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Perceived risks for slipping and falling at work during wintertime and criteria for a slip-resistant winter shoe among Swedish outdoor workers.

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ABSTRACT

The leading cause of work related accidents in Sweden is falls. Many slips and falls occur on icy and snowy surfaces, but there is limited knowledge about how to prevent accidents during outdoor work in winter conditions.

The purpose of this study was to describe risk factors of slips and falls and criteria for slip-resistant winter shoes from a user perspective. The result is based on focus group interviews with 20 men and women working in mail delivery, construction and home care in Sweden. The data was analyzed with qualitative content analysis.

Risk factors described were related to physical work environment, risky work situations, individual and organizational factors. User criteria for winter work shoes focused on safety, adaptation to the environment, usability and own priorities.

The mechanisms of slips and falls during outdoor work are complex. There is a need for more functional and user friendly work shoes than those available and user preferences should be considered by shoe designers. Future challenges include finding ways to make individually adapted shoes suitable for changing work environments, situations and tasks.

Key words: Accident prevention, Qualitative study, Occupational safety, Slips and falls, Risk factors, Shoes

INTRODUCTION

The leading cause of work related accidents in Sweden is falls (AFA 2011). Almost one third of all serious work accidents are falls, both indoors and outdoors caused by workers tripping, slipping or for some other reason losing their balance. Between 2009-2010 AFA Insurance registered 2281 outdoor falls, 1756 indoor falls, 1091 falls from heights, 789 falls in stairs, 178 unspecified falls and 156 were related to stepping in and out of a vehicle. Bentley and Haslam (2001) suggest that one explanation may be that many high-risk occupations involve work which takes place in unpredictable, uncontrolled and variable outdoor environments. During 2009-2011 accidents caused by falls on the level have increased. This could be related to the snow rich winters in Sweden 2009/2010 and 2010/2011 (AFA 2012). Studies have shown that slip and fall accidents are more common during winter months and cold conditions (Bentley & Haslam 1998, Bell et al 2000, Leamon & Murphy 1995). In a survey among outdoor workers in northern Sweden fall events were reported to happen most frequently on icy surfaces also covered with snow (Gao et al 2008). Also in the UK slip and trip accidents are the leading cause of occupational injury (HSE 2013).

Within the construction industry, slip, trip and fall incidents are common, and inappropriate or worn-down footwear has been identified as one of the key risk factors (Bentley et al. 2006). Another profession exposed to high risks for falls is mail delivery workers. Slippery underfoot conditions and poor slip resistance from footwear were considered as the key risk-factors for slips among mail delivery workers in UK (Bentley & Haslam 2001). In a Swedish study 74 % of the surveyed newspaper delivery workers reported a fall, of which 52% resulted in injuries (Gao et al 2008). Within healthcare falls are also a leading cause of occupational injury but the risk factors of falls in this sector have only recently been studied. A high risk for falls has been reported for community health workers and these falls predominantly occurred outdoors, in patients' rooms and kitchens. Slippery surfaces due to icy conditions or liquid contaminants were a leading contributing factor and the falls were more frequent during the colder months (January-March) (Drebit 2010).

Injuries associated with occupational falls cause both individual suffering as well as increased costs for employers and society. Common injuries registered by AFA (2011) are lower leg and forearm fractures and half of the injuries lead to medical disability. These injuries are associated with a greater risk of long term sick leave, especially when they occur in higher ages. Effective preventive measures are thus warranted.

In relation to the scope of the problem, to the best of the author's knowledge, little research has been done regarding risk factors and prevention of slips and falls for outdoor workers. Main contributors are Bentley and Haslam (1998, 1999, 2001) whose research concerned mail delivery workers in UK. They identified probable risk factors using a range of accident-centered and accident-independent methods. Key factors included slippery underfoot conditions, non-weather related environmental hazards, poor slip resistance from footwear, unsafe working practices, management safety practices, and underlying organizational influences. They recommended interventions that target accident risks at three levels: slip resistance, exposure to hazardous conditions, and employee behavior in the face of hazardous conditions. They also emphasized the use of a participative approach to intervention selection and design.

1.1. The need for a slip-resistant shoe

The use of slip-resistant shoes has been associated with a 54% reduction in the reported rate of slipping and falling in a study of US restaurant workers (Verma et al 2011). The Health and Safety Executive in the UK stresses that appropriate footwear can play an important part in preventing slips and trips at the workplace (HSE 2013). To wear slip-resistant footwear is considered important for employees working or travelling outdoors as a part of their jobs and has been recommended by the US National Institute for Occupational Safety and Health (NIOSH 2010). The use of attachable anti-slip devices on ordinary shoes has been shown to reduce slips and falls outdoors, particularly for elderly people (McKiernan 2005). Limitations with these devices can however be an altered gait pattern, discomfort, and problems of attaching and detaching to shoes. (Gard & Berggård 2006).

