1. Observation of elderly pedestrians on signalized crossings and of jaywalkers in the vicinity of pedestrian subways

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1.1. INTRODUCTION

In a new research on the observation of pedestrian behaviour, we have selected two opposing forms of behaviour for study, starting from the crossing situation. The dangers involved in certain cases of rule-complying behaviour are opposed to the dangers of consciously breaking the rule and taking extra risk.

The crossing behaviour of elderly pedestrians was one problem to be studied. As they are known for better observing the rules than other age groups of road users, we wanted to know, how safe they really are and what sorts of problems they have to cope with, when choosing the "safest" way to cross the road. The other area of investigation was to see the circumstances of conscious crossing violations and the motives underlying them. We analyzed the extremes of rule-compliance and risk taking.

1.2. BACKGROUND DATA

In 1994 474 pedestrians were killed in Hungary. This means that 30 percent of the fatal victims of road accidents (1562 persons) were pedestrians.

Although the ratio of pedestrians killed has shown a continuous decrease in the last few years (it was 38% in 1986, for instance), it is still high as compared with the countries of high motorization: in the majority of West-European countries 18-20% of the fatal accident victims lose their lives as pedestrians. We cannot be sure that the decreasing number of pedestrian accidents and victims is a sign of the improvement of pedestrian safety. It is more probable that the mobility of pedestrians has decreased due to the development in motorization.

Before 1988 pedestrians constituted the group most at risk in road traffic also in Hungary, but from that time on more people are killed as drivers of cars or passengers than as pedestrians, first of all outside built-up areas.

Within built-up areas it is still pedestrian accidents that have the highest number of fatal victims, so it has been a priority task to prevent them. It deserves attention that of the 474 persons killed as pedestrians in 1994, 181 (38%) were over 60 years of age. So it is first of all the elderly, for whom the participation in traffic as pedestrians means an increased accident risk.

To identify the means and possibilities of prevention, it is important to acquire a profound knowledge of the accident circumstances. The first step is to analyze the circumstances of accidents that have happened.

Of the 4647 personal injury pedestrian accidents that occurred in Hungary in 1994 4046 (87%) occurred within built-up areas and 601 (13%) outside built-up areas.

The table below shows the personal injury pedestrian accidents that occurred in 1994 by accident type.

	NUMBER	OF	ACCIDENTS	
Accident type	Fatal	Seriously injured	Slightly injured	*Total*
Pedestrian crossing in front of (behind) stationary vehicle	11	115	193	*319*
Pedestrian hit in stop of public vehicle	8	48	711	*127*
Pedestrian hit on straight road section, on marked crossings	43	233	347	*623*
Pedestrian hit on straight road section, outside marked crossings	116	700	788	*1604*
Pedestrian hit in road curves, on marked crossings	4	19	20	*43*
Pedestrian hit in road curves, outside marked crossings	0	1	1	*2*
Pedestrian hit in road junction, on marked crossings	32	257	288	*577*
Pedestrian hit in road junction, outside marked crossings	24	108	141	*273*
Pedestrian hit when proceeding parallel to traffic	39	155	189	*383*
Other pedestrian accidents	6	35	54	*95*
Total	*283*	*1671*	*2092*	*4046*

Table 1:
Distribution of personal injury pedestrian accidents in 1994 in built-up areas in Hungary by accident type

Pedestrians being hit while crossing on straight road sections, outside marked crossings, has been the most frequent pedestrian accident situation (1604 in 1994) in built-up areas for many years.

The number of pedestrian accidents where pedestrians were hit while crossing on marked crossings on straight road sections, in curves or in junctions -- that is where pedestrians have the right of way according to the Highway Code -- is 1243, which is 30% of the total number of pedestrian accidents having occurred in built-up areas.

In the following we focused our attention on the age group of people over 65, being at the highest risk of getting involved in pedestrian accidents.

The table below shows the distribution of pedestrians over 65 years of age, injured or killed in 1994, by the place of the accident and the accident outcome.

