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Preventing winter falls: a randomised controlled trial of a novel intervention

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Abstract

Aim To investigate the hypothesis that wearing socks over shoes improves traction on icy footpaths.

Methods Randomised controlled trial involving 30 pedestrians (median age 21 years, range 18–70) travelling in a downhill direction on icy public footpaths at two sites in Dunedin, New Zealand. Intervention: different coloured socks applied over normal footwear or usual practice (unadulterated footwear). Primary outcome: difference in mean self-reported slipperiness on a 5-point scale. Secondary outcomes: falls, observer-rated slipperiness, observer-rated confidence, time to descend study slope.

Results Two-thirds of participants (65%) had previously fallen on ice. Wearing socks over normal footwear was associated with a statistically significant improvement in traction; the difference in mean self-reported slipperiness scores between the control (n=15) and intervention (n=14) groups was 1.3 (95%CI: 0.4–2.3). Agreement between self-rated and observer-rated slipperiness was high (r=0.70). A higher proportion of the intervention group (71% vs 53%) appeared confident. One member of the control group fell. There was no evidence of risk compensation in the intervention group (difference in mean descent times 1.9 seconds, 95%CI: -6.1–10.0). The only adverse events were short periods of indignity for some members of the intervention group.

Conclusion Wearing socks over shoes appears to be an effective and inexpensive method to reduce the likelihood of slipping on icy footpaths.

There are anecdotal reports that pedestrians who wear socks over top of their footwear are less likely to slip and fall in icy conditions. Advocates of this practice include our local council (in Dunedin) which advises residents who prefer to walk (rather than drive) in icy conditions to "put a pair of old socks over your shoes to increase grip".[1]

Methods to enhance footwear traction have particular relevance for our population. While the university, hospital, and business areas of Dunedin are located on relatively flat land, most residential areas are clustered on the surrounding hills. In winter, damp weather followed by freezing conditions can transform a quick journey to work into a lengthy and perilous expedition.[2]

Searches of Medline and the Cochrane Library (using the terms "ice", "falls", "prevention", and "socks") failed to locate any evaluations of unorthodox sock wearing. To remedy this surprising gap in falls prevention research, we decided to undertake a randomised controlled trial to investigate the hypothesis that wearing socks over shoes improves traction on icy footpaths.

Methods

Participants and settings—We initially considered recruiting volunteers to walk down a short suburban street (Baldwin Street) which, according to the Guinness Book of Records, is the steepest street in the world. However this proved impractical for two reasons. First, requiring volunteers to traverse a 1 in 2.86 gradient in icy conditions seemed ethically and legally unwise. Second, in order to travel downhill in this cul-de-sac, the researchers and volunteers would need to scale the incline. This was not an attractive prospect.

We therefore decided to adopt a pragmatic approach and intercept passing pedestrians at two other sites (Figure 1). These particular sites were chosen because many university employees, students, and members of the public used these routes each morning. Moreover, painful experience meant that all of us were acquainted with their slippery nature in icy conditions.

Figure 1. Study sites

To be eligible for inclusion in the trial, passing pedestrians simply needed to be travelling in a downhill direction. It was decided *a priori* that persons already wearing socks over their shoes would not be eligible.

At both sites, the researchers were divided into two groups: recruiters and outcome assessors. These groups were stationed at the uphill and downhill ends, respectively, of the study slopes. Recruiters asked pedestrians whether they were willing to take part in a study to assess the anti-slip performance of different types of footwear and different types of socks worn over the top of footwear.

Participants gave verbal consent and completed a questionnaire which collected demographic data, as well as information about experience with icy conditions, previous falls on ice, injuries, familiarity with the route, and type of footwear (also photographed). Once this information had been recorded, recruiters opened a sealed envelope to ascertain the group to which the participant was allocated.

Intervention—Participants in the intervention group were provided with a pair of socks to put on over their footwear (Figure 2). The acrylic-blend work socks (size 11–14) were purchased in bulk from a budget department store using independent research funds.

Individuals in the intervention (socks) and control (no socks) groups were directed to walk downhill as normally as possible (given the conditions). In light of the observed behaviour of pedestrians (often young men) at these sites on previous mornings, participants were asked to refrain from deliberately skidding or sliding.