The Swedish Work Environment Act (SFS 1977:1160) states that the employer is obliged to provide personal safety equipment needed to prevent accidents and injuries, including safety shoes, which should be adequate in relation to the risks and suited to workplace conditions (AFS 2001:3). Regulations and guidelines for the basic requirements for safety, protective and occupational footwear provided by an employer have been published in a number of countries such as USA, Canada, Australia and for the European Union. These also include anti-slip protection on contaminated surfaces, however anti-slip protection on snow and ice is not specifically referred to. Furthermore to the best of our knowledge no standards have been set for footwear procured by the employee e.g. home help workers.

A primary risk factor for slipping is low friction between shoes and underfoot surface (Grönqvist

2001, Hanson 1999). Most previous research on slips and falls identified by the author mainly focuses on floors and/or contaminated floors. However icy and snowy surfaces near thawing temperature can be more slippery (Gao & Abeysekera 2004). The most slip resistant soling material on floors and lubricated floors may not provide sufficient slip resistance on ice (Gao et al 2004).

1.2. Usability aspects

Usability is *"the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency, and satisfaction, in a specified context of use"* (International Organization for Standardization [ISO], 9241-11).

Significant correlations between high perceived usability and a higher use of the shoes have previously been shown regarding custom-made orthopaedic shoes (Netten et al 2010). This indicates a need to consider a range of factors contributing to perceived usability when designing work-shoes.

1.3. Reasons for the study

Existing research focuses mainly on slip resistance and falls on wet and slippery surfaces indoors. We know less about factors contributing to slips and falls in outdoor environment during cold conditions. Varying outdoor conditions pose different requirements on the shoes. In addition the tasks and demands of the work most likely affect the desired properties of the shoe. The required functions of the shoes are hence closely related to the actual working conditions. Perceived usability and other factors contributing to a user-friendly shoe may affect to what extent a shoe will be worn. However little information can be found regarding workers experiences of slips and falls outdoors during wintertime, nor regarding their subjective opinion on important factors for slip resistant winter shoes. A better knowledge of perceived usability may improve our understanding of fall risk factors and assist in the design of preventive measures for work related falls outdoors.

The present study is part of a larger research project conducted by Lund University and Lund Institute of Technology, whose overarching purpose is to develop design recommendations for shoes regarding friction requirements and slip resistance based on friction measurements, biomechanical tests of walking and balance and perceived risk of slipping.

2. AIM

The purpose of this study was to describe perceived risks for slipping and falling at work during wintertime and user criteria for slip-resistant winter shoes among construction, mail delivery and home care workers in Sweden.

3. MATERIAL AND METHODS

3.1. Participants and procedure

This study used a qualitative approach with focus group interviews (Barbour 2007) as a method for data collection. Three focus group interviews were conducted with persons in high risk occupations who frequently work outdoors during winter. These were construction workers, home care workers and mail delivery workers. Each focus group consisted of five to eight participants from the same profession. The participants were recruited through their trade unions, with the aim to get a varied sample of participants within each profession. Three larger unions in the southern part of Sweden were identified and contacted by the author by phone or e-mail to assist in the recruitment of eight participants each for a group interview. The union contact persons were instructed to aim for variation in the sample regarding factors such as age, gender, current workplace, work experience and if possible experience of falling.

The participants in the first group were state employed postal workers, all working full time sorting and delivering mail in residential areas. In addition they were all local union or safety representatives at their respective workplace. The second group was construction workers consisting of two bricklayers, one concrete worker, one scaffolder and four carpenters. They were all local safety representatives and they all had predominantly outdoor work during all seasons, except for one man who worked in a workshop. The third group was home care workers working in a town community care. One person mainly attended patients in a rural area while the others spent most of their time in an inner town area. Apart from the rural home care worker who used a car, the others walked or used a bicycle. One of the home care workers was called away by work during the interview so that only four persons completed the interview. Participant characteristics are presented in table 1. All but one individual had an own experience of a slip or fall incident. Most of the mail delivery and construction workers but none of the homecare workers had shoes provided by their employer.

Table 1. Participant characteristics regarding gender, age and present work experience.

	N (male/female)	Median age (min-max) yrs	Median work experience (min-max) yrs
Mail delivery workers	7 (5/2)	36 (25-59)	12 (5-34)
Construction workers	8 (8/0)	36 (21-50)	11 (2-31)
Home care workers	5 (0/5)	45 (39-64)	20 (12-24)

The setting for the interviews was in all cases a smaller conference room at a location arranged by the union contact person. The sessions lasted about 1 hour each. They were performed as group discussions with the research leader introducing open questions from a semi-structured interview guide (Appendix A). A co-moderator took notes and supported the research leader. All participants were given verbal and written information before the interviews, explaining the purpose of the study, that participation was voluntary and that all data would be treated confidentially (Appendix B). They all signed an informed consent prior to the interviews. All interviews were recorded, and transcribed shortly after.

3.2. Analysis

The interview data was analyzed using qualitative content analysis ad modum Granehiem & Lundman (2004). The analysis had an inductive approach (Elo & Kyngäs 2008). First the interviews were read as a whole several times to obtain an overall view of the content. All data related to the research questions (meaning units) was identified and separated into two major domains; “perceived risk factors for slipping or falling” and “user criteria for winter shoes”. If the meaning of a text passage was considered related to both domains it was included in both. After condensation and coding the text passages where compared and subcategorized and finally put into broad categories based on differences and similarities in their meaning (See example in table 2).