	NUMBER	OF	PERSONS	*INJURED*
PEDESTRIAN TRAFFIC	Fatally	Seriously	Slightly	*Total*
On marked crossings	39	158	131	*328*
Between refuge island and pavement	3	11	15	*29*
At stop of public transport vehicle	3	22	21	*46*
In road junction, outside "zebra crossing"	18	55	35	*108*
On the road at other places	88	230	163	*481*
Total	*151*	*476*	*365*	*992*

Table 2:
Distribution of the number of pedestrians over 65 years of age hit in built-up areas in 1994, by the place of pedestrian movement and by accident outcome

Although most (481) pedestrians over 65 have been hit at "other places" on the roadway, the number of elderly people hit on marked pedestrian crosswalks -- that is theoretically on places under protection -- is very high as well.

Let us analyze the distribution of the number of the 992 elderly pedestrian victims according to whether there was a traffic signal on the spot and if so, whether it was functioning as usual or showed a flashing yellow light, or it was out of order (Table 3.).

		TRAFFIC	LIGHTS		
PEDESTRIAN TRAFFIC	None	Yes, in order	Yes, flashing yellow	Out of order	*Total*
On marked crossings	244	53	28	3	*328*
Between refuge island and pavement	22	6	1	0	*29*
At stop of public transport vehicle	39	5	2	0	*46*
In road junction, outside "zebra crossing"	104	3	1	0	*108*
On the road at other places	472	7	2	0	*481*
Total	*881*	*74*	*34*	*3*	*992*

Table 3:
Distribution of the number of pedestrians over 65 years of age hit in built-up areas in 1994, by the place of pedestrian movement and by the presence or functioning of pedestrian lights

Most elderly pedestrians (881) were hit at places where there were no traffic lights; the accident occurred on the roadway or at other places in 472 cases and on the marked crossing in 244 cases. 74 pedestrians were hit at places furnished with normally functioning traffic lights, 53 of them on marked pedestrian crossings. 34 elderly pedestrians were hit at flashing yellow lights, 28 of them on marked crossings.

1.3. THE VIOLATING PEDESTRIAN

Places where pedestrians cross the road avoiding to use pedestrian subways or overhead crossings are especially dangerous. Pedestrians are supposed not to hinder the proceeding of vehicles here and the drivers don't accept their priority. They don't count with the presence of pedestrians at such places to such an extent than in the case of road junctions or marked pedestrian crossings.

The establishment of pedestrian subways or overhead crossings is very expensive, but these structures are theoretically suitable to provide complete protection to the pedestrians. Experience shows however that many of the pedestrians don't use them, which spoils their efficiency to a great extent. It is therefore important to reveal the characteristics of the people not using these establishments, to know the motives for not using them and to investigate, what these rule-breaking crossings at road level look like.

A site in Budapest has been chosen, where several pedestrians are hit near the pedestrian subway (in 1993 4, in 1994 3 pedestrian accidents occurred here).

This place is near one of the central railway stations of Budapest. One of the exits of an underground station joins the pedestrian subway. Passengers leaving the underground station can directly enter the railway station, or any sidewalk of a broad, heavy trafficked road. It is a two direction road with six lanes (parking lane, traffic lane and the inner lane leading traffic to a bridge). The ramp of the bridge begins here. On the next lane vehicles are coming down from the bridge with high speed . On the next two lanes traffic near the bridge is proceeding.

If someone wants to cross the road on road level, he/she is exposed to several risks. Traffic is heavy and almost continuous. (This is especially true for traffic coming down from the bridge.) In the lane leading to the bridge there are often traffic jams, while on the next lane -- coming down from the bridge -- vehicles proceed at a speed of 50-60 km/h. Vehicles often mask (hide) one another; crossing the road requires full attention. A special risk may be that traffic is very slow or stopped in one lane because of traffic jams, while vehicles in the next lane are proceeding with high speed.

The exits of the pedestrian subway are not equipped with traveling stairs. There are 30 stairs leading to road level. At an easy pace it takes 2 minutes to get to the other side of the road using the pedestrian subway.