Figure 2. Correctly fitted socks

Outcomes—On reaching the outcome assessors, participants were asked to complete an assessment form. Self-rated slipperiness (the primary outcome) was measured using a validated slipperiness scale.[3] Participants were asked to indicate on the 5-point scale how slippery they found their descent: "not slippery", "somewhat slippery", "slippery", "very slippery", or "extremely slippery". Previous research has shown a strong, statistically significant correlation between subjective reports of slipperiness and objective measures of friction (r=0.90).[4] Participants were also asked to report any falls and to make any other comments they wished.

To validate self-reported slipperiness, outcome assessors independently recorded (using the 5-point scale) how slippery participants appeared to have found the footpath. Assessors were also asked to document any falls and to comment on the demeanour of the participants during their descent (for example, "walked confidently", "clung to fences or parked cars", "crawled"). Finally, to detect any risk compensation in the intervention group, the assessors used stop-watches (standard issue obtained from one electronics shop) to time the descent of each participant. Landmarks such as water valve covers and traffic signs were used as starting and stopping points.

Sample size—Sample size calculations were undertaken using PS software.[5] To detect a difference of 1.5 in mean self-rated slipperiness, with a 1:1 ratio of intervention to control participants, using an alpha of 0.05, 90% power, and a within group standard deviation of 1.1,[3] we calculated that 12 people in each arm of the trial would be required.

Randomisation—Microsoft Excel software was used to generate the random allocation sequence which was stratified by site. Sheets of paper noting the allocation status (socks / no socks) were placed in numbered opaque envelopes which were then sealed. Recruiters were instructed to use these envelopes in numerical sequence after they had administered the baseline questionnaire.

Blinding—It was not possible to blind the participants and outcome assessors to treatment allocation. However, certain measures were employed to conceal the exact nature of the study hypothesis, and hence minimise biased assessment of outcome.

First, to avoid any implication that socks were superior, all recruiters and outcome assessors were instructed to wear unmodified footwear. Second, participants and assessors were simply told that we were interested in assessing the performance of different types of footwear and different types of socks worn over the top. Third, participants' footwear was photographed for later reference and this might have encouraged participants and assessors to think that the characteristics of footwear were important. Fourth, because we had heard anecdotal accounts about the supremacy of certain types of socks, we deliberately allocated socks of three different colours to confuse any avid sock supporters about what, exactly, was being tested. To avoid any disclosure of the true state of affairs (that the socks were of identical composition), the labels were removed by the principal investigator. This action was also

necessary because the socks were labelled "alpha ♂™" and we did not wish to encourage any rash behaviour in the intervention group.

Statistical methods—Observer comments about the demeanour of participants were summarised into three categories: "confident", "cautious, but did not hold onto supports" (fences, railings, or parked cars), and "held onto supports". The data were analysed according to intention to treat. The groups were compared using a t-test for the continuous or ordinal variables and a Fisher's exact test for the categorical variables. Because men were known to be more intrepid than women, the sample size was increased to allow adjustment for sex.

Ethical approval—Ethical approval was granted by the University of Otago Ethics Committee at departmental level.

Results

Participants—The trial was conducted on 15 August 2008. A total of 30 pedestrians underwent randomisation (Figure 3). One young woman after agreeing to participate, and appearing to understand the instructions, inexplicably turned to walk back uphill and disappeared. The most common reason given for not participating in the trial was "running late for lectures".