Table 2. Example from the process of coding and categorizing meaning units, within the domain 'user criteria for winter shoes'.

Meaning unit	Condensed meaning unit	Code	Subcategory	Category	Group
Woman: Yes it should be warm. And the one we have now are definitely not warm. Sometimes it gets wet and the snow is leaking in, which makes your feet freezing cold. So you can´t feel your toes when you get home. So I want warm shoes.	Wants a winter shoe that´s warmer and more moisture resistant than the current one.	Cold and moisture resistance	Weather appropriate	Shoe adaptation to environment	Mail delivery

Where there was uncertainty regarding the meaning of the participant's statements based on the text the author returned to the taped interviews. The analysis was a dynamic process where codes and categories were continuously revised with the purpose of achieving a consistent coding throughout. An experienced mentor familiar with the material and the method was also consulted in the analysis process and some further revisions were after discussion. The final categories and subcategories represent the manifest content, and a theme illustrates the latent part of the analysis (table 3 and 4). Quotes from the interviews are used to illustrate categories and subcategories in the result section. These were translated from Swedish to English with the help of a native English speaking research colleague, together with the author who had knowledge of the interview context to ensure that the meaning of text was not lost.

The study has been approved by the Regional Ethical Review Board of Lund University, dnr 2012/20. The application was made as part of a larger study on slip and fall accidents, friction requirements and balance ability conducted by Lund University and Lund Institute of Technology.

4. RESULTS

4.1. Perceived risk factors of slips and falls

The participants described a range of factors that they perceived affected the risk of slipping and falling at work. The overall theme that emanated from the statements concerned the challenge of balancing external demands and the participants' resources. The content analysis identified four main categories. These were: the physical environment, risky work situations, individual factors and organizational factors. For each main category two to four sub-categories represent different aspects

of the content (table 3). Below categories are described and illustrated with quotes from the interviews.

Table 3. Perceived risk factors for slips and falls

Theme	Balance between external demands and own resources			
Categories	Physical environment	Risky work situations	Individual factors	Organizational factors
Sub-categories	Slippery surfaces Sloping surfaces Low visibility Inaccessibility	Bicycling Sharp turns Carrying Enter/exit building	Safety behavior Physical prerequisites	Insufficient ice/snow clearance Inadequate equipment/shoes Lack of choice

4.1.1. Physical environment

The perceived risks for slip and fall accidents were described as directly related to the external environment such as slippery surfaces, sloping surfaces, low visibility and poor accessibility.

Slippery surfaces

Slipping and falling were often attributed to slippery surfaces that gave low friction between shoe and support surface. High risk slippery conditions described were: ice, snow, packed snow, loose clay and mud, wet stairwells, wood or tile covered with algae, plastic sheets lying on the ground, polished, smooth and painted surfaces, materials covered with frost, wet or icy planks or plywood boards and steel supports. Poor friction against the surface was also attributed to wet, muddy or snowy shoes. Quote: *"There's a pretty good risk of falling during winter if the pavements are slippery and not cleared from snow and salted."(*Mail delivery)

Sloping surfaces

Participants described slipping incidents occurring on sloping surfaces such as roofs, slopes and scaffolding, and considered the sloping surface to be a risk factor of slips and falls. Quote: *"Working on roofs and slopes and such…it is always worse with those things than working on level ground." (*Construction)

Low visibility

Not being able to see potential hazards due to darkness or concealing objects were felt to increase

risks. Snow covering slippery surfaces was also considered to cause a higher risk. Quote: *”And then another thing lately is that we have been given later work hours, which means that it’s darker out in the stairways and just that means that you don´t always see where you step.”* (Mail delivery)

Inaccessibility

Participants were sometimes exposed to risky situations because of poor access. For example they might have to cross slippery grounds due to lack of suitable parking. Particularly home care workers described slipping incidents related to such circumstances. Quote: *”In (name of rural area) where we deliver cooked meals to that man, that´s where I fell in the middle of the main road. First of all... it´s so hard finding a place to park, because you can´t drive up his driveway and his house is just by the main road. And there is a bus stop just before, but you are not really allowed to park there, so you drive as far out to the side of the road as you possibly can. [...] The asphalt was wet, and the roadside was wet, and that´s where I slipped, with one foot just off the roadside.”* (Home care)

4.1.2. Risky work situations

Particular activities were considered high risk situations since they were recurrently related to slip and fall incidents. Risky work situations described were bicycling, sharp turns, carrying and enter/exit buildings.

