Goldilocks, slip resistance and the wicked problem of falls prevention

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Abstract: Predictions of rapidly escalating health costs due to increasing hospitalisation of the elderly have helped to fund falls prevention initiatives in developed countries facing an ageing population crisis. Has recent research alleviated the problem, or is the inevitable merely being delayed? While the current interventions may improve the quality of life and increase lifespans, when will we reach the point of diminishing returns? In the context of meta data analyses of the community dwelling elderly, how does one factor in the societal costs and lost productivity of a working parent who is incapacitated due to an environmentally induced fall? Has an over-reporting of elderly slips incidence created a false impression that higher slip resistance requirements might prevent crumples? If fewer people slip than published risk analyses would predict, do they need revision or is our method of slip resistance measurement inappropriate? How do specifiers allow for potential loss of slip resistance as products become worn or soiled? If Goldilocks goes grey, she will still want floors that are just right: not too slippery when worn, but never too rough so that they are too hard to clean (or a stumble hazard). Falls prevention is everybody’s problem: is it really too wicked to be capable of sensible solution?

Practitioner Summary: Politicians, health care professionals and falls experts need to take a holistic perspective of falls prevention, to recognise the limitations that exist in many areas, and to be wary of over-reliance on orthodox views that may need revision. Regulators, in controlling aspects of the built infrastructure delivery process, need to be vigilant to ensure that expert review is vigorous, to enable sensible outcomes that best fulfil societal needs and safety expectations.

Keywords: slip resistance, falls prevention, intervention

Nous sommes Goldilocks

We live in the hope that our lives will be just right, not perfect but comfortable and without tragedy. According to the Goldilocks’ principle, we want floors that are just right throughout a long service life: not too slip resistant (so as to initially be impossible to clean); and never too slippery. While this might seem aspirational, the European Construction Product Regulation No 305/2011 requires that flooring products must provide adequate slip resistance at the end of an economically reasonable working life. The timely realization of this challenge ultimately depends on relevant data acquisition and wise knowledge application (and funding).

Chang et al (2013a) revealed that despite the research progress in recent decades, multidisciplinary system approaches are needed to understand the mechanisms involved in occupational slips, trips and falls, and to implement preventive interventions. The problem of falls prevention becomes more wicked (Rittel) when considering the competing needs of the building industry, the public, those responsible for the health, aged care, occupational safety and building sectors, the flooring manufacturers and other interested parties.

Nature versus nurture

While competitive research proposals plead selfish cases, holistic reviews must periodically consider the relative successes of past and current approaches and to what extent initiatives should be reprioritised. This paper considers the slips and trips that might be prevented by reflecting on environmental issues rather than addressing the falls that are related to biomedical factors. What might the building regulators need to know? What proportion of existing floors is slippery? Who slips on them, and under what circumstances? What is the risk of slipping on any given floor? What are the inherent problems in regulating slip resistance?

Hyde (2002) provided a classification of falls where slipping was caused nearly exclusively by environmental factors; tripping was a fall caused by unforeseen contact with a near-ground obstacle;
Falls injuries. Only yield incremental advances, and in areas that represent only partial solutions to these issues: “Rapid Minimization of Slips, Trips and Falls Injuries”. It recognised that different pathological induced dissimilar postural stability responses; interventions needed to be individual-specific, addressing the pathologies that affected subjects every day interactions with their surroundings. It can be argued that continued pursuit of well-established research methodologies (e.g. exercise interventions) might only yield incremental advances, and in areas that represent only partial solutions to the problem of reducing falls injuries. Biomedically related falls might be postponed for a while, but environmentally induced falls were: Understanding human balance; Refining risk factors for falls; Preventing falls in acute and rehabilitation hospitals; Preventing falls and fractures in at home and aged care sectors was evidenced by investment in such research and its implementation at local government level and throughout the hospital system. Just as the characteristics of bathrooms vary, so do people. Many falls prevention interventions have had mixed or limited success because interventions have been randomly imposed on study participants rather than being targeted. It is not surprising that home interventions have been most effective when delivered by an occupational therapist capable of assessing clients’ individual needs (Gillespie, 2012).

