.0282	3.0082	0.0268	—
United Kingdom	−1.9702	5.1535	−0.8220	10%
U.S.A.	—	—	—	—
Spain	0.3918	0.0357	0.4572	—
Denmark - Sweden	−0.6295	7.0967	−0.9583	1%
Germany (& Vienna)	2.3128	0.3193	0.4765	—

Table 7. Survey of the found parameters, product-moment correlation coefficients and levels of significance.

zebra crossings are installed where in the Netherlands it would have been signal controlled crossings, and vice versa.
5. As to the details of controls, it should be noted that a green pedestrian light in the United Kingdom means there is no vehicular traffic on the crossing. In the Netherlands there may be turning traffic.
6. As contrasted with the situation in the United Kingdom, the lights of most signal controlled crossings in the Netherlands are switched off at night, with the result that during those hours the crossings no longer function as signal controlled ones but either as zebra crossings if they are marked accordingly, or not at all as a specific crossing.
7. Furthermore, the possibility should not be precluded that differences in character between the inhabitants of the two countries may be responsible for a particular type of crossing to be a greater or smaller success.

Although each of the above seven points may have contributed to the difference between Dutch and English results, it is impossible to determine exactly the workings of cause and effect in all cases.

As a general note to the differences and gradations in the various relationships it might be repeated that perhaps the situation of pedestrian facilities rather than their number is important for the pedestrian's safety. The present study has not covered this aspect in greater detail, but a partial study (which is more difficult to realise) can probably give better insight into this aspect.

Figure 14 shows the significant relationships of the various countries together. Germany has not been included because the calculations for this country differed from those for the others. It is remarkable that the relationships all show the same trend, but also that they are at different levels.

Finally a remark concerning the measure of the relative risk for pedestrians. A Swedish report (Chalmers Tekniska Högskola, 1967) recommends to take the frequency of pedestrian accidents per 1000 inhabitants in every area considered as a basis for measures. In this present investigation, however, when one figures out the formula used, it appears that as a measure of the relative risk for pedestrians the frequency of pedestrian accidents per 1000 inhabitants *divided by the density of population* is taken.

When comparing the Swedish method with the Dutch method it turns out that a relationship found by using the Dutch method disappears completely when taking the Swedish method. Also the other way round: when there is no relationship with the Dutch method there is no relationship with the Swedish method either. This is a strong indication that the density of population should be taken into account in measuring the relative risk for pedestrians.