Bicycling

Slip and fall incidents were described in situations related to bicycling or stepping of a bike. Some participants also said that they avoided bicycling during the winter if it was slippery outside. This subcategory is mainly relevant to the mail delivery workers and home care workers. Quote: *“The worst is when you are on a bike and you put your foot down on icy ground, of course it is also slippery when you are on foot, but it´s worse on the bike.”* (Mail delivery)

Sharp turns

Taking sharp turns or rapidly going around a corner of a house were considered high risk situations that could result in slipping and falling. Quote: *”So if you’re in a bit of a hurry walking around a corner then all of sudden you’ve landed on your behind”* (Construction)

Carrying

Carrying things, especially heavy and bulky objects were considered a high risk situation. The participants had a feeling of not being able to regain balance if they slipped, or to use their hands to stop the fall. Quote: *"But I think that the greatest risk is as she says when we deliver the dinners, because then we've got one, two even three bags"* (Home care)

Enter/exit building

Falls were often described in situations related to entering or leaving a building, including stepping out of a car. Especially coming in to a stairwell seemed particularly risk full. These situations could also involve rapid temperature change. Quote: *"Yes it's when it's like wet or slippery and you're coming from outside to indoors, it's just then that something can happen." (*Mail delivery)

4.1.3. Individual factors

In addition to external factors a person's individual prerequisites and behavior was thought to contribute to the risk of slipping.

Safety behavior

It was believed that individual behavior in risky situations could affect the probability of accidents. Examples of safe behavior that reduced the risk of slipping accidents were caution, attention, speed adaptation, avoiding risks and using appropriate shoes or other equipment. A factor had a negative effect on safe behavior was stress. Stressful situations could lead to reduced attentiveness and cautiousness. Quote: *"Well stress can be one thing. You're stressing between the clients, it's then you're in a hurry. Especially the morning routine, everybody wants help at about roughly the same time, like 8 ,9 10 o'clock. Just then you're rushed and when you leave one place and on your way to another you don't always think "My goodness it's slippery today" you just keep on going and there's a bigger risk of falling" (*Home care*)*

Physical prerequisites

Physical abilities, such as balance, strength and joint mobility were believed to influence the risk of falling in certain situations. Also self-perceived clumsiness and age were mentioned as affecting factors. Some participants believed that previous injuries could lead to impaired functional control and to an increased risk for falls. Quote: *"I think it's an individual thing as well. You know somebody who's 50 or 60 who doesn't have muscles like a younger person could need better*

working shoes, while a well-trained 20-25 year old maybe doesn't need as good a shoe, he manages anyway. Maybe a younger person doesn't even lose his step where an older man would. It's very individual." (Construction)

4.1.4. Organizational factors

Organizational factors refer to circumstances that affect the working conditions such as routines for snow removal equipment, overriding regulations and job demands.

Insufficient snow clearance

Participants described that maintenance of streets and ground, such as snow clearance and salting, were not always handled satisfactorily by the responsible party. This was identified as a problem that increased the risk of slipping. For the mail delivery workers and home care workers the responsibility for ground maintenance was often not within their own organization, which made them feel vulnerable to unpredictable conditions that they could not influence. Construction workers, who usually worked within a specific site, more often mentioned special circumstances that made it difficult to keep the workplace free from snow and ice. Quote: *"Yes, I mean on concrete before we mount the roof beams and before putting on the boards. It is very difficult keep that area clear, and we're not allowed to put salt there either." (Construction)*

Inadequate equipment/shoes

Use of inadequate shoes or equipment in the workplace was described to increase risks of slipping. For example work materials especially designed to prevent slips were not used for cost or time reasons. Home care workers argued that they were disadvantaged because no work shoes were provided by their employer. Sometimes shoes inadequate for slippery conditions were worn because comfort and cost were prioritized. Quote: *"About shoe material…. I usually have trainers. Not smart when the frost comes because they're not made for being outdoors so much. And I mean they get worn down and then the ground feels even more slippery."* (Home care)

Lack of choice

A feeling of not having any choice but to get the work done affected the participants' possibilities to ensure their own safety, and made them feel more exposed to risks of slipping and falling. Quote: *"Privately I can choose not to go out. I mean I don't have to go out if I don't want. If it looks like an ice rink out there, no, I don't go outside. But when I'm working I don't have a choice. I have to.*

Have get out and do my job." (Home care)

4.2. User criteria for winter shoes

The criteria for winter shoes were multifaceted. Four main categories were identified. These were: user safe shoe, shoe adaptation to environment, own priorities and usability. For each main category two to five subcategories represent different aspects of the content (table 4). Below categories are described and illustrated with quotes from the interviews.

Table 4. User criteria for winter shoes

Theme	Complex and multifaceted adaptation to both user and environment			
Categories	User-safe shoe	Shoe adaptation to environment	Usability	Own priorities
Sub-categories	External protection Stability User control	Appropriate for weather Sole friction Adapted to varying environments	Quick and simple Light and flexible Multifunctional Durable Comfortable	Affordable Possibility to choose

4.2.1. User safe shoe

The shoe should provide external protection for the feet, as well as being ergonomically suitable.

