Hazard
(Edition No. 59)
Summer 2005
Victorian Injury Surveillance
& Applied Research System (VISAR)

www.monash.edu.au/muarc/visar

Monash University
Accident Research Centre

This edition of Hazard is mainly focused on analysing the latest Victorian injury surveillance data on home fall injuries that are amenable to structural and design solutions.

Preventing home fall injuries:
structural and design issues and solutions

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Summary

Significant proportions of fatal and non-fatal unintentional injury occur in the home environment. Analysis of the latest year of injury surveillance data for Victoria shows that the home was the location of 16% (*n*=166) of all unintentional injury deaths in 2002 and 23% (*n*=19,560) of unintentional injury hospital admissions in 2002/3.

Falls are the major cause of home injury. Falls in the home accounted for approximately one-fifth (*n*=31) of all unintentional home injury deaths that occurred in 2002, and two-thirds (*n*=12,977) of home injury admissions in 2002/3. One-third of unintentional home injury Emergency Department presentations were also fall-related (*n*=24,608).

Research indicates that a large number of these home fall-related deaths and injuries are related to structural or design features of the home.

Inappropriate flooring material and paving and poorly designed or constructed stairs, steps, windows and balconies are the most frequently identified structural features of the home that contribute to home fall injury. Slippery and non-impact absorbing flooring materials and small level changes in floors are common hazards.

Research also shows that stairs with one or two steps, inappropriate geometry, or non-uniform dimensions, and stairways with poorly designed or no handrails are implicated in a high number of fall-related injuries and deaths. Falls from or through balconies and windows are another cause of home fall injury.

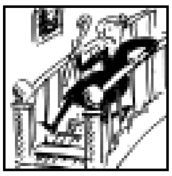
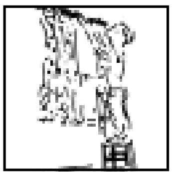
Recommendations

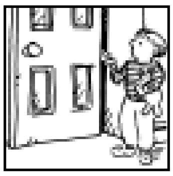
Design and materials engineering solutions that eliminate structural deficiencies have the potential to reduce home fall injuries.

Measures such as requiring slip resistant flooring in toilets, bathrooms, kitchens, and laundries and the use of appropriately dimensioned stairs and handrails in all homes are recommended.

Australian building codes should mandate Australian Standards based on universal design concepts so that all home will be friendly to all users especially children, the elderly and disabled.

This issue also includes a supplementary report on hand entrapment (finger jam) injury in doors. This is another cause of home injury that appears amenable to innovative design solutions.

Introduction

Unintentional home injury, especially falls, are a significant problem in Victoria. In 2002, 166 Victorians died, and a further 20,000 were admitted to hospital, as a result of unintentional injuries that occurred in the home environment. The toll of home injury on the health of Victoria is not well recognized by government and the community with the result that home injury prevention is relatively under-resourced.

In this issue of *Hazard*, measures to address falls in the home, the major cause of unintentional home injury, are discussed, with an emphasis on identifying the design and structural elements of the home that contribute to fall injury, and potential solutions. Analysis of the latest available year of injury surveillance data (2002 for deaths and 2002/3 for hospital-treated injury), showed that falls in the home accounted for 19% of all unintentional home injury deaths, two-thirds of unintentional home injury hospital admissions and one-third of unintentional home injury Emergency Department presentations. In these years, the home was the highest-ranked location for hospital-treated unintentional injury (admissions and ED presentations) and the second-highest ranked location for unintentional injury fatalities, behind transport locations.

Significant reductions in injury mortality and morbidity have been achieved in the road transport setting by designing road infrastructure to be more forgiving and motor vehicles to be crashworthy[1,2]. There is emerging evidence that past use of building regulations to improve home safety (such as those mandating that hot water systems deliver bathroom tap water at a maximum temperature of 50∝C, fitting of smoke alarms, erection of safety barriers around home swimming pools, and the use of toughened glass in doors and windows) are beginning to show benefits in terms of injury reductions.

For example, analysis of the yearly trend in scald injury hospital admission rates for young children and older people aged 70 years and over indicates that the rate of hot water scald admissions has decreased in both groups since regulations were introduced in 1998[3]. From 1996/7 (the year before the publicity leading up to the introduction of the hot tap water regulation) to 2002/3, the annual scalds hospitalisation rate for young children has decreased by 12% per year on average and the scalds hospitalisation rate for the elderly has decreased by 6% per year on average.

