NON-MOTOR PEDESTRIAN ACCIDENTS: A HIDDEN ISSUE

Results of the ITF/OECD report on Pedestrian Safety, Urban Space and Health

Véronique Feypell
International Transport Forum of the OECD, Paris, France.
veronique.feypell@oecd.org

Rob Methorst
Rijkswaterstaat Centre for Transport and Navigation, Delft, the Netherlands.
rob.methorst@rws.nl

Tim Hughes
New Zealand Transport Agency, Wellington, New Zealand.
tim.hughes@nzta.govt.nz

Abstract

Pedestrian only accidents (*i.e.* pedestrian falls in an urban space) are rarely reported in official statistics, as they are not considered as a *traffic* accident.

However, the number of injuries, and even fatalities, following a non-motorised accident is surprisingly high and these accidents represent a significant cost for society. The fear of falling also constitutes a mobility constraint for the elderly.

This paper presents the preliminary conclusions of the ITF/OECD Working Group on more recent estimates on the magnitude of pedestrian only accidents and results of recent studies across ITF/OECD countries. As an example, a 2009 Dutch study estimated that one third of pedestrian fatalities and two thirds of pedestrian injuries happened after a fall in the urban space.

The paper describes the characteristics of pedestrian-only accidents (locations of accidents, age of the victims, and context of falls) and the injury types that pedestrians suffer.

It reviews the causation factors of these accidents, which include the pavement and sidewalk conditions, the impact of the weather, the presence of other users on the sidewalk (such as rollers /skaters), etc.

Finally, the paper provides guidelines for designing pedestrian friendly pavements.

Biography

Véronique Feypell – de la Beaumelle is an Administrator at the Joint Transport Research Centre of the International Transport Forum and the OECD, where she is responsible for projects in areas such as freight transport, traffic safety and urban mobility. She has co-ordinated the work of the ITF/OECD on Pedestrian Safety, Urban Space and Health. .

Rob Methorst is chairman of COST 358 Pedestrians' Quality Needs and senior consultant at the Rijkswaterstaat Centre for Transport and Navigation (NL Ministry of Infrastructure and the Environment). Rob has 30 years of experience in the field of transport and traffic safety, both in pedestrian advocacy and in government.

Tim Hughes is the Senior Engineer responsible for walking and cycling guidelines at the New Zealand Transport Agency. He was responsible for New Zealand's *Pedestrian Planning and Design Guide*, and *Guidelines for Blind and Vision Impaired Pedestrians*. Tim has supervised recent pedestrian safety and walkability research in New Zealand. He has thirty years experience in road safety engineering.

NON-MOTOR PEDESTRIAN ACCIDENTS: A HIDDEN ISSUE

1. Definitions

A **pedestrian accident** is an accident involving any person who at the time was not riding in or on a motor vehicle, railway train, streetcar, animal-drawn vehicle, other motorised vehicle, or on a pedal cycle or animal. The definition includes a person changing the tyre of a vehicle or making adjustments to a motor vehicle on foot. It also includes the user of a pedestrian conveyance such as a baby carriage, ice-skates, perambulator, push-cart, push-chair, roller-skates, scooter, skateboard, skis, sled and wheelchair (powered).

The definition of a pedestrian accident in this report includes both traffic collisions and falls among pedestrians, where no vehicle was involved.

A **traffic accident** involving bodily impact is defined by the Vienna Convention as follows[1]:

"*Accidents which occurred or originated on a way or street open to public traffic, which resulted in one or more persons being killed or injured, and in which at least one moving vehicle was involved. These accidents therefore include collisions between vehicles, between vehicles and pedestrians, and between vehicles and animals or fixed objects. Single vehicle accidents, in which one vehicle alone (and no other road user) was involved, are included.*"

The problem with this definition is that pedestrians without a collision partner are excluded, as no vehicle was involved, thereby resulting in the problem of injuries due to pedestrian falls being overlooked.

Pedestrian fall means pedestrians falling and injuring themselves in public areas without involving a vehicle (accidents due to falls in the home and sporting activities are excluded).

Public area: The public area includes footpaths, pedestrian malls, bicycle paths, motorways, public roads outside urban areas, public roads inside urban areas, unspecified roads, bus stations, railway areas, freight terminals, quays, track ways and vehicle access routes in docks, and transport areas.