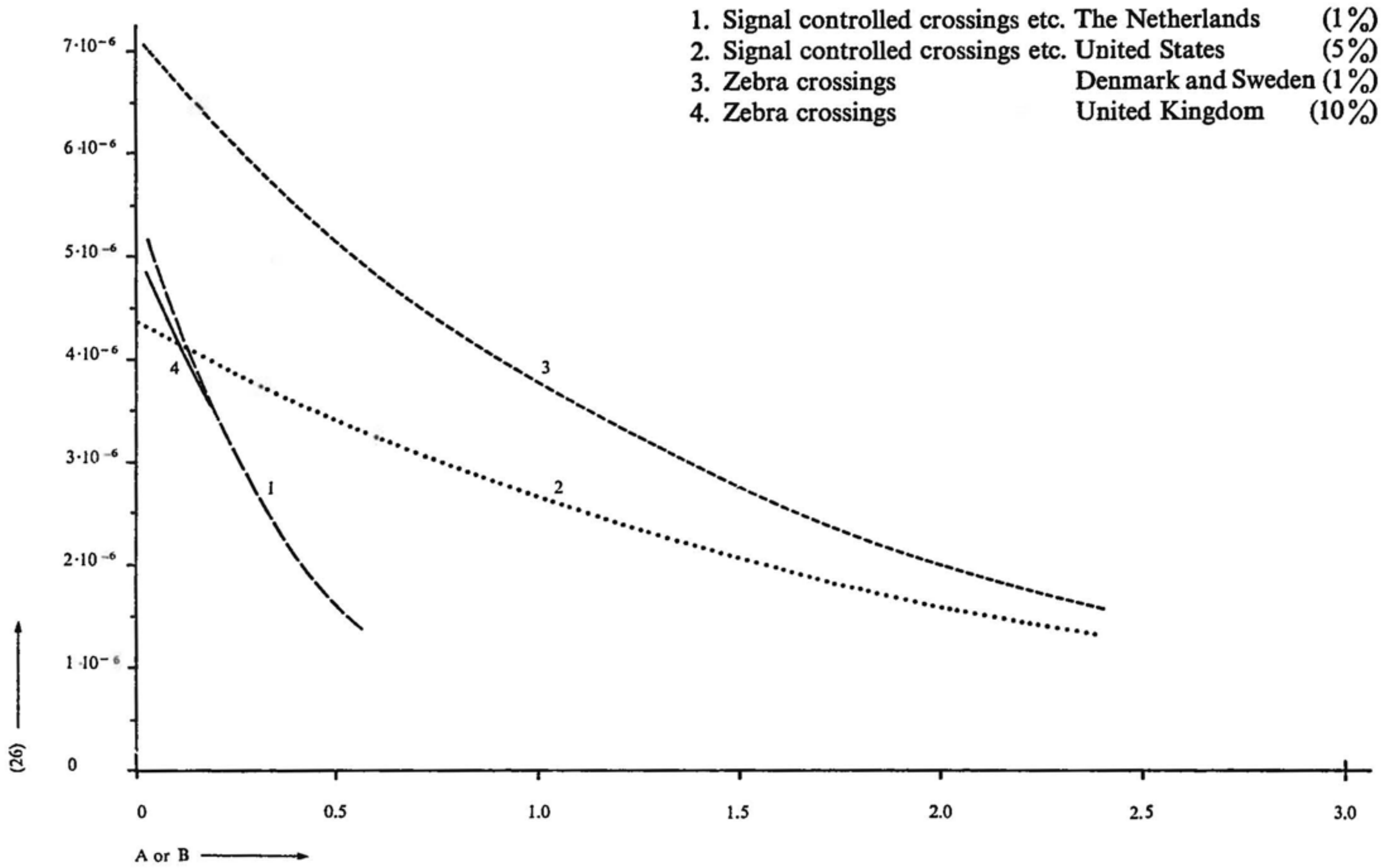

Figure 14. Graphs for the relationships found.

7. Literature

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Appendices I-III

Appendix I

Calculation of the number of potential collisions and of the relative risk

There is a lot of confusion about the question of how the degrees of safety of pedestrian crossings must, or can, be expressed in relation to one another or as a function of time. The following can be stated on this subject.

If pedestrians were to cross the road as if there were no vehicular traffic, and if vehicles were to drive as if there were no pedestrians crossing, a certain number of collisions could be expected on a certain road within a certain period of time.

The number of actual collisions between both categories of road-users will be a fraction of that number, because both drivers and pedestrians, under normal circumstances, avoid collisions by correcting their respective speeds or, to a lesser extent, their course. In other words: by allowing their actual behaviour to be partly influenced by the presence of the other category of road-user, their speed and course are modified in such a way that conflicts are avoided as much as possible.

On a road without special facilities for crossing pedestrians, the biggest contribution in this respect will have to come from the pedestrian. He waits on the kerb until he thinks he can cross safely (correction of speed), or he walks further along the pavement until no more vehicles are approaching and then crosses (changing course). In these cases the vehicles are hardly affected. On the contrary, at a busy zebra crossing protected by regulations, it may happen that pedestrians continue walking (especially those who arrive at a moment when other pedestrians are already on the crossing), whilst the vehicles stand still in front of the zebra crossing.

In a great many situations, however, a certain adaptation of behaviour is expected from both categories of road-users. The more successful this mutual consideration the smaller becomes the fraction of actual collisions compared with the number that would have been likely without this adaptation. This last number (or at least the average chance of a collision occurring) can be determined with the aid of the calculation of probabilities, provided several simplified assumptions are used as a basis.