Such Cochrane Database of Systematic Reviews provide meta analyses on the relative success of implementing various single, multiple and multifactorial falls prevention interventions including home and group exercise programs, often with a strength and/or balance emphasis; medication reviews including provision (vitamin D, with and without calcium), and withdrawal (of psychotropic medicines); home safety; education; surgery and visual aids, etc., as well as psychological behavioural strategies.

Budgetary constraints have led to subjective psychophysical techniques being used to assess the slip resistance of floors rather than objective measurements. While home owners might be prepared to remove rugs or pay for some modifications, they must first accept the proposal is worthwhile. The interventions have failed to study of the effectiveness of increasing the slip resistance.

Falls prevention interventions

Falls prevention is a widespread goal that has gathered momentum as it has become a more fashionable research area. The National Falls Prevention for Older People Initiative was announced in the 1999/2000 Australian Budget, when the term “falls prevention” was unfamiliar to many and meaningless to some. Falls prevention was predominantly associated with physical or tangible interventions such as household modifications, use of walking aids, changing footwear and improving vision: obvious extrinsic initiatives that might be taken to minimise the risk of a fall. During the Injury 2000 Conference, the Australian Minister for Health and Aged Care announced a major injury research partnership: the National Falls Prevention for Older People Initiative was contributing A$1 million to a $2.5 million grant from the NHMRC Injury Partnership grants program to a Prince of Wales Medical Research Institute falls prevention project “The Prevention of Injuries in Older People”. The six key areas were: Understanding human balance; Refining risk factors for falls; Preventing falls in acute and rehabilitation hospitals; Preventing falls and fractures in at-risk groups of older people; Identifying safe footwear and walking surfaces; and Developing falls assessment screens. Many excellent outcomes have resulted from this project and other groups where the research has drawn together disciplines across basic, clinical and public health research sectors to address various intrinsic risk factors. The large societal investment in such research and its implementation at local government level and throughout the hospital and aged care sectors was evidenced by 500 participants at the 6th Biennial Australasian Falls Prevention Conference in Sydney in November 2014, but few papers dealt with extrinsic risk factors.

One short-listed NHMRC Injury Partnership grant proposal stood apart in that it was primarily concerned with extrinsic issues: “Rapid Minimization of Slips, Trips and Falls Injuries”. It recognised that different pathologies induced dissimilar postural stability responses; interventions needed to be individual-specific, addressing the pathologies that affected subjects every day interactions with their surroundings. It can be argued that continued pursuit of well-established research methodologies (e.g. exercise interventions) might only yield incremental advances, and in areas that represent only partial solutions to the problem of reducing falls injuries. Biomedically related falls might be postponed for a while, but environmentally induced falls
might be eliminated or minimised. Given the physical challenges of the built environment and the importance of policy and standards development, a thorough understanding of the propensity of diverse individuals to slip and trip was required. The proposal focus was on the entire population rather than those most at risk of falling. An annual saving of A$32million (in direct medical costs for each 1% reduction in slip and trip-related falls in Australia) was predicted, but the relative causes of falls in the elderly were not widely appreciated.

How accurate is the published falls data?

Falls in the elderly are influenced by the complex interaction of intrinsic factors such as the person’s physical and cognitive status, medication use, use of assistive devices, and extrinsic features of the physical and social environment. An important but poorly recognized barrier to fall prevention is the lack of objective evidence on how and why falls occur (Aziz et al). Traditionally, our understanding of the mechanisms of falls has been based on interviews with the faller or witnesses, if any, which often occur weeks or months after the fall. However, falls are often un-witnessed, and recalling the precise details of falls is difficult even for young adults (Feldman and Robinovitch). Combined with the frequent co-existence of multiple environmental, biomedical and behavioural risk factors, this creates challenges in designing or selecting fall prevention strategies at the patient or population level. Furthermore, fallers may tend to rationalize falls as being due to a slip – an external, unavoidable cause – to avoid the perception, recognition or acceptance of vulnerability.