2. Under-reporting of pedestrian injury

The levels of under-reporting of injuries involving pedestrians involved in both traffic crashes and falls are a serious concern.

Data on non-fatal and fatal traffic casualties, based on police reports, provide detailed information about traffic accidents involving a (mostly moving motorised) vehicle. However, while police data on fatalities are generally accurate, injury accidents are largely underreported (Derriks and Mak, 2007).

[1] This definition is closely though not exactly followed by EU25. National definitions vary slightly, e.g. by defining vehicles as motorised, including material damage or any event causing injuries or fatalities on public areas, and not being limited to involving vehicles.

In addition, pedestrian falls in public space, resulting from, for example, poor road conditions are rarely reported as they are excluded from the international agreed definition on injury accidents, namely:

"*Any accident involving at least one road vehicle in motion on a public road or private road to which the public has right of access, resulting in at least one injured or killed person".* (ITF/ /EUROSTAT, UNECE, 2009).

Therefore, pedestrians injured in accidents not involving a motor vehicle are not reported by the police. At best, they are recorded in hospital records. Furthermore, usually fewer coding variables are used to register external causes of injury events on death certificates conducted by each Member State than are provided by the coding manual of the International Classification of Diseases Version 10 (ICD-10) of the World Health Organisation (WHO) (e.g. only three of four coding digits). Thus a correction of the general under-reporting of fatal vulnerable road user injuries and analysis of injury types, modes of transport, road type or time of day are not feasible at the moment. As specific coding variables are missing to connect the location of the "public road" with falls of pedestrians, the analysis of their fatal injuries on public roads is also not possible.

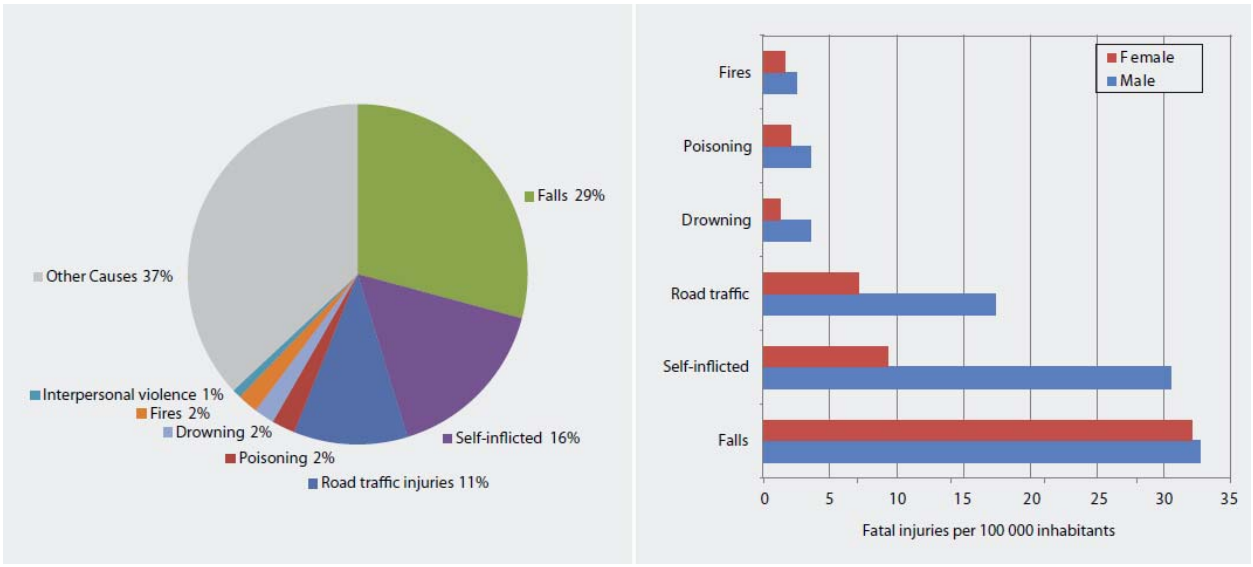
It is within this context that the European Injury Database (IDB), hosted by the European Commission, includes accident and injury data from selected emergency departments of Member State hospitals. The data comprise routine causes of death statistics, hospital discharge registers and data sources specific to injury areas, including both road and work accidents. While the IDB is the only data source in the EU that contains standardised cross-national medical data, it is focused on home and leisure accidents in Europe and most likely does not include the majority of traffic accidents.