Consider an imaginary crossing with the width 1 of an average pedestrian, on a road with the width D of an average vehicle (see Figure I.1).

On this crossing there will be a certain collision when either pedestrian or vehicle enters the (hatched) crossing area when the other is already wholly or partially on it (N.B.: Normal pedestrian crossings are wider and longer than assumed here; that is why the above statement does not apply to them; see below, however).

It is assumed that both vehicle and pedestrian *whilst passing over the pedestrian crossing* are moving at the constant speeds of V and v respectively. The time during which the vehicle will be wholly or partially on the crossing is:

$$T = \frac{L + 1}{V}$$

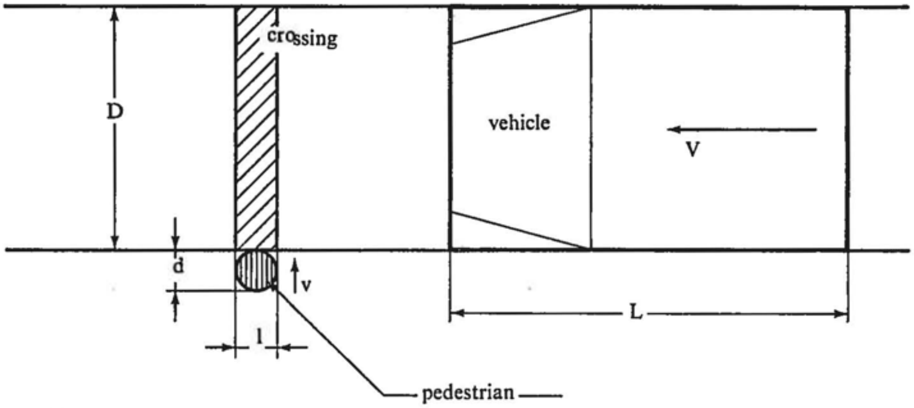


figure I.1.

The time during which the pedestrian will be wholly or partially on the crossing is:

$$t = \frac{D + d}{v}$$

Generally speaking, $t > T$.

Suppose that the vehicular flow is I (vehicles per sec per road width D), the pedestrian flow is i (pedestrian per sec per width 1 of the crossing), and assume provisionally that I and i do not vary in time and that the intervals between two vehicles and between two pedestrians are constant.

A collision will then occur, and only then, when a vehicle *enters* the crossing area at any moment in the period $(T + t)$, i.e. the chance of a collision is present during $(T + t)$ sec. Since i pedestrians cross over per sec, this hazardous period occurs i times per sec, and the total duration of these hazardous periods equals $(T + t)\,i \times 100\,\%$ of the total time. Since I vehicles are also passing per sec, the average number of potential collisions per sec on this crossing will amount to:

$$P = (T + t)\,Ii = \left(\frac{L + 1}{V} + \frac{D + d}{v}\right) Ii$$

The product Ii is termed the traffic moment.

Analytically and logically, it can be demonstrated that the formula holds true unchanged for crossings with larger length and width dimensions, provided the flows are given per total roadway width and per crossing width. The dimensions of the crossing do *not* therefore influence the probability of collision.

It is even possible to consider the entire road network of a town (or at least the roadways) as one gigantic pedestrian crossing. In that case the best value that can be filled in for I is the average vehicular flow on all roads in the relevant town.

The 'width' of the pedestrian crossing is in that instance equal to the total length of the road network, which means that i has to be represented by the total number of pedestrians crossing roads throughout the town per sec.

The number of actual accidents in the period of time under consideration can be written as:
$W = c.P = c\,(T + t)\,Ii.$

$0 < c < 1$ forms a factor which is, in principle, without dimension and which expresses the extent to which collisions are reduced through the joint efforts of pedestrians and drivers. Apparently this reduction factor can be expressed:

$$c = \frac{W}{(T + t)\,Ii}$$

It will be referred to as the relative risk.

In assessing the relative risk whether it is related to one crossing or to a whole town, the number of accidents will therefore have to be related to the respective *flows of vehicular and pedestrian traffic* as well as to the factor $(T + t)$.