Home falls are the other obvious priority for injury prevention through safe design. This report reviews the latest injury surveillance data and research literature on the prevention of home fallsó including same level falls, falls from stairs and steps and falls from balconies and windowsóto identify intervention points and preventive strategies and measures with a focus on design solutions. Potential areas for further research are also identified.

Method

Injury data for this report were obtained from the Australian Bureau of Statistics ñ Death Unit Record File (ABS-DURF), Victorian Admitted Episodes Dataset (VAED), and Victorian Emergency Minimum Dataset (VEMD) (See Box 1 at the end of this report for more details of data sources and extraction methods). An Internet search using Google and a literature search of Medline were undertaken to identify the latest research findings on the epidemiology and prevention of same level falls (slips, trips and loss of balance) and falls from stairs and steps, balconies and windows.

Background

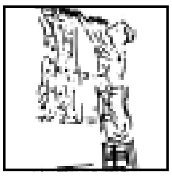
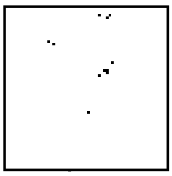
Pattern and causes of home fall injury

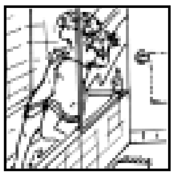
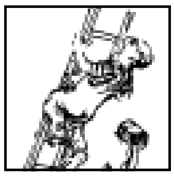
Analysis of the latest available year of injury surveillance data (2002 for deaths and 2002/3 for hospital-treated injury), showed that falls caused 19% (*n*=31) of all unintentional home injury deaths, 66% (*n*=12,977) of home injury hospital admissions and 32% (*n*=24,608) of home injury Emergency Department presentations.

Table 1 shows the detailed breakdown of the causes of home fall injury deaths, hospital admissions and emergency department presentations for the latest available year of injury surveillance data. The specific cause of the fall was not given in 24% of fall hospitalisations (*n*=3,067 cases) recorded on the VAED. Fall injury ED presentations are classified into only two causal groups on the VEMD: *ëFall-low (same level or less than one metre, or no information on height)í* and *ëFall-high (greater than 1 metre)í*. For this comparative analysis, presentations were re-classified to match ICD-10 falls cause codes (Table 1) based on information in case narratives. Only 35% (n=8,703) of falls ED presentations could be re-classified to falls sub-cause codes; the remainder were classified under ëother same level fallsí or ëother different level fallsí.

ï Different level falls carry a higher risk of fatal consequences ñ 61% of fall deaths are caused by different level falls yet they comprise just over one-quarter of fall admissions and ED presentations. Different level fatal falls most frequently involved stairs and steps (23%), ladders (13%) and buildings and structures (10%).

ï Same level falls accounted for half of falls admissions and three-quarters of ED presentations. In 2002/3 hospital admissions for same level falls coded to slips (fall due to slipping on contaminated or polished surfaces), trips (fall due to tripping on or over person, animals, objects and other projections and indentations), and stumbles (fall due to loss of balance) were disaggregated. Of the 4,140 slip, trip and stumble admissions, 33% were slips (*n*=1,377), 55% were trips (*n*=2,272) and 12% were stumbles (*n*=491). Analysis of VEMD narrative data indicates that of the 2,856 same level slip, trip and stumble ED presentations, 42% were slips (*n*=1,200),

Causes of unintentional home fall injury deaths (2002), hospital admissions and Emergency Department presentations, non-admissions (2002/3), Victoria **Table 1**