Such records are also often used for the estimation of the degree of injury under-reporting, that is, the estimation of the actual number of casualties of a given level of severity, in relation to the respective number of casualties recorded by the Police. Nevertheless, under-reporting can be fully addressed only once standardised definitions are applied and medical data are exploited. Given the additional issues related to pedestrian injury data, the estimation of under-reporting of pedestrian accidents and injuries is expected to be even more complicated.

3. Pedestrian falls: the magnitude of the problem

Falls are a leading cause of injury for people of all ages, but especially the elderly (see Figure 1). While a large percentage of falls occur on stairs and inside buildings or homes, pedestrians walking or jogging on footpaths, stepping off curbs and crossing roadways also fall. Because falls are largely unreported, there is little data on the magnitude and consequences of pedestrian falls. Falls in public spaces need to be recognised as a prevalent public health problem with significant human and economic consequences.

Figure 1 **Fatal injuries among older people (60+ years) by causes of death and gender**



Source: European Injury Database; Bauer and Steiner (2009)

A recent study estimated that every year in Europe, 1.6 million pedestrians are injured due to falls on public roads in the European Union (Kormer and Smolka, 2009) and an unknown number of people die from these same falls (see table 1). This represents almost 3,000 victims per one million inhabitants.

Table -1 Estimated number of injuries due to falls (from Kormer and Smolka, 2009)

Country	Non-fatal home and leisure injuries without sport****	Injuries due to FiP	Percentage of injuries due to FiP in home and leisure injuries
AT	465.750	41.796	9%
DK*[80]	385.560	35.315	9%
FR[81]	3.847.500	96.716	3%
NL**	523.260	32.500	6%
SE***	422.820	24.120	6%
Subtotal	**1.411.830**	**98.416**	**7%**
Min			**3%**
Max			**9%**
EU25****	**22.680.000**	**1.580.980**	
EU25 rounded		**1.580.000**	

* Source: Danish Injury Register 2004

**Source: Dutch Injury Surveillance System 2004, Consumer Safety Institute

***Source: IDB 2004, Epidemiological Centre, The National Board of Health and Welfare, SE

**** Source: IDB Report 2002-2004, excluding sports injuries (19% of the total estimated injuries)

In 2009, the Netherlands undertook an in-depth study (Methorst et al., 2010) of pedestrian and bicycle accidents to estimate the real number and the severity of these accidents (where the real number is the sum of police-reported traffic crashes and unreported crashes). This study revealed that most pedestrian and bicyclist casualties came from accidents not involving another vehicle (see Table -2) and that around 1/3 of pedestrian fatalities and 80% of pedestrian injuries were due to falls.

Table -2 **Real number of pedestrian injuries in the Netherlands, 2003-2007**

Average number of victims per year (2003 – 2007) – real numbers				
	Deceased	Hospitalised (excl. deceased)	Urgent Medical Assistence (excl. Hospitalised)	Total
Pedestrians	**150**	**5.200**	**49.700**	**55.000**
Of which single accidents	*45*	*4.000*	*45.900*	*50.000*
Of which traffic accidents	*105*	*1.200*	*3.800*	*5.000*
Bicyclists	**220**	**7.600**	**60.200**	**68.000**
Of which single accidents	*50*	*6.000*	*47.500*	*53.500*
Of which multiple vehicle	*170*	*1.600*	*12.700*	*14.500*
Other modes	**595**	**8.200**	**48.100**	**57.000**
Total	**965**	**21.000**	**158.000**	**180.000**
NB. The numbers are rounded and corrected for doubles				

The most frequent crash types were: bicycle only, pedestrian only, pedestrian crossing, bicycle crossing, and pedestrian and bicycle near public transport stops and trains crossings. Little is known about the circumstances, causes and possible preventive measures. Swedish studies (Oberg, 1996, Larsson, 2009) showed similar results with 75% of injured pedestrians due to pedestrian only events (Table-3).