The value of c can be calculated theoretically for every pedestrian crossing, provided that the quantities in the right-hand term are known. It is found that c varies from crossing to crossing and also that different values of c are found for the same crossing according to the period under consideration. A great influence is attributable here to chance because, particularly in the case of the number of actual accidents (W), extremely low figures are of course involved.
However, if the values of c in different cases vary by some orders of magnitude, there is every reason for investigation whether these differences can be further explained. The most likely factors which may affect c are: the type of pedestrian crossing, viz. zebra crossings, signal controlled crossings or 'elsewhere'; in addition, one or more extra characteristics which may vary within one type (prior warning, location, lighting) and, once again, the flows of vehicular and pedestrian traffic.
In this investigation the factor c serves as a criterion for the relative risk of a whole town, insofar as pedestrians crossing roads are concerned.

As to the factor of $(T + t) = \left(\frac{L + l}{V} + \frac{D + d}{v}\right)$, approximate use can be made of the following values:
$L = 4.5$ m $\quad l = 0.5$ m
$D = 2$ m $\quad d = 0.5$ m
$V = 10$ m/sec $\quad v = 1.25$ m/sec
whence: $(T + t) = 2.5$ sec.
In the report $(T + t)$ has been replaced by T_0. The value of 2.5 sec has been introduced for this.

Thus far, constant flows of vehicular and pedestrian traffic and, moreover, constant intervals have been assumed. In reality both types of traffic always show considerable fluctuations in flow during the course of the day. Also the intervals are not equal even during periods of constant flow, but reveal a distribution which can sometimes, but not always, be described satisfactorily by one of the distributions known from the calculation of probabilities.

Here it is extremely difficult to indicate the extent to which the length of an interval at a certain moment must be considered as being determined by the predominant flow, or either by the irregular distribution.

In view of this, the formula for c can be rewritten as:

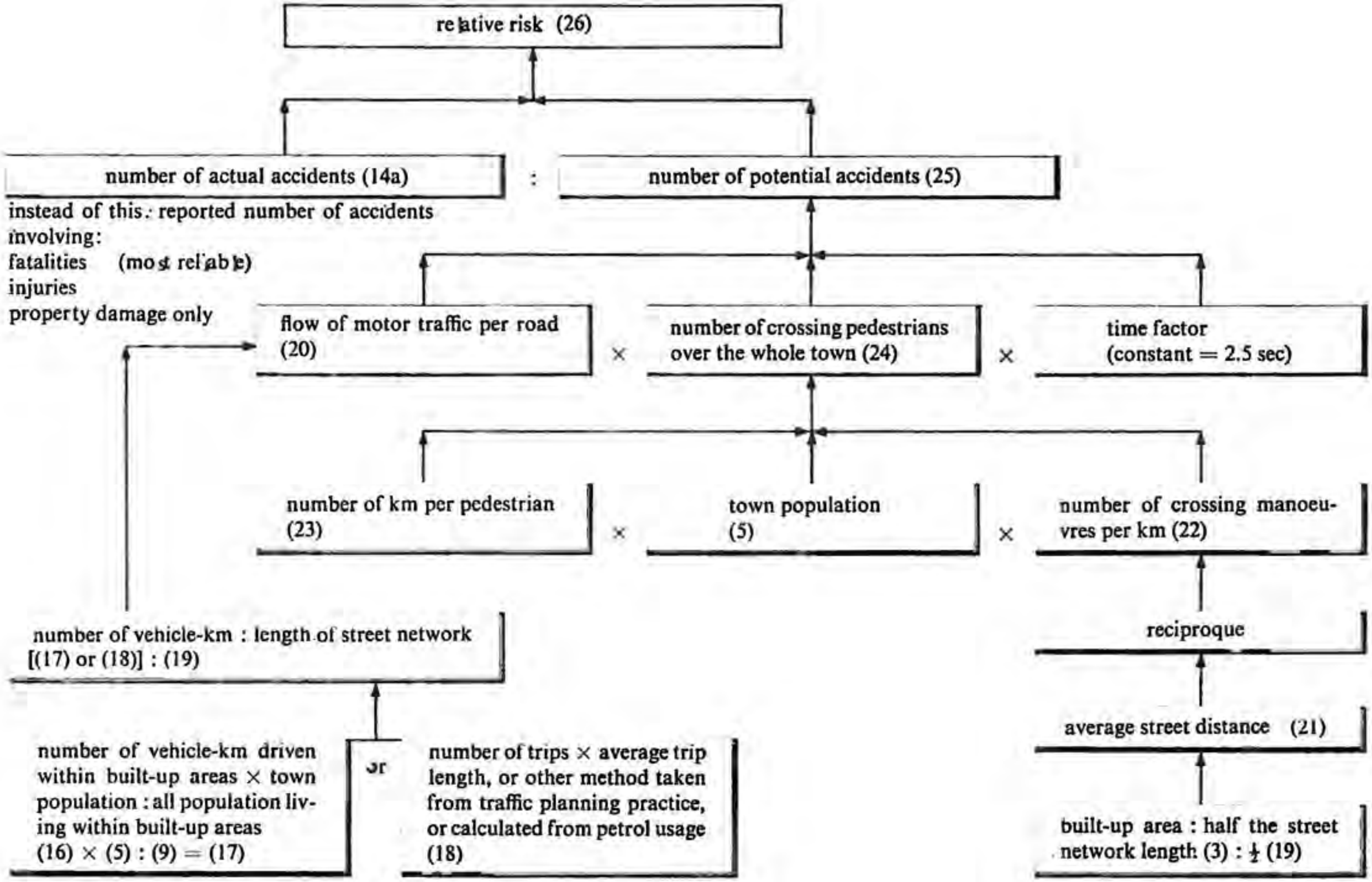
$$c = \frac{W}{T_o \, (Ii)_{eff}}$$

in which $(Ii)_{eff} = p.Ii$, or in words: the effective traffic moment is equal to a factor p times the product of the average flows of both types of traffic. The bigger the fluctuations in the flows and/or the more irregular the distribution of the intervals, the bigger the value of the factor p. It must be investigated to what extent a constant could be introduced for p in practical calculations, but this has not been further elaborated.

Appendix II

Scheme for the calculation of the relative risk

Unless otherwise stated all data apply to the built-up area of the town considered. Most data are per time unit. Figures between brackets correspond with those of the questions in the questionnaire (Appendix III).


relative risk (26)
number of actual accidents (14a)
:
number of potential accidents (25)
instead of this: reported number of accidents involving:
fatalities (most reliable)
injuries
property damage only
flow of motor traffic per road (20)
×
number of crossing pedestrians over the whole town (24)
×
time factor (constant = 2.5 sec)
number of km per pedestrian (23)
×
town population (5)
×
number of crossing manoeuvres per km (22)
reciproque
average street distance (21)
built-up area : half the street network length (3) : ½ (19)
number of vehicle-km : length of street network [(17) or (18)] : (19)
number of vehicle-km driven within built-up areas × town population : all population living within built-up areas (16) × (5) : (9) = (17)
or
number of trips × average trip length, or other method taken from traffic planning practice, or calculated from petrol usage (18)

Appendix III

Questionnaire

During the investigation several versions of this questionnaire have been used. This version is the most complete one.

Unless otherwise stated, figures should apply to the *built-up area* of the town only.

