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THE RISK OF SLIPPING AND FALLING AS PEDESTRIAN DURING WINTERTIME

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ABSTRACT

Injuries from fall accident on icy or snowy surfaces are frequently occurring in Sweden, 25-30 000 per year. This means 2-3 injuries/1000 inhabitants needing medical care are expected to occur in Sweden every year. Similar proportions exist in other northerly located countries such as Finland, Norway, Japan, Canada and so on. Outdoor activities are essential for a healthy life, therefore the prevention of slip and fall accidents are important.

An intervention study has been performed during Feb-April 2008 among healthy subjects in northern Sweden. The subjects have been divided into three groups: an Intervention Group (N=25), a Control Group (N=25) and a Comparison Group (N=17) with similar distribution of gender and age. The intervention group were equipped with one of three different types of anti-slip devices for their shoes: a Heel-device, a Foot-blade device or a Whole-foot device.

Four questionnaires were used:
-Background, health, and earlier experiences of falling accidents during the winter 2007/2008
-Daily diary of walked distance, walking conditions, occurrence of incidences or falls reported weekly
-Detailed accident or fall report used after each occurrence.
-Experiences of using anti-slip devices

The results show that the subjects had experienced 24 falls during the winter before the trial period. 64 incidents/accidents took place, without any injuries needing medical care, during the 10 week trial period with more than 2600 reported days. The anti-slip users walked longer compared to non users. An incident or fall among subjects wearing anti-slip devices reduced the walking distance that day. Anti-slip devices prevents from falling. The risk of slipping and falling is reduced for anti-slip users. The users of anti-slip devices will continue to use them and they will also recommend others to do so. The risk of falling as pedestrian during wintertime can thus be reduced by using anti-slip devices.

INTRODUCTION

In TSU92 (Gustafsson and Thulin, 2003) – a questionnaire-based and continuously running national survey in Sweden – single-pedestrians accidents account for 49% (1 141 962) of the total number of all road transport accidents (2 335 017) for people aged 1-84, during 1998-2000. All of these accidents are self-reported and not necessary needing medical treatment. The most exposed group is 25-44 years of age and the largest portion of single-pedestrian accidents occurs in the age group 7-14 years of age. The youngest, aged between 1 and 14, have a greater portion of self-reported single accidents than their proportion of exposure. Between 15 and 24 years exposure and accidents are almost the same and for people between 25 and 84 years their proportion of exposure is greater then their proportion of self-reported accidents. Younger people are more at risk than other age groups. The risk of a single-pedestrian accident is 346 accidents per million person kilometres. This includes all variations of single-pedestrian accidents (Gustafsson and Thulin, 2003). The single-pedestrian accidents on snow and ice are estimated to be approximately ten times as frequent as the official police-reported number of pedestrian accidents. (Öberg et al, 1996).

Hospital-based injury statistics from Sweden clearly show a high frequency of injuries from single-pedestrian accidents on slippery surfaces, i.e. on ice and snow. Annually, 25 - 30 000 people (3.2 per 1000 inhabitants) need medical care for treatment of injuries from falling on ice and snow. On average, every year there are more than two injuries per 1000 male inhabitants and more than three injuries per 1000 female inhabitants from falls on icy surfaces that are so serious that they need medical care. Females are overrepresented especially for the age group 45 – 74 (Nordin, 2003). Similar conditions occur in other countries with seasonal variations such as Finland, Norway, Canada, USA and Japan. More than 100 000 pedestrians in the Nordic countries are every winter expected to receive medical treatment due to winter weather and slippery conditions (based on estimations from Nordin, 2003; Kelkka, 1995 and Perälä et al, 2001).

Pedestrians injured in single accidents on icy and snowy surfaces, compared to pedestrians injured on other surfaces, experience the most severe injury consequences immediately after the accident as well as within one month and within six months of the accident. This is true with respect to length of hospital stay as well as length of sick leave (Berntman, 2003). Measures to reduce the accident rate and/or the severity of accidents can be either community-based or based on individual initiatives. Using appropriate shoes and anti-slip devices are examples of individual measures that have been suggested (Björnstig et al, 1997; Lindmark and Lundborg, 1987; McKiernan, 2005; Nilsson, 1986).