Pedestrians crossing at the road level have been video-recorded. Experience shows that it was in the early afternoon period that most pedestrians crossed here, without using the subway. (We recorded 18 pedestrian crossings in an hour, the number of crossing pedestrians was 26). 58 surface crossings were recorded, the number of crossing pedestrians was 90. The majority of crossings followed the line of the subway. (The pedestrians crossed the road at the place of the subway, but the crossing took place on the surface.)

Our assumption was that those elderly (ill) people choose to cross at road level, for whom it is difficult to use the stairs. The results didn't prove this assumption. There were only 3 people among those crossing above the subway who had apparent walking difficulties, for whom using the stairs would have been very exerting.

The majority of the crossing pedestrians were between 16 and 35 years of age. The estimated age of 3 pedestrians was between 60 and 70. Among the pedestrians crossing against the rule there were 63 men (70%) and 27 women (30%). 30 pedestrians were crossing alone, while the majority in pairs.

No serious conflicts have been recorded during the observations until now. The explanation for this may be that the pedestrians in question were fully aware that they should give way to the vehicles and that they should adapt their behaviour to the movements of the vehicles. The drivers gave priority to the violating pedestrians only in the case of traffic jams, because of which the vehicles were moving very slowly. (There was only on exception, when an elderly man with a walking stick was crossing.)

The majority of the crossings took less than 1 minute. (The longest crossing lasted for 77 seconds, the shortest for 9 seconds). In the first part of the crossing the pedestrians were not running, they gathered information and were waiting when necessary (even for 30-40 seconds). It seems however that in the second part of the crossing there is no more patience and the majority of the pedestrians begin running.

In the case of young pedestrians one could see on their movements that they were practiced in crossing on the road level. No sign of fear or anxiety could be detected from their movements. They got used to danger, or they simply didn't realize the risk. They tried to cross the road with the slightest possible time loss. We observed several times that they were proceeding on the lines separating the lanes, parallel to traffic, trying to use in this way the time which they were forced to devote to giving priority to the vehicles.

By making interviews, we wanted to get acquainted with the motives of not using the subway. Those, who really were in a hurry, stayed away from the interviews, because of refusing it due to time pressure. Most of the pedestrians were hurrying because they didn't want to miss their train. Those in a hurry significantly overestimated the time which could be spared by crossing

on the surface. They thought that crossing against the rules resulted in a time gain of 5-10 minutes. The time gain was actually not more than 1-1,5 minutes.

The rule-breaking crossing behaviour of those pedestrians who were willing to be interviewed was motivated first of all by the love of comfort (laziness). The majority simply didn't want to use the stairs, although nothing limited their motions. Only one man said that he was unable to use the stairs because of obliterated arteria disease, and one pregnant woman referred to using the stairs as physical stress.

At the site of the investigation -- because of the nearby railway station -- there are many people from the countryside, not having local knowledge. They can find their way better on the road level than using the subway. Many of them didn't even know that it was possible to cross the road using a subway. One of the entries of the subway is really not conspicuous enough, it isn't within the direction of the main pedestrian flow, a small detour (of about 10 meters) has to be made to reach it.

It happened not only to country people, but also to people living in the capital that they have arrived to the road level at the wrong place. If someone lost the direction, he didn't go back, but tried to approach his destination on the surface. He/she wanted to avoid the burden of using the stairs and orientation is easier on the surface too.

The overwhelming majority of the pedestrians crossing at level didn't regard their behaviour for risky at all. Only the man with obliterated arteria disease and a 63 year old woman (who usually doesn't avoid using the subway) reported to feel fear while crossing the road.

1.4. PROTECTED CROSSING -- UNPROTECTED ROAD USER

There is usually no doubt about the increased risk of elderly pedestrians in traffic, but this well-known fact still seems to receive little attention in road safety activities. By the arguments summarized below I would like to stress the difficulties experienced by the elderly, crossing the road at the "safest" locations of the road network, at light signals.

Three signalized crossings were selected for the measurements. Three hours of observation at each crossing directed our attention to some characteristics that may be regarded as general. One site is of low, two are of high pedestrian volume. A narrow refuge island directly at the observation site 1. gives some illusion of being protected in the middle of the road at one of the locations. At site 2. there is a tram stop directly at the crossing. At site 3. selected for the measurements, there is turning vehicle traffic in one direction. The selected sites are located on a road with two lane traffic plus tram rails in both directions.