Table-3 Pedestrian injuries in Sweden, 1998-2007

		Traffic accident	Non traffic accident	Total
Sweden (1998-2007)	**Injured pedestrian (number)**	6433	19656	26089
	Injured pedestrians (%)	25%	75%	100%

Source: Larsson (2009)

The 1999 U.S. study on "Injuries to pedestrians and bicyclists" (U.S. Department of Transportation, 1999) analysed the circumstances of 1345 cases of pedestrian injuries. It showed that 64% of pedestrian injuries did not involve a motor vehicle. The Spanish National Health Survey (Ministeria de Sanidad y Politica Social, 2006)[2] for 2006 recorded all casualties by location. In Spain, there were as many people injured in a traffic accident as there were falling in the street. Both traffic accidents and falling accounted for 16% of all injuries. Other sources of injuries are home injury (31%) and injury at work (23%).

New Zealand has around 700 pedestrians admitted to hospital per year due to slips, trips and stumbles on the road and roadside - similar to the 738 pedestrians admitted for motor-vehicle injuries in 2008 (Thomas and Frith, 2010)

In Australia, in 2003-2004 there were 4587 hospitalisations due to "falls" classified as "on street or highway". This is 72% greater than the 2666 pedestrian hospitalisations associated with motor vehicles (Thomas and Frith, 2010).

2

4. Cost of pedestrian falls

Few data exist on the societal cost of pedestrian falls. The information in Table 4 is based on a Dutch study (Methorst et al., 2010) which showed that almost 40% of all societal costs of traffic accidents are related to bicycle and pedestrian accidents.

As 30% of pedestrian fatalities and 80% of injured pedestrians are due to falling, the associated costs to the Dutch society are around 1.4 billion Euros per year (i.e. 16% of total traffic accidents costs).

The high costs are due to the very high numbers of presentations and admissions to emergency departments of hospitals. Governments incur high medical, employment disability and transport costs within the context of the Social Support Act.

Table -4 Travel accident costs, The Netherlands

Summed travel accident coststs (x milion Euros, rounded)					
	Total		Killed persons	Hospital admitances	Urgent Medical assistence
	Total	Per inhabitant			
Pedestrians	2,065	**130**	370	1,300	400
Bicyclist	2,920	**180**	540	1,900	480
Other Modes	3,895	**240**	1,460	2,050	385
Total	8,880	**54**	2,370	5,250	1,265

Source: Methorst et al., 2010

In New Zealand, it is estimated that falls costs amount to 1.7 billion NZD (EUR 920 million) (O'Dea and Wren, 2010).

5. Characteristics of pedestrian non traffic accidents

5.1. Location of pedestrian non traffic accident

Table -5 and Table -6 illustrate the location of pedestrian falls from the E.U. and U.S. studies.

Table -5 Pedestrian injuries in Sweden, 1998-2007

Location	**%**
Pavement, pedestrian mall	30
Public road inside urban area	29
Cycle way	14
Road, unspecified	9
Public road outside urban area	9
Transport area, other specified	4
Bus station, railway area, freight terminal etc.	4
Transport area, unspecified	1
Total	**100**

Source: IDB and APPOLO report

Table -6 **Distribution of pedestrian injury cases treated in hospital emergency departments by location and type of event, United States**

Location of Injury Event	Type of Injury Event		Total
	Pedestrian – motor vehicle	Pedestrians Only	
Roadway	439 (70.0)[1] (88.0)[2]	188 (30.0) (22.2)	**627** **(46.6)[2]**
Non-Roadway[3]	60 (8.4) (12.0)	658 (91.6) (77.8)	**718** **(53.4)**
Unknown	23 (23.5) (--)	75 (76.5) (--)	**98** **(--)**
Total	**522** **(36.2)[1]**	**921** **(63.8)**	**1443**

[1] Percentage of row total.
[2] Percentage of column total (excluding unknown cases).

Source: US DoT (1999)

5.2. Who are the victims?

Both the European and U.S. studies showed that the ratio of males to females injured following a fall is almost equal.

The European study also showed children (0-14 years) and the elderly (65 years and over) are especially affected by such injuries. More than three-quarters of all pedestrian injuries happen during general walking around. Nine per cent of pedestrian injuries happen during the course of other activities, 6% during play and leisure activities, 4% during sports or athletics activities. Two percent of pedestrian injuries happen during shopping, 1% during a common activity such as eating or drinking (see Table **-7**).