Robinovitch et al (2013) illustrated how and why falls occur, using 264 networked video cameras to collect and analyse 227 “real-life” falls in 130 elderly individuals in two long-term care sites in Vancouver. The most frequent cause of falling was found to be incorrect weight shifting (41%) followed by trip or stumble (21%), hit or bump (11%), loss of support (11%), and collapse (11%), whereas slipping only caused 3% of the falls. The three activities associated with the highest proportion of falls were forward walking (24%), standing quietly (13%), and sitting down (12%). Compared with previous reports from long-term care settings, they identified a higher occurrence of falls during standing and transferring, a lower occurrence during walking, and a larger proportion due to centre-of-mass perturbations than base-of-support perturbations.

Yang et al (2015) found that incident reports agreed with video analysis on the cause of imbalance in 45.5% of falls, on activity at time of falling in 45.1% of falls, and on use of mobility aids in 79.5% of falls. In considering the activity at the time of 421 falls, the incident reports indicated 225 involved walking. While video analysis revealed there was only agreement in 132 instances, there were 185 cases that involved falling. Video analysis revealed 81% agreement in the reports for 277 witnessed falls and 72% agreement with 493 unwitnessed falls. The small improvement in agreement may reflect the challenges for witnesses in detecting and describing the circumstances of falls, which tend to have a duration of only 0.7 to 3.0 seconds.

When compared with video analysis, incident reports over reported falls due to slips, and falling while rising and while using a wheelchair or walker. Incident reports also underreported falls due to hit/bump and loss-of-support, and falling while standing and sitting down. The cause of imbalance was analysed in 334 cases, where video analysis revealed that only one of the 49 reported slips was actually a slip; and only two slips in total (and 26 cases of a loss of consciousness). Most reported slips were classified on video as loss-of-support or incorrect weight transfer. This may reflect the tendency among both care staff and fallers to rationalize the event as due to an external cause. Only 20 of the 44 reported trip/stumbles were due to a trip/stumble, where video analysis determined a total of 53 trip/stumbles. From a building regulators’ perspective, it might be expected that the floors themselves were free of trip hazards.

A major limitation of this excellent (extended) study is it was restricted to the public common areas of the facilities (where a slip resistant vinyl was used) and did not include the bedrooms and bathrooms, where other types of falls are likely to occur.

Although slips were greatly over reported as causing falls, this highlighting of the common sources of inaccuracy in fall incident reports is particularly important when considering the reliability of other published results. Care staff have many duties to fulfil and are unlikely to be trained in the fine differentiation between causes of imbalance. The sanctioned questionnaires or documentation may be unhelpful in probing for the desired or desirable detail. Rapidly completed minimalistic and/or inaccurate report responses may become systemic, just as checklists can be misinterpreted unless there is adequate ongoing training and supervision. ‘Slip’ may be a simple exonerating excuse for a faller and a convenient four-letter default where staff are uncertain. Most people use slips and trips as inaccurate substitutes for the various types of stair missteps. The identification of slips and trips in text narratives enables subjective rather than objective analysis.
Are home environmental assessments more accurate?

Occupational therapists, as a profession, have the expertise to assess, devise and implement rehabilitation plans which incorporate both types of interventions: an occupational therapy approach encompasses both environmental change and the interaction of the individual with their environment, their actions and their behavioural adaptations at home and in the community. While occupational therapists are highly skilled in applying clinical reasoning when profiling personal risk and developing prioritised action plans, home safety audits will not be as dependable as the community would expect until occupational therapists become familiar with the crouch and sight test for detecting irregular stair geometry and learn how to conduct improved psychophysical slip resistance assessments (Bowman et al, 2015a).

Since 1998, the Victorian Government has run a Home Renovation Service that provides eligible aged or disability pensioners with free inspections to identify what works are required to enable continued independent living at home for as long as practicable. Archicentre is responsible for identifying works of a health and safety nature that appear to be required at the resident’s property. The resident is then responsible for arranging (and paying) for the works they want carried out. The participating architects have completed a specialised training course and each inspection report contains detailed information about necessary home modifications. The architect and occupational therapist work with the client to form a specific brief, enabling the architect to provide a sketch, scope of works and estimate of cost.