External protection

One important criterion for the shoe was that it should protect against injuries from sharp objects, impacts, crushing etc. In the construction industry, and for some tasks performed by the mail delivery workers, safety shoes with steel cap and protective sole was required by law. Home care workers mainly described the shoes as protection against dirty and unsanitary indoor and outdoor environments, and as protection if they were to drop a syringe. Quote: *"We have to have steel toed protective footwear in our work. For example when we drive trollies indoors we have to have protective shoes, there are rules which we must follow"* (Mail delivery)

Stability

A desired property of the shoe, mentioned by participants from all three professions, was that it

should provide ankle stability. Quote: *"But I would like to have stability sideways also because if you tramp on something, your foot might give way and that's when we get these sprain injuries. A little more stability sideways"* (Construction)

User control

Participants perceived that their ability to adjust for instability and to maintain balance in certain situations was dependent on that the shoe allowed for movements and for the user to feel the ground underfoot.. Lack of such qualities was particularly noticeable for the construction and mail delivery workers who used steel cap shoes or work-shoes with thick soles. Quote: *"Yes I think that your balance is a little worse. Yes, that's what I mean, I think that the sole at the heel is too thick so that's why I feel I have poorer balance than in my own shoes. And it feels as if that you're a bit…because you're a bit taller you've automatically got a poorer balance because it's further down to…" "Yeah it doesn't feel that your stability is good". "You don't have the same feeling of contact"* (Mail delivery)

4.2.2. Shoe adaptation to environment

Since risks of slipping and falling were often attributed to environmental factors shoes that were appropriate for the surrounding environment were consequently desired.

Appropriate for weather

The most frequently mentioned criterion for winter shoes was for them to be adapted to winter weather. This includes the capacity of the shoe to maintain warmth, resist moisture and deep snow. The possibility to change between different shoes by the season or weather was also considered appropriate. Quote: *"Yes they have to be warm and the ones we have are definitely not warm, sometimes they get damp and the snow seeps in and then the feet get ice-cold so that you don't feel your toes when you get home, so I do want warm shoes."* (Mail delivery)

Sole friction

All three groups gave suggestions on how the sole of the shoe should be designed not to slide. Soles that provided friction against slippery, hard and smooth surfaces as well as on snow and mud were desired. Suggestions included rough soles with deep treading. However patterning could also be negative when snow got stuck underneath and made them slippery. Sturdy studs or spikes were considered optimal for icy surfaces, but at the same time this was not practical as workers alternate between different surfaces including indoor floors. Innovative suggestions were discussed, for

example materials that adapt to changing surfaces and temperatures, non-adhesive materials where snow and mud don´t get stuck and studs on selected locations on the heel and forefoot of the shoe to prevent slips at heel-strike and toe-off. Suggestions were also made about taking influences from hiking shoes and the car tire industry. There were different opinions regarding optimal contact area between sole and underfoot surface. Overall there seems to be different needs depending on where and how you work as well as varying opinions about solutions. Quote: *"I am not going around wearing studded shoes, I'll be more at risk when climbing the scaffolding. I mean if I'm to climb on piping and don't have a steady flat* surface. *If you're talking about those ice clamps that you put on the shoe then there's no way I'm going about climbing in those.* (Construction)

Adapted to varying environments

Especially the construction workers considered it problematic to find an optimal shoe because they move between different environments and surfaces during the day. All professions stated that they commonly wear their shoes both indoors and outdoors, and that sudden temperature changes could occur. Quote: *"You still have the problem with indoors and outdoors. I mean for us who work both on the service side and on the sites or when we go indoors for lunch or something. Maybe, nowadays we sit in pretty good work rooms and to walk around there with ice clamps on plastic matting, well nobody would be a happy for that. Not to mention parquet floors... So if we are running in and out of houses and such…it's just not on."* (Construction)

4.2.3. Usability

Usability includes properties of the shoes that makes them user friendly. Participants described a great variety of factors they perceived to be important in making the shoe useful for them in relation to the intended work. Within these descriptions five subcategories emerged.

Quick and simple

Speed and simplicity had high priority for most participants, but was especially highlighted in the construction and home care group. For example participants described not having time to put on anti-slip devices on their shoes. Quote: *"When you are just popping in and out it takes longer to take your shoes off…"* (Home care)

Light and flexible

All three groups had mobile jobs and the shoe had to allow them to move around, both indoors and

outdoors. Mainly participants wanted the shoes to be light-weight and flexible and heavy shoes were believed to make you clumsy. Quote: *"They ought not to be too heavy because we're always on the move indoors and outdoors."* (Mail delivery)

Multifunctional

Opinions were raised regarding the complexity in finding a shoe that functions for all occasions For example the shoe offering the best protection against ankle sprains might not be as flexible as required. A protective steel cap often results in lesser comfort. And soles with good anti slip properties on one surface may be unsuitable for another. The main point was that many aspects had to be considered. Quote: *"Absolutely, all this we're talking about is very important. You have to find a good mix of everything. Because I mean we are exposed to these things every day."* (Construction)

Durable

Participants described that there was heavy wear on the shoes. They also experienced that worn down and shiny soles could increase the risk of slipping. It was pointed out that soft materials in the sole of the shoe got worn down more quickly. Quote: *"It must be easier to slip and fall when they (shoes) get worn down"*.*"Yes, so must be the case. Especially trainer shoes… which may get quickly worn down and becomes shiny underneath. And with those, then it's so easy to have a slip."* (Home care)

Comfortable

Comfort was given high priority by participants in all three groups. Factors considered to increase comfort were ergonomic design, individual adaptation to the feet (e.g. molded soles), ventilation, support, stability, cushioning and light weight. Comfortable shoes helped prevent tired feet and legs at the end of a long work day. Trainers were overall considered the most comfortable shoe. Quote: *"There's a reason why people reject wearing the work shoes and choose trainers instead. They are not so comfortable, but the shoe I have now is a summer shoe and they feel ok."* (Construction)

4.2.4. Own priorities

In addition to function and usability of the shoes other factors could also affect the participants' priorities regarding their work shoes. Personal economy and individual choices were commonly mentioned factors.