[3] Non roadway location can include : parking lots, train station,

Table -7 Pedestrian falls by activity

Activity	%
General walking around	78
Other activity	9
Play and leisure activity	6
Sports or athletics activity	4
Shopping	2
Vital activity	1
Total	**100**

Table -8 provides information on the **ages** of pedestrians treated at the participating hospital emergency departments in the U.S. 1999 study. Children under five years of age were especially over-represented in non-roadway motor vehicle collisions. Older adults, in contrast, were over-represented in pedestrian-only events occurring on non-roadway locations. Thirty-eight percent of these events involved adults in the 45-64 or 65 years and over age groups. For the 45 to 64 year-olds, more than 40 per cent of their non-roadway falls occurred in icy weather conditions; if these cases are excluded from the table, the 45-64 age group are no longer over-represented, but pedestrians aged 65 years and over remain over-represented.

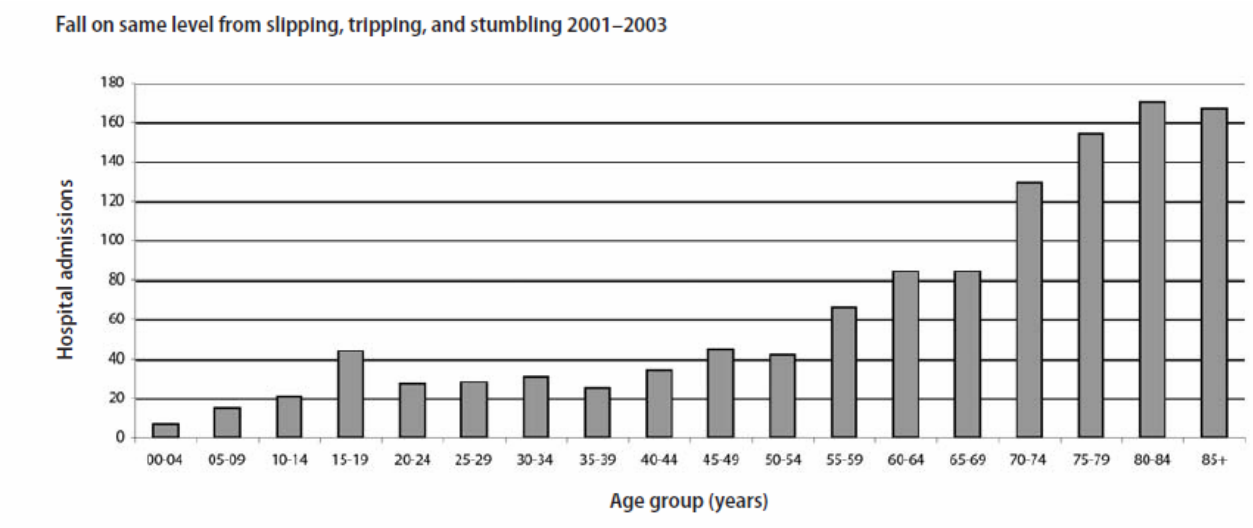
Table -8 **Distribution of pedestrian age by injury event type**

Pedestrian Age	Ped Only Road	Ped Only Non-Road
0-4	4 (2.2)	38 (5.8)
5-9	12 (6.5)	57 (8.7)
10-14	34 (18.5)	69 (10.6)
15-24	48 (26.1)	76 (11.7)
25-44	46 (25.0)	167 (25.6)
45-64	22 (12.0)	142 (21.8)
65+	18 (9.8)	103 (15.8)
Total	184	652

[1] Percentage of column total.
Source: US DoT (1999)

In New Zealand, approximately 400 people are admitted to hospital each year due to slips, trips and stumbles on the same level in the road environment. They tend to be elderly as shown in Figure xx and are more likely to be seriously injured if they fall. The predominance of elderly in hospital admission from falls is a result of an increased likelihood of falling but also a greater fragility resulting in greater likelihood of broken bones. Many spend considerable time in hospital requiring bed rest which triggers a chain of health consequences that result in high costs to the health system and premature death.