Archicentre (2002) summarised the findings of 14,035 inspections over a 32 month period in 2000-2002, where 75% of the inspections were of post-World War 2 homes and 91% of the homeowners lived in single storied houses. While 19% of homes had trip and slip hazards, there was no differentiation between them.

The health and safety of building occupants is a principal goal of the Building Code of Australia (BCA). As a part of the process of developing and reforming the BCA to ensure that community health and safety expectations are met, the Australian Building Codes Board (ABCB) commissioned two reports known as the Health and Safety Risks in Buildings report (Atech, 2003) and Monash University Accident Research Centre (MUARC) Report 281 (Ozanne-Smith, 2008).

The Atech report analysed workplace injury statistics and injury statistics for the whole population (Australian Bureau of Statistics deaths data, the National Coroners’ Information System and hospital admissions data) and found that ‘Slips, trips and falls’ was the highest single risk category, particularly on stairs but also on level surfaces. The data did not enable a determination of the actual risk contribution of relevant factors, such as the building design (or building component); obstacles not forming part of the structure that create a trip hazard; the presence or absence of surface contaminants (such as water, oil or grease); the degree of alertness of the person suffering the injury; and the number of people exposed to each particular hazard. Since the available data did not allow a determination of the exposure of the population to the various hazards, it was thus impossible to correctly calculate the relative risks associated with each hazard. However, the overall findings were similar to a recent British study into building hazards in houses and commercial buildings (Raw et al, 2001). The report recommended the commissioning of a literature review to indicate cost-effective building designs (or building components) that could be utilised in new or existing buildings to reduce the incidence of slip, trips and falls.

Gunatilaka (2005) reported the Archicentre findings in relation to preventing home fall injuries: “Trip and slip hazards were found in 19% of the homes. The most common structural slip and trip hazards found were shower bases, defective floor finishes, dangerous staircases and obstacles like protruding door thresholds. These homes are not an unbiased random sample of Victoria’s home stock. Nevertheless, the report on these inspections highlights important home hazards encountered by the home-dwelling elderly in Victoria”.

The ABCB commissioned MUARC in 2006 to investigate and determine what relevant factors actually contribute directly to the risk of slips, trips and falls in buildings, including the causes found in the Atech study; and to also identify and prioritise the incidence, frequency or severity of slips, trips and falls in relation to the design and construction of buildings; identify the age group most at risk of incurring injury from slips, trips and falls; and provide information regarding the cost of slips, trips and falls. These objectives were to be achieved by risk assessment analysis using existing data systems and comprehensive literature review including foreign literature.

While MUARC Report 281 reported the most common structural slip and trip hazards found in the Archicentre study, it did not report that such hazards were found in 19% of the homes, or otherwise quantify the incidence of slips or trips in relation to the design and construction of buildings.
According to MUARC Report 281, "Lloyd and Stevenson (1992 cited in Moyer) indicated that while slips and trips caused 32 percent of falls for young people, 67% of falls for the elderly were initiated by slips (Moyer 2006). If one reads the Lloyd and Stevenson paper, these statistics were attributed to Fildes (1990), a long term MUARC staff member whose research contributions were not referenced in the MUARC report.

There was almost no other quantification of the incidence, frequency or severity of slips, trips and falls in relation to the design and construction of buildings. The slipping and slip resistance recommendations mirrored those of Gunatilaka (2005), namely "As well as clearly quantifying factors in addition to the required coefficient of friction which can be used to reliably measure and ensure the safety of a particular flooring surface, there are several recommendations from the literature that could be applied to encourage increased uniformity in regards to both measurements and definitions of slip resistance. These include the provision of comparative information on slip resistance by manufacturers and retailers to consumers, the development of building codes to require the installation of slip-resistant surfaces in the internal wet areas and external pedestrian areas of all new homes and renovated homes, and the national adoption the Local Government and Shires Associations of NSW initiative whereby certificates of occupancy are only issued to buildings where all flooring surfaces meet the recommendations on slip resistance of pedestrian surfaces as outlined in the revised Standards Australia Handbook HB 197:2005". One might expect such an idealistic position from an accident prevention organisation, but it is sad that MUARC, the ABCB and its expert review panel failed to observe (in 2007) that the revised HB 197:2005 did not exist.