	Deaths 2002		Hospital Admissions 2002/3		ED Presentations 2002/3	
	N	%	*N*	%	*N*	%
Same level falls	**9**	**29.0**	**6,433**	**49.6**	**17,802**	**72.3**
Other fall on same level	*1*	*3.2*	*2,225*	*17.1*	*14,754*	*60.0*
Fall on same level involving ice and snow	-	-	*2*	*<1*	*2*	*<1*
Fall on same level from slipping tripping stumbling	*8*	*25.8*	*4,140*	*31.9*	*2,856*	*11.6*
Fall from iceskates skis rollerskates skateboards	-	-	*16*	*<1*	*120*	*<1*
Fall same level- collision with another person	-	-	*50*	*<1*	*70*	*<1*
Different level fall	**19**	**61.3**	**3,477**	**26.8**	**6,806**	**27.7**
Fall being carried or supported by other persons	-	-	*42*	*<1*	*32*	*<1*
Fall involving wheelchair	-	-	*55*	*<1*	-	-
Fall involving bed	*1*	*3.2*	*640*	*4.9*	*1,113*	*4.5*
Fall involving chair	-	-	*509*	*3.9*	*732*	*3.0*
Fall involving other furniture	-	-	*143*	*1.1*	*824*	*3.3*
Fall involving playground equipment	-	-	*120*	*<1*	*533*	*2.2*
Fall on and from stairs and steps	*7*	*22.6*	*894*	*6.9*	*1,493*	*6.1*
Fall on and from ladder	*4*	*12.9*	*458*	*3.5*	*417*	*1.7*
Fall on and from scaffolding	-	-	*11*	*<1*	*8*	*<1*
Fall from, out of or through building or structure	*3*	*9.7*	*313*	*2.4*	*307*	*1.2*
Fall from tree	*1*	*3.2*	*48*	*<1*	*196*	*<1*
Other fall from one level to another	*3*	*9.7*	*244*	*1.9*	*1,151*	*4.6*
Unspecified fall	**3**	**9.7**	**3,067**	**23.6**	**-**	**-**
Total	**31**	**100.0**	**12,977**	**100.0**	**24,608**	**100.0**

Source: Deaths: ABS DURF, 2002; Hospital Admissions: VAED, 2002/3; Hospital ED presentations: VEMD, 2002/3

57% were trips (*n*=1,631) and 1% (*n*=25) were stumbles.

Age and gender patterns

Over the 3-year period 2000-2002, the home fall fatality frequencies and rates were much higher in older persons (from age 65 years), than in children aged 0-14 years and adults aged 15-64 years (Figure 1). The male fatality rate was much higher than the female rate for all 5-year age groups from age 15 years, excluding ages 15-29 when the rate was the same for males and females (Figure 1).

The home fall hospital admission rate was higher for older Victorians, increasing almost exponentially with age beyond 40 years (Figure 2). From age 50 years, females have a higher home falls hospitalisation rate than males (Figure 2). Analysis of the frequency of home fall hospitalisations over the same period showed that 30% of hospital admissions occur among persons aged less than 65 years (Figure 3) suggesting the issue of home falls should not be overlooked in the younger age groups.

Rates cannot be calculated for ED presentations due to incomplete injury data as not all Emergency Departments contributed to VEMD in 2002/3. Analysis of frequency data revealed that home fall injury presentations were highest in children, peaking in 0-4 year olds (Figure 4). Males were over-represented in all 5-year age groups to age 29 years, whereas females were more likely than males to present to ED with home fall injuries in all age groups upwards of age group 30-34 years.

Interventions to reduce injury

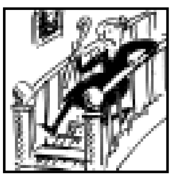
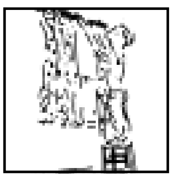
The analysis of fall injury data above identified a number of areas where improved home design and construction, and tighter controls at the home building stage, could lead to significant reduction in falls and fall injury in the home. These include strategies and measures to support the widespread installation of slip resistant surfaces and impact absorbing surfaces throughout the home, and improvements in the design and construction of stairs and steps, high windows and balconies

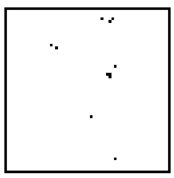
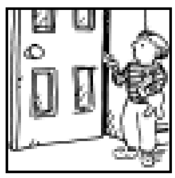
1. Installation of slip-resistant surfaces in domestic housing

Analysis of hospital-treated data for the year July 2002-June 2003 showed there were 1,377 admissions and at least 1,200 ED presentations for fall injuries resulting from slips in the home.