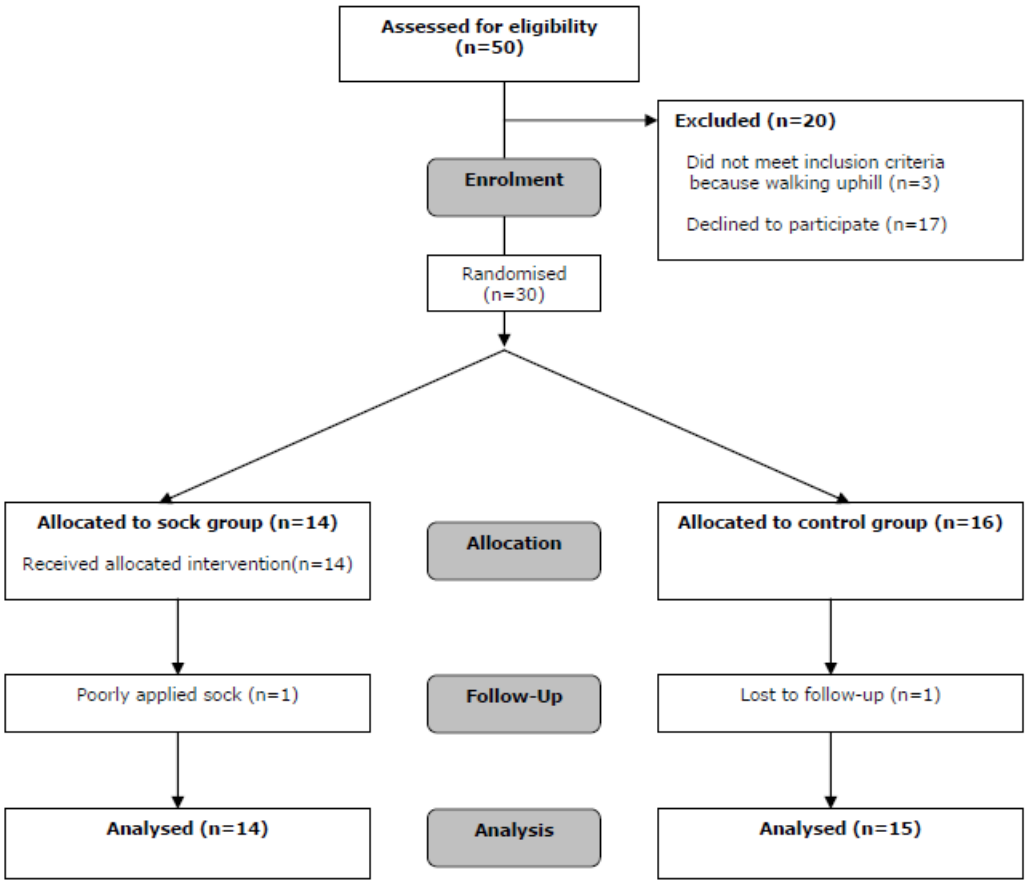
No-one was already wearing socks over their shoes. Only one participant did not fully comply with the study protocol: a segment of redundant sock at the toes (resulting from improper application) created a hazard. In accordance with intention to treat principles, her data were analysed as randomised.

The baseline characteristics of the participants are shown in Table 1. High proportions of both groups had previously fallen on ice. All participants were wearing sensible footwear.

Table 1. Baseline characteristics of study participants

Variables	Intervention group (n=14)	Control group (n=15)
Women (no [%])	7 (50)	5 (33)
Median age (range)	22.0 (19 – 58)	21.0 (18 – 70)
First winter in icy conditions (no [%])	—	1 (7)
Previous falls on ice (no [%])	8 (57)	11 (73)
≥ 1 fall this winter (no [%])	4 (29)	7 (50)
Injury from fall this winter (no [%])	1 (7)	—
Time been walking this route (no [%]): <6 months 6–12 months >12 months	 3 (21) 9 (64) 2 (14)	 2 (13) 9 (60) 4 (26)

Figure 3. Flow of participants through the trial



Outcomes—Wearing socks over footwear significantly improved traction (Table 2). The mean self-reported slipperiness scores in the intervention and control groups were 1.6 (SD 1.14) and 2.9 (SD 1.32) respectively (difference in means 1.3, 95%CI: 0.4–2.3). This difference increased to 1.4 (95%CI: 0.4–2.3) after adjusting for sex. There was a high level of agreement between self-rated and observer-rated slipperiness (r=0.70).

A higher proportion of the intervention group (71%, 10/14) than the control group (53%, 8/15) appeared confident while descending the study slopes, although the difference was not statistically significant (p=0.45). There was no evidence of risk compensation in the intervention group (difference in mean descent times 1.9 seconds, 95%CI: -6.1–10.0).

Table 2. Pre-specified primary and secondary outcomes

Outcomes	Intervention group (n=14)	Control group (n=15)	Difference in means (95% CI)
Primary outcome (mean [SD])			
Self-rated slipperiness	1.6 (1.14)	2.9 (1.32)	1.3 (0.4 – 2.3)
Secondary outcomes (mean [SD])			
Observer-rated slipperiness	1.6 (0.66)	2.3* (1.07)	0.64 (0 – 1.3)
Seconds to descend slope	37.7 (9.36)	39.6 (11.57)	1.9 (-6.1 –10.0)

*Observer-rated slipperiness score was missing for one control.