While MUARC report 281 used the notional interpretive material in AS/NZS 4663:2004 to state that the standard regarded a coefficient of friction (CoF) of 0.40 or greater as slip resistant (when dry) it did not seek to apply the notional interpretive material for wet surfaces in the same way. In looking at the HB 197 (1999) recommendations, one might have deduced that a wet CoF of 0.36 indicated that an aged care ensuite was slip resistant but that a wet CoF of 0.47 was required for a communal shower room to be considered slip resistant. The ABCB has not sought a definition of slip resistance in the revised AS 4586 and AS 4663 standards but has chosen to follow HB 197 (1999) in requiring different levels of slip resistance in the BCA 2014 to fulfil the previous non-slip requirements. Many manufacturers and retailers of flooring surfaces have long made available comparative information on the slip resistance of new materials. However, with the benefit of hindsight, some data may have been more relevant. Much data may be illusory in that most products lose some slip resistance with wear, and some products rapidly lose much slip resistance. This recognition led to many of the HB 197 recommendations being inflated to allow for anticipated wear such that a failure of a floor surface to meet the recommendation should not be automatically taken as indicating that the floor surface is responsible for initiating a slip. Similarly the superseded AS/NZS 4663:2004 notional interpretations have their limitations as discussed subsequently. While manufacturers’ slip resistance data and the decisions making framework are less than ideal, the MUARC report did not identify the specific detail and relevant context, thus limiting consideration as to the appropriate required initiatives.

What is required?

How do we know what level of slip resistance is required in specific situations? We unfortunately lack an adequate benchmarking of the slip resistance of the built environment that might inform us what is generally accepted as being safe. However, virtual reality simulations should eventually provide suitable risk models for specific situations (Bowman et al, 2015b). We also lack a data bank of the available slip resistance when slip induced falls occurred, but recognise the need for detailing the various fixed risk factors for slipping (floor surface characteristics, footwear characteristics, etc.) and transient factors (rushing, distraction, etc.). To what extent should building code and other regulations allow for transient factors and personal negligence?

Bowman (2013) had proposed that a second means of classification should be added to HB 197, whereby products could be selected on the basis of their slip resistance potential (after being subjected to an appropriate accelerated wear conditioning program). Test houses could also use such a table to determine whether or not existing floors might be deemed to still be adequately slip resistant. While such a table would be most useful, it may not receive ABCB or other regulatory body approval as a demanding approach could potentially condemn much of the existing built infrastructure. A benchmark survey is needed to help establish appropriate limits or requirements, rather than adopting a lowest common denominator approach. What factor of safety should there be, and how should it be determined?

Harper et al (1961) used Pearson curves and the incomplete β-function to calculate that there was a one in a million risk of a slip for a 0.36 CoF between foot and floor when an able-bodied pedestrian was walking
in a straight line on a level surface at a moderate pace while not carrying, or pushing or pulling a load. Pye (1994) used the same data to report that a 0.24 CoF was equivalent to a 1 in 20 risk of slipping, stating that the assumption (of extrapolating from a small sample) was statistically suspect. AS/NZS 4663:2004 notionally interpreted values of 35 - 44 BPN as a moderate contribution to the risk of slipping when water wet (where 35 BPN is equivalent to a 0.36 CoF). Few people would consider a one in a million risk of slipping as being moderate. Table 1 shows a risk analysis (Chang et al, 2013b), which tends to confirm the UKSRG (2000) interpretation of Four S pendulum values above 35 BPN indicating a low potential for slipping.

Table 1 Sample of Chang et al (2013b) risk analysis (for self-selected walking speeds).