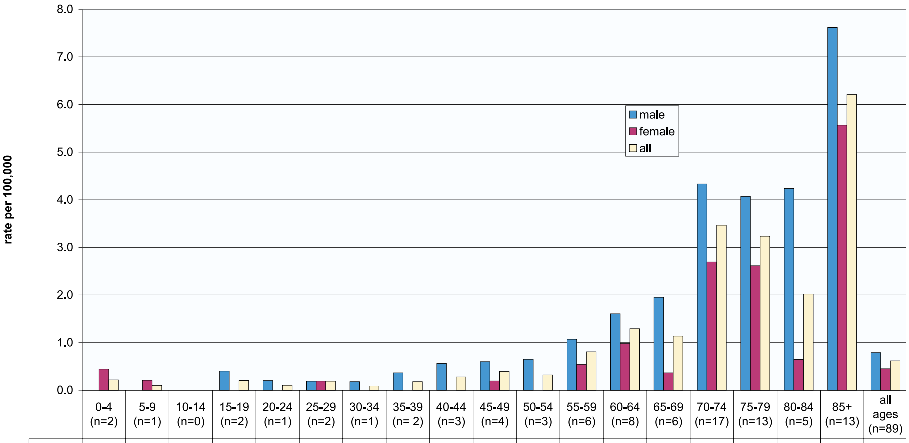
ï Females accounted for 75% of slip-related fall admissions (*n*=1,033) and 57% of ED presentations (*n*=682)

ï Seniors aged 75 years and older accounted for more than 50% of

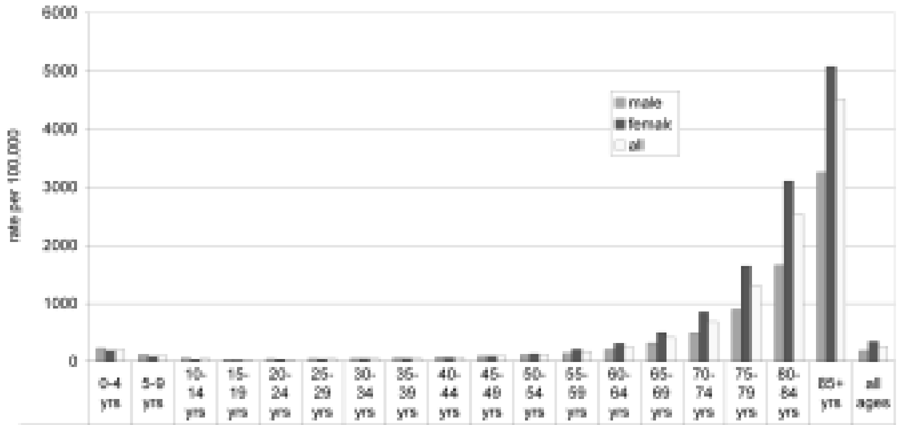
Crude mean annual rate (per 100,000 population) of home falls deaths by gender, Victoria 2000/02 — Figure 1



	0-4 (n=2)	5-9 (n=1)	10-14 (n=0)	15-19 (n=2)	20-24 (n=1)	25-29 (n=2)	30-34 (n=1)	35-39 (n= 2)	40-44 (n=3)	45-49 (n=4)	50-54 (n=3)	55-59 (n=6)	60-64 (n=8)	65-69 (n=6)	70-74 (n=17)	75-79 (n=13)	80-84 (n=5)	85+ (n=13)	all ages (n=89)
male	0.0	0.0	0.0	0.4	0.2	0.2	0.2	0.4	0.6	0.6	0.6	1.1	1.6	2.0	4.3	4.1	4.2	7.6	0.8
female	0.4	0.2	0.0	0.0	0.0	0.2	0.0	0.0	0.0	0.2	0.0	0.5	1.0	0.4	2.7	2.6	0.6	5.6	0.5
all	0.2	0.1	0.0	0.2	0.1	0.2	0.1	0.2	0.3	0.4	0.3	0.8	1.3	1.1	3.5	3.2	2.0	6.2	0.6

Note: Frequencies are total frequencies over the three-year period not mean annual frequencies.
Source: ABS-DURF 2000-2002.