However evidence of association between the use of anti-slip devices and prevention from slipping and falling is slowly growing. An intervention study was conducted in the USA during the winter 2003/2004 among 101 fall-prone subjects aged 65 and older. The subjects were randomized to wear an anti-slip device or their ordinary winter footwear outdoors. It is concluded that wearing the specific anti-slip device may reduce the risk of outdoor winter falls, and of non-serious injurious falls in older community-dwelling people with a history of previous falls (McKiernan, 2005). A pilot study on the use of anti-slip devices was made in Finland (Juntunen et al, 2005). A total of 93 subjects participated voluntarily; 63 were woman and 30 were men. A

total of 64 subjects used anti-slip devices and 29 used studded shoes. Preliminary results shows that the subjects (aged 20 - 80) were exposed to three fall accidents. Anti-slip devices or studded shoes were used in one of these three cases. They were also exposed to eight "close to" fall accidents where anti-slip devices were used in three of the cases, studded shoes in two cases and ordinary shoes in three cases (Juntunen and Grönqvist, 2005).

No similar study has earlier been made in Sweden. Therefore an intervention study has been conducted during the period February – April 2008 among healthy subjects in Northern Sweden.

AIM

The aim of the study was to register and study the:

- Pedestrian exposure during wintertime
- Occurence of slips/falls
- Preventive gains of anti-slip devices

METHOD

The subjects have been divided into three groups: an Intervention Group (N=25) and a Control Group (N=25) with similar distribution of gender and age and a Comparison Group (N=17). The different groups showed similar age and gender distribution (27 – 67 years of age). In all of the groups 60% were female. The Intervention Group were equipped with anti-slip devices. The Intervention Group and the Comparison Group were informed about slip and fall accidents during wintertime. The Comparison Group was just informed about their participation in a travel survey. None of the subjects in any group were asked not to use, or prohibited to use, anti-slip devices of their own during the trial period.

Four questionnaires were used and collected during different phases of the trial period:

- Background, health and previous experiences of fall during the winter 2007/2008 collected in the beginning of the trial period
- Daily diary of walked distance, walking conditions, walking aids and occurrence of incidences/falls reported weekly
- Detailed incident/fall report reported after each occurrence of incidents/fall.
- Experiences of the use of anti-slip devices to those who used anti-slip devices during the trial period, collected after the trial period.

RESULTS

The subjects had experienced 24 actual falls previously during the winter 2007/2008, before the trial period, without any injury.

There was no significant difference in daily average walking distance and walking time among the different groups (See table 1). The Intervention Group walked 38% of the total walking distance, the Control Group walked 44% and the Comparison Group walked 18% of the total walking distance. Walking sticks were used during 40 (<2%) of the diary days and anti-slip devices were used during 356 (14%) of the diary days.

Table 1. Total walking distance and walking time.

Characteristics	Groups			
	Intervention	Control	Comparison	Total
Subjects using walking diaries	22	23	16	61
Mean daily total walking distance, km	2.95 (N=919)	2.85 (N=1093)	2.77 (N=451)	2.87 (N=2463)
Mean daily total walking time, minutes	32 (N=919)	33 (N=1094)	37 (N=446)	33 (N=2459)
Total walking distance, km	2714	3099	1247	7061
Mean daily walking distance with walking sticks, km	5.00 (N=4)	5.00 (N=16)	4.69 (N=20)	4.85 (N=40)
Mean daily walking distance with anti-slip devices, km	3.36 (N=284)	5.88 (N=52)	3.15 (N=20)	3.71 (N=356)

Anti-slip devices were used in 356 diary days (See table 2). The average total walking distance among the younger subjects (<44 years of age) (N=1075) were significantly (df=1, F=43.277, p=0.000 < 0.05) shorter, 2.48 km, compared to among the older subjects, 3.21 km (N=1357). The average walking distance with anti-slip devices among the younger subjects were 1.73 km (N=69) and significantly (df=1, 49.818, p=0.000 <0.05) longer among the older subjects, 4.19 km (N=287).

72% of the total walking distance, when using anti-slip devices, was performed in the Intervention Group, 23% in Control Group and 5% in Comparison Group. 80% of the diary days reporting using anti-slip devices were in the Intervention Group, 15% in Control Group and 5% in Comparison Group. For subjects not using anti-slip devices the mean daily total walking distance is significantly (df=1, F=86.1139, p<0.05) shorter, 2.66 km, compared to subjects using anti-slip devices, 4.08 km (See table 2).