Affordable

The participants working in home care, who bought their own shoes since it was not provided by their employer, described cost to be a key factor when choosing their shoes. The footwear used at work often had a lower priority than other everyday shoes, and shoes were sometimes used at home first and taken to work when they were almost worn out. Quote: *"I feel that it's too expensive to have two pairs of working shoes. We need to keep ourselves in both working clothes and shoes to do our work. …"* (Home care)

Possibility to choose

Being able to make individual choices regarding what shoes to wear was considered important. A selection of different shoe options according to work tasks was desired. Participants also described that they for various reasons sometimes used their private shoes instead of the ones provided by the employer. Quote: *"Because we have varying working tasks we need different shoes for different tasks*" (Mail delivery)

5. DISCUSSION

5.1. Method and limitations

Most existing research concerning occupational accidents is based on data from accident registers or survey studies. However it has been emphasized that intervention research aimed at accident prevention requires a qualitative understanding of the social meanings and social relationships that make up the study environment in order to clarify possible explanations for the quantitative findings (Needleman 1996, Baril-Gingras 2006). In the present study the method of focus group interviews was chosen to gather qualitative data. Using focus groups made it possible to investigate and gain detailed information about incidents that occur sporadically. The author assumed that individual interviews would not yield as rich data about the research questions, and that group discussions would lead to a more nuanced result. According to Barbour (2007) and Robinson (1999) focus groups can facilitate discussion and critical reflection among the participants when stimulated by other persons views on the subject. Focus group interviews have previously been used and considered useful in providing suggestions for fall prevention among health care personnel (Shokouhi et al 2010).

The limitations of group interviews are possible risks of negative influence of peer pressure and established roles and expectations within the group, and limited depth of the interviews. As pointed

out by Rapley (2001) the conversations in the groups must be viewed as the result of a specific interaction in a specific context. Explanations given by workers related to an occupational accident experience can be defensive (Niza 2008).

In the present study qualitative content analysis was chosen as the method for analysis. This is a well-established method that can be used for focus group data (Elo & Kyngäs 2008, Kitzinger 1995). Since the purpose was not to test a preexisting theory, but rather to gain a better understanding of a relatively unexplored subject, an inductive approach was considered more appropriate. Content analysis has been considered limited in creating explanatory frameworks and models (Hsieh & Shannon, 2005). This was however not the purpose of the present study.

In most qualitative research the researcher is a central figure in the process of gathering and interpreting data. Efforts to minimize subjective influence were made by using open questions, having a mentor peer, well versed in the method, to review the process of analysis and raising awareness of personal prior understandings of the subject investigated.
Also the selection process of the participants may affect the outcomes. The selection of the participants was made with the help of a contact person from the union and was aimed at collecting a varied sample. Several of the participants were local union or safety representatives, and these persons most likely had a higher knowledge regarding occupational safety and risks compared to most workers, which may have contributed to rich data. In one of the group interviews the contact person from the union was allowed to stay in the room during the interview. This could have affected the participants' answers. Before the interview started all participants gave their permission for him to stay, and the author did not notice any obvious influence related to his presence.

5.2. Results and future challenges

5.2.1. Risk factors for slipping or falling during outdoor work in wintertime
The focus group discussions revealed that the participants in all three professions experienced a high risk for slip and fall accidents during outside work at winter. All participants had personal experiences of slip or fall incidents, and identified risks related to the physical environment, risky work situations, individual factors and organizational factors. To the best of the authors' knowledge qualitative descriptions of perceived risks specific for outdoor work in wintertime have not been published and hence provide new information. There are however similarities between the risks

reported in this study, and risk factors for slip, trip and fall accidents previously identified among mail delivery employees (Bentley & Haslam1998), and construction workers (Bentley et al 2006).

The participants in the present study described risks related to slippery and sloping surfaces. These results support previous quantitative research that has demonstrated correlations between sloping and slippery surfaces and falls (Hanson et al 1999, Simeonov et al 2003). Another risk factor identified by the participants was low visibility caused by concealing objects, snow or darkness. In the analysis by Bentley & Haslam (1998) of accidents occurring during the delivery of mail three-quarters of falls occurred between 7 and 9 a.m. This could be related to poor visual conditions during these early hours. An explanation may be that use of anticipatory and adaptive strategies is prevented when visual detection of slippery surfaces is not possible (Grönqvist et.al 2001). The qualitative descriptions of risky situations, such as carrying and taking sharp turns, help explain findings earlier reported quantitatively by Myung (2010), Holbein (2012), Cham (2001) and Chiou et al (2002). Past research on other high risk situations identified in this study, such as bicycling and enter/exit buildings, are lacking. These risks are especially relevant for persons working outside during wintertime, and should be considered in future accident prevention research.