Two members of the control group and one in the intervention group (who tripped on improperly applied socks) slipped, but only one fell (a control). Although participants in the intervention group were told that they could keep their socks, many (who appeared to have image issues) opted to return them to the outcome assessors — including one young man who promptly fell on leaving the assessment area. Falls were also observed, incidentally, in non-sock-wearing pedestrians negotiating intersecting streets. No obvious injuries were sustained in the vicinity of the study sites.

Feedback from the intervention group about the use of socks was informative: "socks are key!!", "that was sweet as", "recommend socks for hungover people", "socks helped with slipperiness but wouldn't wear them to uni[versity]!"

Adverse events—The only adverse events were short periods of embarrassment for the image-conscious in the intervention group.

Discussion

Wearing socks over footwear significantly reduced the self-reported slipperiness of icy footpaths and a higher proportion of sock-wearers displayed confidence in descending the study slopes. The only falls occurred in people who were not wearing (external) socks.

The trial had other unanticipated benefits. For example, a retired couple who lived beside one of the study sites provided a compelling oral history covering several decades of ice-related mishaps on their street.

It was not possible to blind participants or outcome assessors. However, some obfuscation of the exact hypothesis reduced the potential for biased outcome assessment. Moreover, it was reassuring to learn that many of the participants had previously been unaware of this novel use of socks. Apart from sex, no adjustment was made for imbalances in the baseline characteristics of the groups as these were not specified before beginning the study. It is possible that the control group, having a larger proportion of participants who had previously fallen on ice, were more inclined to report slipperiness and to be less confident. However, the difference in proportions was related to the sex imbalance between the two groups and the fact that men in the control group were more likely to have fallen than the women. We did not enquire about the circumstances of previous falls, but if the excess among the men resulted from deliberate attempts to slide this would make it less likely that our results are an artefact of a higher level of trepidation within the control group.

The research presented several unique challenges. Unfortunately, freezing conditions, unless accompanied by a certain degree of moisture, do not guarantee a slippery footpath. Thus we could not set a specific date for data collection. Although our Head of Department's suggestion to furtively spray the study slopes with water had some practical merit, we were obliged to reject his idea and wait for suitable conditions. Inevitably, when they did occur, it was difficult to reach the study sites.

It has been suggested that new arrivals to cold climates should be warned about the dangers of falling on ice and, moreover, should be given special training on how to walk in such conditions.[6] As part of this preventive approach, perhaps municipal authorities in colder regions of the country could consider issuing a large pair of socks (in local colours) to each new resident.

Research questions for the future include "does wool perform better than synthetic?" and "which socks perform best in a cost-effectiveness analysis?" Other suggestions for future investigations are of a practical nature: provide a thick rug for participants to sit on while putting on socks, supply socks of varying sizes, and pack a thermos flask.

Conclusion

Despite some residual scientific uncertainty, because of the high frequency of ice-related falls in our population, the cheap and simple nature of the socks-over-shoes intervention, and the absence of physical harm (if correctly fitted), we feel inspired to join an eminent professor, herself a long-time proponent of socks, in adopting this practice this winter.

Competing interests: None known. In particular, none of the authors has financial links with sock manufacturers and none of us own sheep.

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References:

1. Dunedin City Council. Winter driving. Dunedin City Council website. 3 July 2008. http://www.dunedin.govt.nz/services/roading/winter-driving
2. Porteous D. Icy roads make for difficulties. Otago Daily Times. Otago Daily Times website. 11 August 2008. http://www.odt.co.nz/news/dunedin/17187/icy-roads-make-difficulties
3. Gao C, Holmér I, Abeysekera J. Slips and falls in a cold climate: underfoot surface, footwear design, and worker preferences for preventive measures. Appl Ergon. 2008;39:385–91.
4. Abeysekera J, Gao C. The identification of factors in the systematic evaluation of slip prevention on icy surfaces. Int J Ind Ergon. 2001;28:303–13.

5. Dupont WD, Plummer WD. Power and sample size calculations: a review and computer program. Control Clin Trials. 1990;11:116–28.
6. Gao C, Abeysekera J. Slips and falls on ice and snow in relation to experience in winter climate and winter sport. Safety Science. 2004;42:537–45.