Name of the town (see note 1)		(1)
Town area within administrative limits	km²	(2)
Built-up area (see note 2)	km²	(3)
How is the built-up area defined?		(3a)
Number of inhabitants within the administrative limits		(4)
Number of inhabitants within the built-up area		(5)
Is there a *general* speed limit in the built-up area? If yes, which?	km/h	(6)
Name of the country		(7)
Number of inhabitants in the whole country		(8)
Number of inhabitants within built-up areas only		(9)
Year to which data apply (see note 3)		(10)
Reported number of vehicle vs. pedestrian accidents within the built-up area, involving fatality (see note 4)	/year	(11)
Ditto involving injury but no fatality (see note 5)	/year	(12)
Ditto involving property damage only	/year	(13)
Total number of reported vehicle vs. pedestrian accidents within the built-up area: (11) + (12) + (13)	/year	(14)
Modified number of reported accidents (in order to make data comparable; the modification will depend on registration level and will be carried out by researchers)		(14a)
Total number of motor vehicle kilometres (mopeds excepted) driven within the whole country	km/year	(15)
Total number of motor vehicle kilometres (mopeds excepted) driven within built-up areas only	km/year	(16)
Approximate calculation of the number of motor vehicle kilometres driven within the built-up area of the town [(5):(9)] × (16)	km/year	(17)
Any other possible estimation of the number of motor vehicle kilometres driven within the built-up area of the town, with a brief indication of the method used (p.e. gravity model for trip generation, petrol usage)	km/year	(18)
Total length of street network within the built-up area of the town	km	(19)
Average flow of motor traffic per road [(17) or (18)] : (19)	veh/year	(20)
Average street distance [2 × (3)] : (19)	km	(21)
Average number of crossing manoeuvres per km straight walk 1 : (21)	/km	(22)

Estimation of the average number of kilometres a town inhabitant walks within built-up areas; with a brief indication of the method of calculating this figure	km/year	(23)
Average number of crossing pedestrians in the built-up area (22) × (23) × (5)	/year	(24)
Number of potential accidents (20) × (24) × 2.5:[3600 × 24 × 365]	/year	(25)
Relative risk (14a) : (25)		(26)
Number of bridges and subways, especially built to be used by pedestrians to cross motor vehicles at a different level, within the built-up area (see note 6)		(27)
Number of signal controlled pedestrian crossings within the built-up area with full-time control (see note 7)		(28)
Ditto with day-time control only		(29)
Ditto with rush-hour control only		(30)
Total number of signal controlled crossings within the built-up area (28) + (29) + (30)		(31)
Number of zebra crossings without further control, within the built-up area		(32)

Notes

1. Delegates are requested to answer a separate questionnaire for each town of over 100,000 inhabitants of which sufficient data are available.
2. In the Netherlands and in a number of other countries every municipality has been divided into a built-up area (the town or the village itself) and a non built-up area (the rural surroundings up to the administrative limits). The built-up areas are determined by the Provincial governments. The entering and leaving of a built-up area is made known to the road user by signs. Some municipalities include more than one built-up area. There are municipalities with a very large non built-up area; others have none. The distinction between the built-up and non built-up areas is maintained through all relevant statistics such as those about population and traffic accidents. This enables the drawing of separate conclusions applying to built-up and non built-up areas respectively. As this research project deals with pedestrian safety in towns, the figures will apply only to the built-up areas. Delegates of countries where no such distinction is made, can skip questions (3), (3a), (5), (9) and (16) and read 'administrative limits' where in other questions is written 'built-up area'. As to question (17) the formula in that case is to be read: [(4) : (8)] × (15).

Nevertheless a brief indication of the extent of the built-up area in relation to the total area within the administrative limits will for each case be appreciated.

3. Figures on one questionnaire should apply to the same year, i.e. the *latest year* for which they are available.
4. Not to quote the number of persons killed, but the number of accidents at which one (or more) person(s) were killed.
5. Not to quote the number of persons injured, but the number of accidents at which one (or more) person(s) were injured.
6. Not to count traffic tunnels with footpaths along the roadway, bridges over water with footpaths alongside, two-level railway crossings etc.

7. As one crossing is always considered: a marked facility to get from one side of a road to the other. In case such a crossing is divided into two sections by a traffic island or a central reservation, it is still considered as one crossing and not as two subsequent ones. A signalised intersection usually is equipped with 3 or 4 crossings. Whereas in the Netherlands at signalised intersections where separate pedestrian signals are lacking, pedestrians *are obliged to take their cue* from the vehicular signals, pedestrian crossings at *those* intersections are considered as signal controlled crossings, also when only pavement markings are present to indicate the crossing.