The outdoor-workers perceived that individual factors such as age and physical capacity influenced the risk of falling in wintertime. A relationship between age and falls has been shown in a study by Kemmlert (1998), where falls were more frequently reported among older women than their younger colleagues. Research by Lockhart et al (2000, 2002) indicates that the ability to successfully recover from a slip (thus preventing a fall) could be affected by lower extremity muscle strength and sensory degradation of the elderly individuals. Participants in the present study also perceived that organizational factors such as routines for snow removal, work equipment, stress and other job demands influenced the risks for slips and falls during winter. The importance of organizational factors for slip, trip and fall accidents have previously been shown by Bentley & Haslam (1998) and Bentley et al (2006).

5.2.2. Criteria for a slip-resistant winter shoe

The result of the present study showed that shoe preferences are individual but many criteria are also shared. The criteria for winter shoes described by the participants in this study included a variety of aspects which were categorized as; safety for the user, adaptation to the environment, usability and own priorities. Similar criteria have been discussed by Gao et al. (2008) who performed a questionnaire survey among outdoor workers (newspaper delivery, mining and military

service).

How to obtain optimal shoes sole friction against the underfoot surface was a challenge discussed in the focus groups. The participants mentioned that underfoot surfaces commonly changed during a workday, and there was no time to change shoes, so achieving optimal anti-slip properties were a problem. Spiked shoes for example might provide the best friction when stepping on an ice patch, but were perceived to be inadequate for indoor floors or steel constructions. Participants in the present study suggested that soles with only a few studs placed around toe and heel area might be a solution. This was based on their experience that slips mainly occurred at toe off and heel strike, which is supported by the research by Strandberg & Lanshammar (1981) and Manning et al (1991). Results from experimental studies indicate that it is most likely to fall due to an anterior foot slide, which would occur during early stance (heel strike) (Robinovitch et al 1996, Hsiao & Robinovitch 1998). In detachable anti-skid devices studs or other anti-slip materials area often located only under the heel area. This concept might be worth considering as a built-in function of work shoes. Such solutions may allow the shoes to be worn when climbing on steel constructions or crossing an floor indoors.

The risk of a slip or a fall occurring is not merely a result of the friction coefficient between the shoe and the underfoot surface but also dependent on the individual's capacity to adjust for the imbalance. A range of human factors affecting balance control in relation to a slip, such as anticipation of slipperiness and gait adaptation, have been summarized by Grönqvist et.al (2001). There are studies suggesting that gait kinematics play an important role in the severity of an ensuing slip (Moyer 2006, Redfern et al 2001). Especially strategies involving movement in the ankle joint seems to be of importance (Chiou et al 2002, Fong et al 2005). Properties of the shoes that affect ankle mobility may therefore be assumed to affect balance control. In addition shoe requirements may vary depending on individual physical prerequisites, job task and environmental circumstances. All of these aspects need to be considered for optimal balance control. At the same time other factors such as safety, usability, comfort and individual priorities should be borne in mind.

An important finding in the present study was that the criteria described by the participants were all highly intertwined, and one aspect could not be overlooked in favor of another without problem. This is important knowledge for work-shoe designers. Usability aspects such as comfort and simplicity have to be weighed against requirements of safety and environmental demands. For

example some participants experienced that a light and flexible shoe allowed the user to better compensate for imbalance. Flexibility was also preferable for tasks that involved a lot of moving around. On the other hand, a shoe that provided stability around the ankle was desirable to prevent sprains, and substantial support and cushioning were perceived important for comfort. The opposing aspects of flexibility and stability were thus considered equally important but difficult to combine. To obtain an optimal balance between flexibility and stability is a future challenge for shoe designers.

In conclusion; the results from this study indicate that the causes of slips and falls are multifactorial In our opinion the results of the present study validate the comprehensive systems model of factors contributing to slip and fall accidents on icy surfaces presented by Gao and Abeysekera (2004). This model includes footwear properties, underfoot surface characteristics, footwear/surface interface (friction), human gait biomechanics, human physiological and psychological aspects and environmental factors (Gao & Abeysekera 2004). Ideally all these aspects should be targeted to prevent accidents. In some situations use of proper footwear can be a feasible way to prevent slips (Verma et al 2011, McKiernan 2005). The participants in the present study however described dissatisfaction with both the shoes provided by the employer and the non-provision of working shoes. The shoes were often not suited for the working conditions or were uncomfortable which resulted in some persons not using the shoes, possibly increasing the risk of injury. Gao et al (2008) showed that professional footwear provided for outdoor workers does not provide enough protection against slips and falls.

Designing perfect shoe ware that is optimal for all circumstances may not be possible. The result s from this study indicated that individual adaptation to both person and environment is important. Collaboration between scientists and users of the shoes might help in finding functional solutions. The results from this study may contribute to the quest of improved winter work shoes, and be used for evaluation of slip resistance properties and usability of foot wear and anti-skid devices. Understanding the workers' perspective is likely to be of importance in accident prevention programs at workplaces. This study therefore aimed at presenting the participants' own perceptions regarding slips and falls and footwear.

A major focus of this study has been on aspects relevant for design of non-slip shoes. The results indicate that organizational aspects involving routines, equipment, snow removal, stress etc. should also be considered in accident prevention. The authors suggest this to be a topic for future research.