We focused on collecting the following information during the observation hours: accompaniment, apparent difficulties because of some "extra load" (heavy bags, walking stick, shopping cart, dog etc., making the movement more difficult or being a sign of walking difficulty), attention paid to traffic (or the lack of attention), the pace of movement (tempo) and whether or not the elderly pedestrians were able to reach the opposite kerb during the green phase. Apparent signs of fear, anxiety or relief after reaching the safe sidewalk could be noted in some cases. Pedestrians estimated by the observers to be over 60 years of age were the subjects, and only those who began crossing the road during the green (or blinking green) signal.

The crossing and watching behaviour of 376 elderly pedestrians -- 227 women (60%) and 149 men (40%) -- were observed. The first evaluation of the results shows the following characteristics.

74% of the pedestrians observed were walking alone, 23% in the company of contemporaries. 2% needed to be accompanied, and the number of elderly people walking with a child was as low as one per cent only. Our investigation covered only the green-walking pedestrians, that is those beginning to cross with green (93%) or blinking green (7%) signal.

35% of the pedestrians were looking left before crossing. 30% were looking only straight ahead and 35% were not paying attention at all. 54% of the pedestrians observed were walking at a normal pace, 22% were slow and 24% had apparent walking difficulties. 32% were looking right at about the half of the roadway. 27% were looking only straight ahead and 41% were not paying attention. 15% of the people observed managed to reach the opposite kerb in green or blinking green. 85% of them had to complete the crossing in red.

The differences between the crossing and watching behaviour of men and women are worth analyzing separately. It could be observed that the elderly male pedestrians were somewhat more assertive, unhesitant while crossing and they showed a fewer number of apparent fear reactions. They seem to be characterized by less walking difficulties (28%/17%). In the sample more men were accompanied by contemporaries than women (27%/20%). Slowness of movement was also more characteristic for women than for men (24%/17%). A considerable difference has been observed in watching behaviour: 44% of the men were looking left before stepping onto the road, while this number was only 29% for women. Watching becomes less frequent while in the middle of the road: only 35% of men and 30% of women is looking right. Attention paid to traffic is more characteristic for male pedestrians in the sample. 33% of the men and 46% of the women did not pay attention to traffic while crossing.

A total of 14% of the female and 18% of the male elderly pedestrians managed to reach the opposite kerb in green signal. 86% of the women and 82% of the men had to complete the crossing in red.

Site 1: Of 62 elderly people crossing only one man has reached the opposite kerb in green; none of them stopped at the refuge island. Many pedestrians (32% of the women and 21% of the men) tried to speed up at about the second half of the crosswalk. The surface of the crossing deserves special attention. Its bad quality puts an extra load on pedestrians with any kind of walking difficulties, or simply wearing high heeled shoes.

Site 2: At this crossing 18% of both men and women managed to reach the opposite kerb in green. 82% reached the opposite side of the road in red.

Site 3: 14% of the women and 23% of the men were able to cross on green. 86% of the women and 77% of the men reached the opposite side of the road in red.

The apparent signs of difficulties experienced by the elderly participating in traffic as pedestrians can be defined as follows:

- very slow movement, physical handicap
- using a walking stick
- carrying heavy bags
- using a shopping cart
- irrational (illogical) behaviour (e.g. running across the road)

- looking in the wrong direction
- looking several times to both directions
- lack of attention

The latter seems to have different reasons (of mental, physical or social origin, or a combination of those), for instance:

1. The pedestrian is completely absorbed in some other activity while walking across the road (conversation, having an ice-cream etc.)
2. The full attention of the elderly is required by walking. In this case the pedestrian has to concentrate on not falling over and he/she has no capacity to pay attention to traffic at all.
3. In the cases when two similar age elderly pedestrians are walking together, one is usually leading the other, trying to pay attention to traffic. The problem of being slow remains there, even if some attention is paid to the vehicles.