Figure 2 **Hospital Admissions from fall in the road environment (New Zealand)**



Source: NZTA (2007)

Skates and skateboard

In most countries, skaters and skateboarders are considered pedestrians (whether circulating on roadways or footpaths). Skaters and skate boarders can also be a danger for the pedestrians walking on the footpath. Findings from the U.S. study showed that of the nearly 200 pedestrian-only events that occurred ***on the roadway***, one-quarter involved the use of in-line skates and a further five per cent involved persons on skateboards. ***Off-road***, the situation was not much safer: 12% of injured pedestrians were using in-line skates and three per cent were using skateboards. These percentages were combined for all ages and are likely to be higher for teens or young adults. While education efforts might help to alert young people to the dangers of these activities, a better alternative might be to provide a safer environment for skating, such as a network of well-maintained off-road trails.

5.3. Type of injuries

The European study showed that about three-quarters (74%) of all pedestrians injured their extremities (lower extremities 42%, upper extremities 32%), while 20% incurred a head injury. The remaining 5% of pedestrians incurred injuries to the other body regions. Fractures occurred to about 30% of all injured pedestrians, 20% of pedestrians received contusions and more than 15% incurred distortions. Fifteen per cent received open wounds while 7% incurred lesions of tendon(s) and/or muscle(s).

The U.S. study found similar types of injuries. These are listed in table 8.

Table -9 Most frequent injuries for pedestrian only accidents, U.S. study 1999

Pedestrian-Only Roadway	Pedestrian-Only Non-Roadway
% Injury Type All	**% Injury Type All**
Lower limb (38%) 37% sprain/strain 29% fractures 14% contusions 13% superficial	**Lower limb (35%)** 33% sprain/strain 31% fractures 21% contusions 8% superficial
Upper limb (32%) 39% fractures 18% sprain/strain 16% contusions	**Upper limb (30%)** 47% fractures 21% contusions 17% sprain/strain
Face / neck (16%) 60% lacerations 18% contusions	**Head (13%)** 50% contusions 23% lacerations 12% other 10% superficial
Head (7%) 47% lacerations 35% contusions	**Face / neck (13%)** 41% lacerations 22% contusions 15% superficial

[1] Percent of all injuries occurring to pedestrians in that injury-type group.

6. Accident causation factors

6.1. Pavement and footpath conditions: design and maintenance

Pedestrians need to concentrate on traffic, and surrounding people and obstacles. It can be difficult for pedestrians to perceive changes in the pavement surface; even small differences in height can easily lead to loss of balance, leading stumbles and falls. In many cases, falls result in serious injuries, including death. This is especially prevalent among older people. Accordingly, particular attention should be given to the condition and maintenance of pavements and footpaths.

Poorly maintained surfaces are ranked as a more persistent cause of accidents than design issues. Poor maintenance includes: uneven construction (e.g. cracks), temporary deterioration.

Design issues include: vertical changes (e.g. kerbs). They are a major contributory factor in pedestrians' falls and injuries, particularly when stepping up (as opposed to down) and slippery surfaces

6.2. Weather conditions

In countries with marked winter conditions, snow and ice are particularly hazardous for pedestrians. In Buffalo, New York, which experienced considerable snow and ice during the winter of 1995-96, over a quarter of all hospital-reported pedestrian injuries during the entire year of data collection were related to icy-weather. In addition to clearing roadways and to make them safe for motorists, footpaths, driveways, and parking lots also need to be made as safe as possible for walking. Too often, roadways are cleared rather than footpaths, and insufficient effort is made to help pedestrians negotiate within parking lots (Parliament of Victoria, 2010).

6.3. Pedestrian factors

Pedestrian conditions

People carrying loads, being tired, engaged in other activities or in hurry through their walking environment are vulnerable to falls, because these factors may limit their vision, distract them from their walking task, and alter their gait

Distractions

In a New Zeeland study, approximately 45% of participants agreed or strongly agreed they had some level of distraction at the time of their accident. This includes: listening to music, using a cell phone, reading, or being distracted by another people (conversation, watching other people...)