86% of the subjects in the Intervention Group reported walking with an anti-slip device. Only 35% of the subjects in Control Group and 31% of the subjects in Comparison Group reported walking with an anti-slip device. 41% of the subjects in the Intervention Group, 57% in the Control Group and 38% in the Comparison Group reported an incident/fall.

30% of the days when not using anti-slip devices were reported in the Intervention Group, 49% in the Control Group and 21% in the Comparison Group.

In the Intervention Group anti-slip devices were used in 30.9% of the days, in the Control Group in 4.8% of the days and in the Comparison Group 4.4% of the days. In average anti-slip devices were used in 14% of the registered days.

Table 2. The exposure for users and *non users* of anti-slip devices.

Characteristics	Group			
	Intervention	Control	Comparison	Total
Total no of reported walking days	1028	1138	492	2658
Subjects using anti-slip devices	19	8	5	32
Mean daily total walking distance for subjects when USING anti-slip devices, km	3.68	6.51	3.55	4.08
Diary days with walk trips for subjects WITH anti-slip devices	284	52	20	356
Mean daily walking distance when USING anti-slip devices, km	3.36	5.88	3.15	3.71
Total walking distance during days USING anti-slip devices, km	953	305	63	1321
Mean daily walking distance for subjects NOT using anti-slip devices, km	*2.63*	*2.65*	*2.73*	*2.66*
Diary days with walk trips for subjects NOT using anti-slip	*635*	*1041*	*431*	*2107*
Total walking distance during days when NOT using anti-slip devices, km	*1670*	*2761*	*1177*	*5608*
Subjects reporting incidents/falls	9	13	6	28
Number of incidents/falls	29	23	12	64
Incidents/falls per day	0.0282	0.0202	0.0244	0.0241
Incidents/falls per subject	1.3182	1.0000	0.7500	1.0491
Incidents/falls per km	0.0106	0.0074	0.0096	0.0091

Mean daily total walking distance compared with experiences of incidences/falls is similar among the subjects in the different groups. The subject stated that the use of an anti-slip device prevented from falling in six cases. One actual fall occurred when using an anti-slip device. It was one subject in the Intervention Group who was using a Heel-device when the fall occurred, without any injury.

The subjects reduced their mean daily total walking distance significantly on days experiencing an incident/fall (See Table 3).

Table 3. Incident/falls and actual falls.

Characteristics	Group			
	Intervention	Control	Comparison	Total
Number of incidents/falls when walking with anti-slip devices	8	1	0	9
Number of actual falls without anti-slip devices	1	5	0	6
Number of incidents/falls when walking without anti-slip devices	21	22	12	55
Stated prevented no. of falls by using anti-slip devices (* and walking sticks)	5	1*	0	6
Mean daily walking distance on anti-slip devices with incidence/fall, km	1.78 (N=8)	4.80 (N=1)	- (N=0)	2.12 (N=9)
Mean daily walking distance on anti-slip devices without incidence/fall, km	3.40 (N=276)	5.90 (N=51)	3.15 (N=20)	3.75 (N=347)

The difference in mean daily total walking distance is significantly (df=1, F=86.139, $p<0.05$) between non-users, 2.66 km, and users, 4.08 km, of anti-slip devices.

The relation between users and non-users of anti-slip devices is 0.67 incidence/falls per km and 0.64 for actual falls per km. This indicates both a reduction in the incident/fall risk and actual fall risk by using anti-slip devices (See Table 4).

Table 4. Relative incidence/falls and actual fall rate for anti-slip users and non users.