Further characteristics are

- illogical decision making
- shortening the length of way
- pottering about, sleep-walking, going about dreamily
- going and not seeing anywhere (with bended head)
- trying to hurry up.

In some cases we observed risky situations arising because of the slowness of the pedestrians on the crossing.

In the selected crossing situations there was practically no need for the pedestrians to communicate with the drivers, except for some cases. One has the impression that in many cases it would have been difficult or impossible for the pedestrian to communicate, because of apparent difficulties. We do not know, whether in these cases it is a conscious decision from part of the elderly to choose the safest way of crossing, a signal controlled junction to cross the road, trying to reduce the risk involved.

The following crossing strategies (and possible philosophies behind them) could be followed.

"Green means safety. I have to pay attention to the light and start immediately when it turns green, so that I can get through." The danger involved in this thinking may be that a car driver doesn't observe the light signal and tries to get through the crossing in the last moment, when the light is changing to red for him, but it is already green for the pedestrians.

The elderly cannot be expected to behave in a rational manner in every situation and the instruction teaching the importance of a checking glance before starting to cross is rare. In this way the elderly are at increased accident risk when starting to cross without looking, whether the approaching vehicles are going to stop. This is often the case, as the elderly tend to pay attention to the signal only, looking straight ahead. The continuation of the crossing becomes problematic, when the light turns red and the pedestrian is only in the middle of the road yet. He/she may try to walk quicker, to stop or to keep going at the same tempo. Any of the cases can be stressful, if not directly dangerous.

2. "I can trust the others. If they can get through, so can I." This is not always the case, as the elderly pedestrian may not realize his own limitations. He may be slower than the others and so he may get involved in risky situations. Crossing in a group seems to give a feeling of security, even when it is not finished with the group.

3. Although we didn't deal with pedestrians crossing in red, we must note that a considerable part of elderly pedestrians began crossing in red at one side of one of the sites. It seemed completely safe and doing so there was more time left for finishing the crossing possibly in the green signal. It is a bit confusing that it seems to be more safe at this particular place to start at the red signal than to wait for green. Such a false setting of the lights may weaken the general intention to obey the rules.

The observed problems are difficult to change, since they depend on the given physical state and the given everyday life of the road user group in question. The social implications of the problem include health care as well as the frequent and necessary self-support of the elderly, which seem to determine their mobility in many cases. Taken the present situation, the need for mobility of the elderly (and its inevitability in some cases) for granted, it is desirable to improve at least those circumstances of their traffic participation, which are relatively easy to improve. Unfortunately, the present day practice is often the opposite: the traffic environment itself puts extra load on the elderly pedestrians.

The extra difficulties include the **time pressure** when using a light controlled pedestrian crosswalk as well as the **bad quality of the surface** of the crossing, which requires the full attention of the old pedestrian, if he/she wants to cope with the situation. It is a real achievement to cross the road in many cases, especially on a crossing, where even the younger pedestrians cannot manage to reach the opposite kerb during the green signal.

If we speak of the safety of the elderly pedestrians, the question of responsibility arises. From the present investigation we excluded those basic situations, in which the elderly can be blamed, because of exhibiting unsafe behaviour. However, pedestrians trying to observe the rules, but not being in the position to perform such behaviour which ensures the safety of the whole crossing procedure, cannot and should not be blamed for their accidents. By stressing this I would like to underline the importance of a more "elderly-friendly" traffic environment and the responsibility of those groups of the society -- both experts and laymen -- who plan, accept and sustain a given level of road safety.

1.5. CONCLUSIONS

The preliminary results of our investigations draw the attention to the influence of the traffic environment on behaviour and safety and the importance of traffic engineering measures. In the case of elderly "green-walkers", who are not able to cross the road safely because of physical handicaps, there seems no other way to improve the situation than to give more time, more "green time" to them. In the case of the other group -- although there may be some hope that education can help preventing non-compliance -- from the safety point of view it is better to

shape the environment so that it doesn't allow risky behaviour, or that at least it should attract and facilitate the use of safety devices and structures.