Footwear

High heels can contribute to fall of female pedestrians especially in Central Business District (CBD). There is evidence that higher heels do not reduce women's walking speeds. (New Zealand Transport Agency, 2010). High-heel wearers are more likely to report that they are travelling too fast for the walking surface when compared with those wearing flat-soled or running shoes. The combination of faster walking speeds with less stable footwear should be taken into account when designing high-pedestrian traffic CBDs

Alcohol

Alcohol is an important contributing factor in both traffic and non-traffic pedestrian accidents. However, it seems that persons injured in pedestrian-only events were generally less likely to have been drinking than those struck by motor vehicles. In the U.S. study, just under six per cent of pedestrians injured in pedestrian-only events were "indicated as impaired," while only a little over 1 per cent were tested and found to have a positive blood-alcohol level..

7. Guidelines for designing pedestrian friendly pavements

Designing for the needs of pedestrians with impaired mobility will provide a high standard for all citizens. Pedestrian network – which includes the footpath, the crossings, and the shared space -- should be predictable, consistent, self explaining and also provide a forgiving environment, which will allow the pedestrians to prevent a fall or an injury when slipping for example.

The section below is based on the New Zealand Pedestrian Planning and Design Guide, which provides a comprehensive and detailed approach to the design of urban infrastructure for pedestrians. :

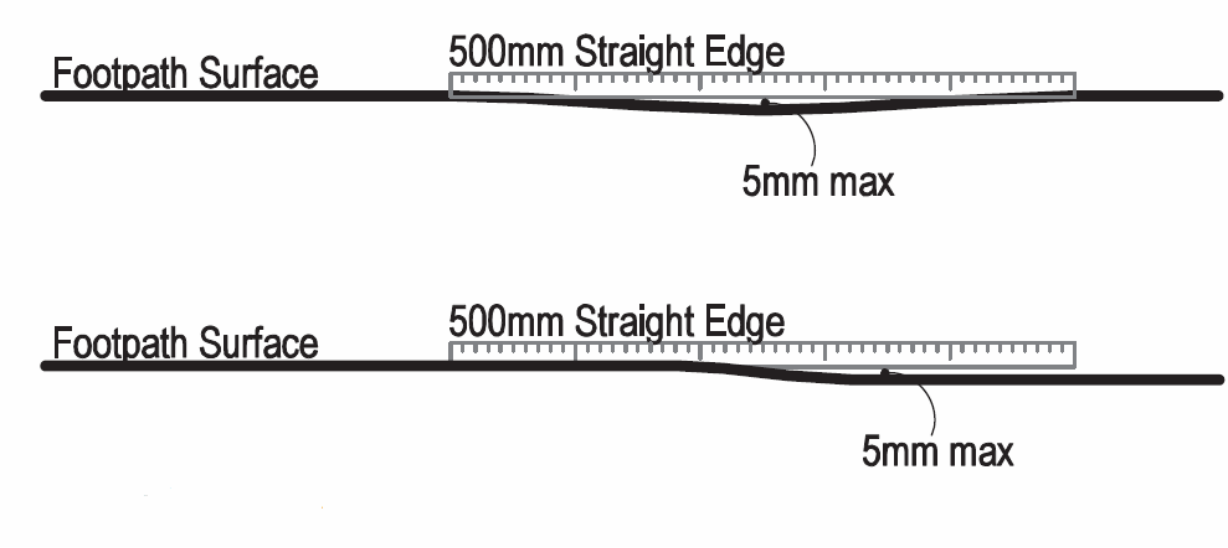
General design

All surfaces on which pedestrians walk should be firm, stable and slip resistant even when wet. To minimize the risk of slips, surface material should have a coefficient of friction of greater than 0.4 when tested wet against a surface representing the sole of a shoe. On slopes this value should be increased.

Sudden changes in height on otherwise even surfaces should be less than five mm. To minimise stumbling hazards, undulations in otherwise even surfaces should be less than 12 mm.

Both the above are achieved where the maximum deviation of the surface under a 500mm straight edge is less than five mm (see figure 3).. This also prevents puddles from forming. Dished channels for drainage should not be incorporated within the through route.

Figure 3 **Measuring the maximum deviation of the surface**



Source: NZTA (2007)

Short, sudden changes in the surface, such as single steps, should be avoided as they are unexpected and can cause pedestrians to trip or catch the front wheels of wheelchairs and baby carriages. Thomas and Frith found that misjudging kerbs and steps was a frequent cause of trips and recommend using a colour contrast to highlight the edges of steps and kerbs.