The risk factors and criteria identified also need to be investigated further to better understand its mechanisms and variations within different groups and contexts. Comprehensive meta-studies summarizing the research in the field are needed. In addition more research regarding implementation of accident prevention interventions is required.

Conclusions

Interviews with out-door workers in high risk professions can give valuable information about slip and fall incidents during winter conditions. Perceived risk factors seem to be related to both work environment and situations as well as individual and organizational factors. To prevent accidents the risks need to be addressed at several levels, including development of proper non-slip footwear. The results of this study support the need for further research into slip protection while working on snowy and icy surfaces and also for the creation of regulations for footwear for homecare workers, who at present are responsible for buying their own shoes. The results of the present study indicate that winter shoes for outdoor workers in mail delivery, construction and home care should be individualized and adapted to both work demands and environment. Work shoes also need to be multifunctional and user friendly. Future challenges for shoe designers include finding ways to optimize underfoot friction in varying conditions, as well as ensuring safety, balance and usability for the individual.

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Appendix A. Interview guide

Intervjuguide

Hur upplever ni risken att halka eller falla vid arbete utomhus på vintern?

I vilka situationer och miljöer föreligger störst risk att halka/falla?

Berätta om en situation då du föll eller halkade i arbetet på vintern?
- Vad tror du var orsaken till att du föll/halkade
- Skulle detta kunna förebyggts på något vis, hur?

Vad känner ni till om hur man kan förebygga fall/halkning i arbetet?

Vilka krav ställer ert arbete på arbetsskor som ska användas på vintern?

Vad upplever ni personligen är viktiga egenskaper för en arbetssko som ska användas på vintern?

Beskriv en optimal sko för arbete utomhus i kall miljö.

Hur upplever ni de skor som ni har idag?
- Tillhandahålls dessa av arbetsgivaren?
- Fördelar/nackdelar med skorna?

Appendix B. Information letter to informants

Intervjustudie om halkrisk i arbetet

Bakgrund och syfte

I Sverige och runt om i världen är olyckor och skador som inträffar i arbetet ett stort problem som leder till personligt lidande, långvarig sjukskrivning och ekonomiska konsekvenser för företag och för samhället. Den vanligaste orsaken till allvarliga arbetsskador är fallolyckor som orsakas av halkning eller snubbling. Hala och våta underlag är ofta en bidragande orsak. I länder som Sverige där vi har ett kallt klimat på vintrarna är halkning på snö- och istäckta underlag vanligt förekommande bland personer som arbetar och rör sig utomhus. Speciellt utsatta grupper är bland annat byggnadsarbetare, brevbärare och hemvårdspersonal.

Forskningsstudier har visat att användande av lämpliga arbetsskor kan minska fallrisken väsentligt både inom- och utomhus. Den mesta forskning har hittills gjorts på inomhusförhållanden, men projekt pågår nu bland annat på Lunds Universitet och Lunds Tekniska Högskola för att ta fram lämpliga rekommendationer för design av skor för utomhusbruk i kalla miljöer.

För att de skor som tas fram ska vara så bra och användbara som möjligt är det mycket viktigt att de är anpassade utifrån de personer som ska använda dem och de krav som deras arbete ställer. Syftet med den här studien är därför att få information ur ett användarperspektiv från personer inom relevanta yrkeskategorier. Detta kommer att genomföras genom intervjuer med fokusgrupper.

Förfrågan om deltagande

Vi vill inbjuda Dig att delta i denna intervjustudie, eftersom Du tillhör en av de utsatta yrkesgrupper som arbetar utomhus vintertid. Vi har fått Ditt namn via Din fackförening.

Hur går det till?

Du kommer att kallas till en gruppintervju där cirka 8 personer deltar i ett gemensamt samtal kring följande frågor:

Upplevd halkrisk i samband med arbete utomhus vintertid och under hala förhållanden.

Kännetecken och kriterier för användbara halkfria vinterskor.

Samtalet i gruppen beräknas ta cirka en timme.

Hantering av data

Intervjuerna kommer att spelas in på band och överföras till skriven text. All information och eventuella personuppgifter avidentifieras och kommer att behandlas konfidentiellt. Endast forskarna involverade i studien har tillgång till materialet som förvaras inlåst. Resultatet av intervjuerna kommer efter analys och sammanställning att utmynna i en artikel som kan komma att publiceras i en vetenskaplig tidsskrift. Syftet är att resultatet ska bidraga till designrekommendationer för halkfria skor. Inga personer eller arbetsplatser ska kunna identifieras i publicerat material.

Frivillighet
Deltagande i studien är frivilligt och Du har när som helst, utan särskild förklaring, rätt att avbryta ditt deltagande.

Ersättning
Vi kan tyvärr inte ge någon ekonomisk ersättning för Ditt deltagande. Vi försöker dock att underlätta deltagande genom lämplig plats och tid för intervjuerna, som vid önskan kan förläggas till Er arbetsplats. Vår ambition är att resultatet kommer att bidra till säkrare arbetsförhållande för Dig och andra.

Ansvariga
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Med vänliga hälsningar

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