<table>
<thead>
<tr>
<th>Risk</th>
<th>Walking speed</th>
<th>Gender</th>
<th>Age</th>
<th>Age</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Normal</td>
<td>Female</td>
<td>Male</td>
<td>18-25</td>
</tr>
<tr>
<td>1 in 1,000,000</td>
<td>0.297</td>
<td>0.311</td>
<td>0.312</td>
<td>0.320</td>
</tr>
<tr>
<td>1 in 100,000</td>
<td>0.289</td>
<td>0.302</td>
<td>0.304</td>
<td>0.311</td>
</tr>
<tr>
<td>1 in 10,000</td>
<td>0.281</td>
<td>0.293</td>
<td>0.296</td>
<td>0.301</td>
</tr>
<tr>
<td>1 in 200</td>
<td>0.263</td>
<td>0.273</td>
<td>0.278</td>
<td>0.280</td>
</tr>
<tr>
<td>1 in 20</td>
<td>0.249</td>
<td>0.257</td>
<td>0.264</td>
<td>0.262</td>
</tr>
</tbody>
</table>

The British Health and Safety Executive (HSE) calculated a 1 in 2 risk of slipping where there is a 0.19 CoF. The HSE approach implicitly assumes involuntary walking where the subject fails to observe any risk and takes none of the normal precautions to mitigate any risk. Since many bathroom floors have CoF much less than 0.19, and also a low falls incidence, the basis of the calculated risks should be reconsidered. Such risk determinations fail to allow for the predominant appropriate use of moderate gait and due care. Many people habitually use mats outside baths and showers, thus using accepted behavioural strategies to manage the potential problem of highly slippery floors. Civil libertarians object to the proposed mandatory requirements (that would prohibit the use of polished marble on bathroom floors) that MUARC supported.

The situation has been further distorted by the recent (2013 in Australia) changed procedure for preparing the rubber test feet for wet pendulum tests. As Bowman et al (2015a) have discussed, it has long been known that this would cause some class X products (with values of 35 to 44 BPN) to drop into the new class P2 (25 – 34 SRV) and even into class P1. It is thus unfortunate that the ABCB published in the 2014 Building Code of Australia that a result of class X in an AS/NZS 4586:2004 test, conducted to prior to 28 June 2013, may be considered to be equivalent to class P3 in AS 4586:2013.

The recommended levels of wet pendulum slip resistance that have been published in HB 198 (2014) are more generally demanding than those published in HB 197 (1999) since many class X products will not achieve a P3 classification. They might achieve (the alternative) R10 oil wet ramp classification, but the Handbook should have indicated the pendulum as the primary test method for most public locations, with the oil wet ramp test as a secondary method. The oil wet ramp test will tend to yield high results where the floor surface can interlock with the heavily profiled shoe tread. The oil wet ramp classifications are useful for industrial and commercial situations where safety footwear is mandated, but may be quite misleading as far as many types of casual footwear.

Australian Building Codes Board policy

The Australian Building Codes Board policy is based on MUARC report 281, which relies upon text narrative description searches of emergency department admission records. The identification of slippery floors and hazardous stairs was subjective, rather than being based on objective measurements. The dubious quality of the available epidemiological data, that the Atec Group and MUARC relied on, has long been known. The MUARC Report was intended to identify and prioritise the incidence, frequency and severity of slips, trips and falls in relation to the design and construction of buildings, but failed (1) to quantify the slip resistance of the built environment, and (2) to establish the necessary relationships between the traction available in locations where slips had occurred, among other pertinent details of the circumstances. The MUARC report failed to demonstrate there was any problem with any subset of traditionally installed materials.

Despite the best intentions of all, we still have a very poor understanding of the relationship between slips, trips and falls and the design and construction of buildings, yet MUARC Report 281 is ostensibly being used as the guide for reform. The most important MUARC recommendation was that stair goings should be
at least 280 mm long, but this essential safety requirement was dismissed on the basis of building economics (Bowman, 2013).

The BCA has been revised, based on the report findings, and now has a class P3 wet pendulum requirement (>35 BPN, Slider 96, lapping film preparation) for dry residential stairways, seemingly based on a recommendation in HB 197 (Bowman, 1999) that also considered stairway use in industrial situations. Dry residential stairways must now have as much wet slip resistance as is recommended for the wet entries of public buildings.