Maintaining the pedestrian network

Both pedestrian-related and other infrastructure-related maintenance can affect pedestrian movements. It is important to manage it correctly to avoid it having major effects on the pedestrian network.

All pedestrian facilities need adequate maintenance. Without it, facilities that initially encouraged walking can become hazards or obstructions to pedestrian movement and a deterrent to walking trips. The impact on pedestrians is not necessarily related to the physical size of the problem – a three metre damaged surface can create as much difficulty as one of 30

m. Seemingly minor issues, such as a small vertical face or minor ponding, can also cause difficulties for some pedestrians.

The footpath

Footpaths should be provided wherever pedestrians will use them; with dimensions and geometry that provides access for all, especially people with impaired mobility

The surface of the footpath is critical and should be selected with care taking due consideration to safety, convenience and aesthetics.

Street furniture, including benches, is useful for pedestrians. First, they are welcome either to rest or socialise in the street, and contribute in making the street lively.

Particular attention is needed on shared path (e.g. with bicycle) and easy and short connections to public transport stops contribute to facilitate the life of pedestrians.

Crossing facilities for pedestrians:

Pedestrians cross the road an average of two to three times on every walking trip and may also need to cross railways, waterways or other natural features. Their perceptions of the walking experience largely focus on difficulties crossing roads and any problems with this can cause delays and create a sense of insecurity. Therefore, correctly designing, building and signing appropriate crossing facilities should be a major consideration when developing pedestrian routes. This applies not only to facilities in the road reserve, but also to off –road environments shared with cars, such as car parks.

Measures to guide pedestrians

All road users need helpful guidance and direction to inform and warn them of the environment ahead. As pedestrians have different characteristics and routes from other road users, the following four specific measures are required:

- providing directional information to pedestrians
- channelling pedestrian flows
- informing other road users of the presence of pedestrians
- indicating to pedestrians and other road users who has priority at crossing points.

Lightening the pedestrian network

Lighting has several purposes for pedestrians. It illuminates potential hazards so pedestrians can avoid them, it enables pedestrians to read signs and orient themselves affects feelings of personal security and comfort; it enables drivers to see pedestrians and thereby improves their safety: it can enhance the walking environment and it makes the pedestrian network continuously available, not just during day.

References

Derriks H and P. Mak (2007). Underreport of road traffic casualties. IRTAD Special report. OECD/ITF, Paris.

ITF/ EUROSTAT / UNECE (2009). *Illustrated Glossary for Transport Statistics,* 4th Edition, http://www.internationaltransportforum.org/Pub/pdf/09GloStat.pdf

Kormer and Smolka (2009). Injuries to vulnerable road users including Falls in Pedestrians in the EU; A data report. APPOLO project KFV, Vienna http://www.euroipn.org/apollo/reports/D5.2_Apollo_VRU_InjuryDataReport_090210.pdf

Larsson (2009), Traffic Safety problems for pedestrians – Injuries according to police reports and health service, VTI report (in Swedish)

Methorst, R., Essen, M. van, Ormel, W. and Schepers, P. (2010, in press). *Letselongevallen van voetgangers en fietsers – een verrassend beeld.* Rijkswaterstaat Dienst Verkeer en Scheepvaart, Delft.

Ministeria de Sanidad y Politica Social (2006), Encuesta Nacional de Salud de Espana 2006, http://www.msc.es/estadEstudios/estadisticas/solicitud.htm

New Zealand Transport Agency (2009). *Pedestrian Planning and Design Guide.*

New Zealand Transport Agency (2010 - to be published). The mechanisms and types of non motor vehicle injuries to pedestrians in the transport system and indicated infrastructure implications.

Oberg (2006*), Injured pedestrian in Sweden: surface condition*. VTI, Sweden.

O'Dea, D., Wren, J.(2010) New Zealand estimates of the total social and economic cost of "all injuries" and the six priority areas respectively, at June 2008 prices: five year evaluation [Report]. Wellington, N.Z. Accident Compensation Corporation, February 2010, 33 p. ISBN: 978-0-478-31473-1

Thomas J and W. Frith (2010, in press). *Don't slip up: Design, maintenance and pedestrian accidents.* NTZA Research Report.

U.S. Department of Transportation (1999), *Injuries to pedestrians and bicyclists : an analysis based on hospital emergency department data*