Crude mean annual rate (per 100,000 population) of home falls hospital admissions by gender, Victoria July 2000-June 2003. — Figure 2



	0-4 yrs	5-9 yrs	10-14 yrs	15-19 yrs	20-24 yrs	25-29 yrs	30-34 yrs	35-39 yrs	40-44 yrs	45-49 yrs	50-54 yrs	55-59 yrs	60-64 yrs	65-69 yrs	70-74 yrs	75-79 yrs	80-84 yrs	85+ yrs	all ages
male	222.8	116.2	57.0	34.1	38.9	45.3	48.6	59.1	72.4	93.2	115.9	140.0	204.6	313.3	487.4	894.2	1696.	3253.	180.9
female	183.4	87.5	32.8	22.0	35.0	39.2	44.9	49.4	64.7	91.0	130.4	207.0	304.3	494.5	853.7	1639.	3105.	5074.	341.7
all	203.6	102.2	45.2	28.1	37.5	42.2	46.7	54.2	68.5	92.1	123.2	173.3	254.6	406.5	681.2	1318.	2548.	4512.	262.5

Source: VAED July 2000 to June 2003.

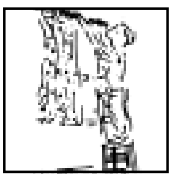
admissions for slip injuries (*n*=716, 52%), yet this age group made up only 10% of ED presentations (*n*=125). Note that ED presentations data under-estimate cases of slips due to the generally poor quality of the narrative data describing the falls for the older age groups.

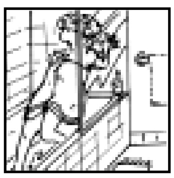
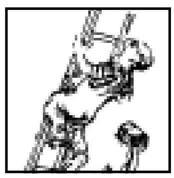
- Children aged 0-14 years comprised 32% of presentations (*n*=380) yet only 5% of admissions (*n*=63)
- Among admissions, almost two-thirds of slip injuries were fractures (n=888, 65%). Upper extremity injuries (*n*=668, 49%) were more common than lower extremity injuries (*n*=304, 22%)
- The most frequently occurring injury among ED presentations was fracture (*n*=335, 28%), followed by open wounds (*n*=283, 24%) and sprains or strains (*n*=252, 21%). Upper extremity injuries were more frequent (*n*=370, 31%) than lower extremity injuries (*n*=329, 27%).

More detailed analysis of the locations and surfaces involved in ED presentations for slips utilising word searches of narrative data yielded the following additional information.

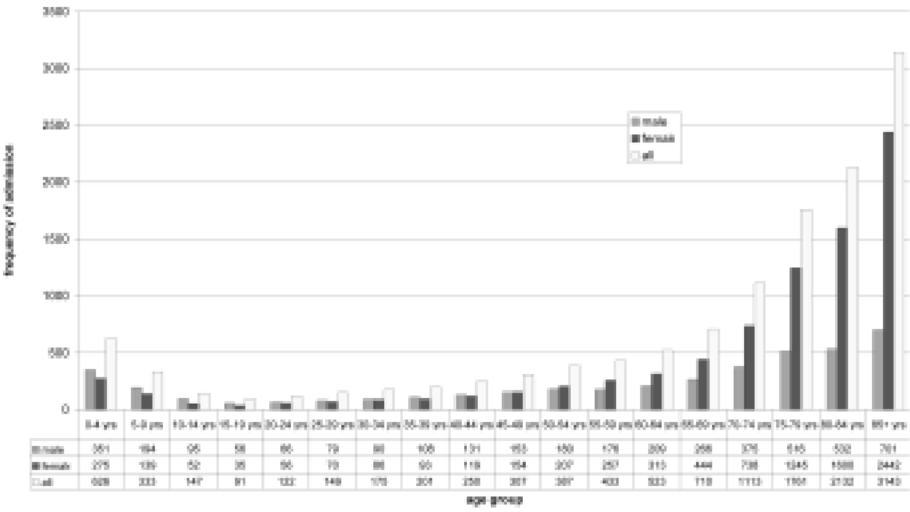
- Specific information on the location (room) or the surface/item involved was used to classify slips as occurring indoors or outdoors. This information was available in 71% of slips narratives (*n*=848). Sixty per cent of slips occurred indoors (*n*=512) and 40% occurred outdoors including verandah/garage/shed (*n*= 336)
- Of the 332 case narratives of indoor slips that specifically mentioned the room in which the slip occurred, 222 (67%) occurred in the bathroom (including bath, shower stall and spa), 59 (18%) occurred in the kitchen and 36 (11%) occurred in the lounge/ living/rumpus room. Of the 179 case narratives of outdoor slips that specifically mentioned the site of the slip, 120 (67%) occurred in the yard/ garden, 24 (13%) occurred on the driveway/path, 10 (6%) occurred on swimming pool surrounds and 8 (5%) occurred in the workshop/garage.
- The type of surface on which the person slipped was not well documented in narratives. Specified indoor surfaces included tiles, timber and wood, carpet and rugs, lino, marble, shelves, cot, couches, tables and bench tops. Specified outdoor surfaces included concrete/cement, grass, stones, bricks, and gravel.