Many of the HB 197 recommendations demand much greater levels of slip resistance than are found in existing floors where traditionally used products have been installed. Many owners have been unable to readily clean their newly installed floor. The maintenance used to solve such cleaning problems can significantly decrease the flooring life cycle. The current overspecification of slip resistance, based on unstated assumptions, has many counterproductive aspects. Safety auditors need a reliable indication as to when a floor might be regarded as being unsafe. Specifications need to be based on risk models that relate to the specific environmental usage.

The adopted slip resistance requirements for stairs are controversial (Bowman, Roys and Davies, 2015) and might be better suited to industrial than residential situations, but specifying excessive slip resistance will not prevent oversteps where stairs have irregular geometry, particularly where the goings are short and wear of nosings is predictable. A slight increase in the minimum going would have provided a far greater permanent factor of safety in preventing the most common and most dangerous misstep: overstepping of the nosing. The MUARC report unfortunately failed to identify oversteps as the most dangerous form of missteps.

However, one might anticipate that the next phase will be more challenging, when the ABCB seeks to quantify the slip resistance requirements for accessible paths of travel. This is when we will have to address some of the issues raised in this paper. There was insufficient relevant data for analysis in the past ABCB-sponsored reports, and there is still inadequate data. Before any further slip resistance requirements are proposed for the BCA, we need to consider what shortcomings exist in the basis for establishing slip resistance requirements (in the absence of relevant data).

**In conclusion**

The purpose of papers such as this is not to personally criticise individuals or organisations. Everyone is limited by the data that is available to them. Building regulators, epidemiologists and data surveillance experts cannot be expected to be slip resistance or stair safety experts. Where problems exist in or between bodies of knowledge, researchers have a responsibility to highlight tentative material in order to minimise any inappropriate use of material, as well as providing revised guidance or facilitating the development of new research and greater understanding. While there are several parties with an innate interest in minimising slips and trips and preventing falls, they can have very different expectations as to how the best outcomes can be obtained where there are severe budgetary constraints.

Researchers have generally had to rely upon self-reporting of incidents as to their cause, and this is highly unreliable, when many blame the floor rather than accept the consequences of their own actions. Existing slip resistance specifications are based on generalized guidance where undisclosed safety factors might have been engineered in to allow for the loss of slip resistance that inevitably occurs (and sometimes very quickly) in many new flooring materials. Manufacturers rarely provide any indication as to the amount of probable slip resistance loss or the rate of such loss, but this is obviously a function of various exposure condition factors. To further compound the global problem, there are competing slip resistance test methods internationally, and prospective disruption associated with future standards harmonization. Despite this, most slip resistance determinations of the existing environment are made using dubious psychophysical assessments. Australia has introduced a few quantified slip resistance requirements in its 2014 building code, prior to consideration of the needs for accessible floors in new buildings and the public environment. Is this akin to the opening of Pandora’s box?

The final concluding conclusion in MUARC Report 281 stated “Slips, trips and falls in buildings constitute a large and costly public health problem, which is expected to grow in coming years due to the ageing of the Australian population and the increase in housing density, with associated trends to multi-storey dwellings. Although falls and injuries in buildings may be caused by a combination of factors including the design and construction of buildings, many potential solutions lie with the building industry and its regulators. Others with responsibility include the residential and community aged care sectors, the health
sector, Standards makers and those responsible for death and injury data systems and research funding. Given the enormous cost of the problem, investment in effective preventative solutions is imperative.

While we expect our governments to minimise unintentional injuries, reduce hospitalisation costs, and ensure workplace safety, falls prevention is a wicked problem (Rittel and Webber). We are also not surprised when governments fail to provide proper and sufficient funding for effective falls preventative solutions. Various diverse and contradictory perspectives must be considered before it becomes simple to obtain appropriately safe floors in accordance with the Goldilocks principle; using environmental initiatives to keep everyone as able-bodied as possible. Legislating inappropriate slip resistance requirements based on inadequate evidence would be a truly wicked principle.

References