	Anti-slip		
	Users	Non users	Total
Number of days	356	2107	2463
Mean daily walking distance, km	4.08	2.66	2.87
Total walking distance, km	1453	5607	7061
Number of incidences/falls	9	55	64
Incidence/fall per km	$6.2 * 10^{-3}$	$9.2 * 10^{-3}$	$9.0 * 10^{-3}$
Actual falls	1	6	7
Actual falls per km	$0.69 * 10^{-3}$	$1.07 * 10^{-3}$	$0.99 * 10^{-3}$

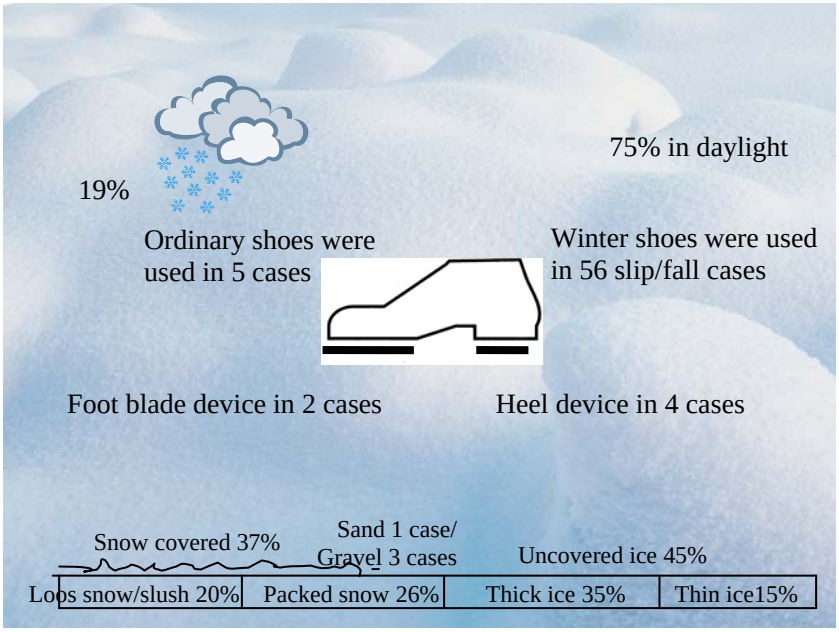

Figure 1. Experiences from reported incidents/falls.

Most of the incidences/falls, 75%, occurred in daylight (See figure 1). 50% were on ice. Most of it were uncovered thick or thin ice. Only 19% occurred during snowfall. Winter shoes were used in most of the cases. Foot blade anti-slip devices (See Figure 2) were used in 2 incidents/falls and heel devices in 4 cases. The type of device in the other 3 cases was not registered. None of the incidents/falls or actual falls caused any injury.

Whole foot device Heel device Foot blade device

Figure 2. The anti-slip devices distributed among the subjects.

Most of the incidences/falls occurred during March and April. Only a few incidences/falls occurred during the trial weeks in February. In Figure 3 the incidences/falls are plotted against the dates together with the temperature in Luleå were most of the subjects made their walking trips. Based on the subjects reports 80 % of the incidences/falls occurred in the temperature range between -6 ^{0}C and 0 ^{0}C.

The answers from the fourth questionnaire, distributed among actual users of anti-slip devices, shows that they found them useful and will both continue to use them and will also recommend others to do so.

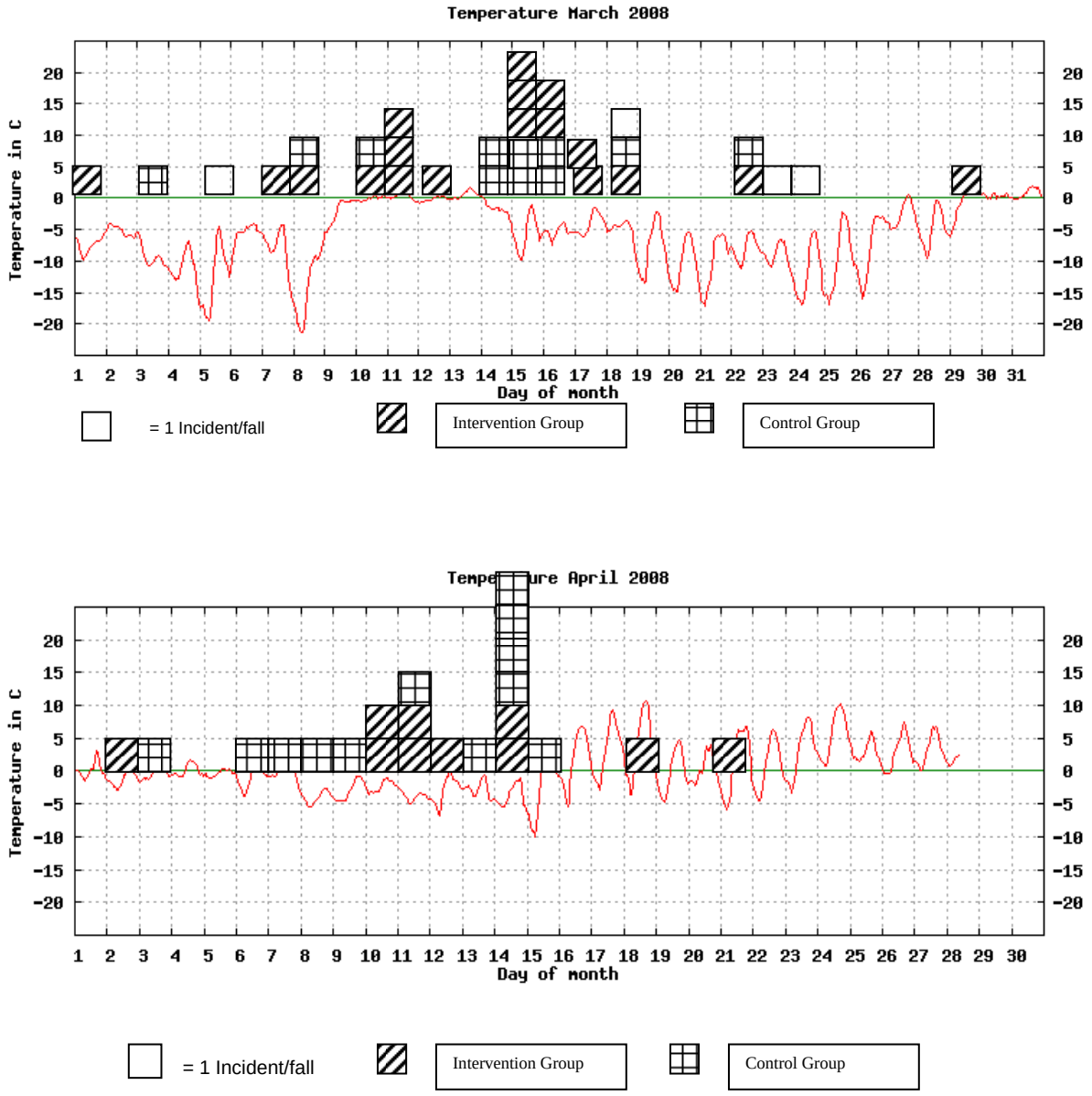

Figure 3. Incident/fall occurrence and temperature during March and April 2008 (The empty box is incidences/falls from subjects in the Comparison Group).

DISCUSSION

The average daily total walking distance in this study is similar to the average walking distance found in the national travel survey data in Sweden. There was no significant difference in total walking distance, or total walking time, between the Intervention Group and any of the other groups. The differences found were among younger (<45 years of age) and the older subjects and between users and non-users of anti-slip devices. A majority of the subjects, 52%, used an anti-slip device at least during one diary day. Those using anti-slip devices increased their daily total

walking distance. When a subject experienced an incident/fall wearing anti-slip devices they reduced the walking distance that day. The risk of an incident/fall and actual fall is reduced by using anti-slip devices, 0.67 and 0.64 respectively. Similar experiences have been found in studies among fall-prone elderly (McKiernan, 2005). The slip per trip rate in that study was 0.063/trip (N=3634) for anti-slip users and 0.113/trip (N=4274) for ordinary winter shoe user. The relationship for falls and slips in that study was 0.56 for anti-slip users and 0.89 for winter shoe users compared to ordinary shoe users. In this study the subjects reported an anti-slip device to prevent from falling in six incident/fall cases.

CONCLUSIONS

The anti-slip users walked longer compared to non users of anti-slip devices. The anti-slip users increased the exposure. The use of anti-slip devise reduced the incidence/fall rate compared to non user. Anti-slip devices prevents from falling. The use of anti-slip devise can therefore be used to increase the exposure without increasing the risk for incident/falls and actual falls. The users of anti-slip devices will continue to use them and they will also recommend others to use anti-slip devices. By reducing slip and fall accidents during wintertime injuries from single-pedestrian accidents can be reduced thus improving the safety in the traffic environment for pedestrians.

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