Only 10% of the 1,200 slip narratives mentioned that the surface was wet at the time of the slip. The literature, however, suggests that slips typically occur on wet surfaces or a surface contaminated with oil, grease, dust, dirt or some sort of spillage[4-7].

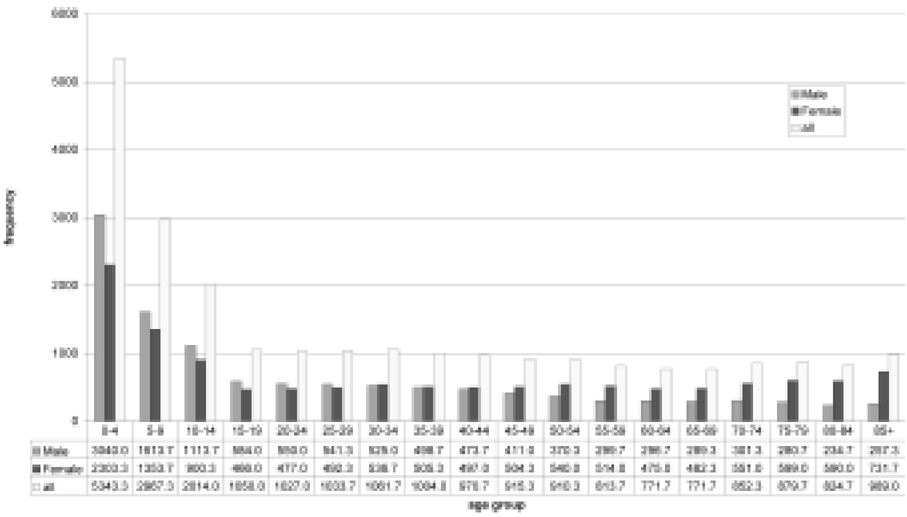




Mean annual frequency of home falls hospital admissions by age and gender, Victoria July 2000-June 2003 — Figure 3



Source: VAED July 2000 to June 2003.

Mean annual frequency of home falls hospital presentations by age and gender, Victoria July 2000-June 2003 — Figure 4



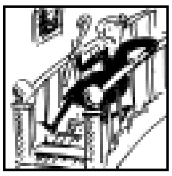
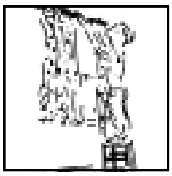
Source: VEMD July 2000 to June 2003.

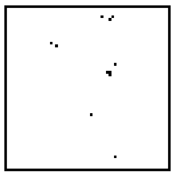
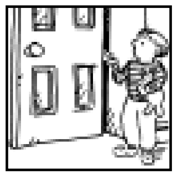
A similar picture emerges from a report on home inspections carried out by Archicentre from January 2000 to August 2002 in 11,264 homes in Melbourne Metropolitan and 2,771 homes in rural Victoria occupied by older residents over 60 years of age[8]. Trip and slip hazards were found in 19% of the homes. 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 Victoriaís home stock. Nevertheless, the report on these inspections highlights important home hazards encountered by the home-dwelling elderly in Victoria.

About 91% of older homeowners included in the sample of homes inspected lived in single-storey homes, which are better suited to the lifestyle of many older residents because these homes generally have less fall risks. Surprisingly, in the sample of homes that was inspected it was found that a greater percentage of trip and slip problems existed in one-storey homes as opposed to two-storey homes.

Prevention of slipping requires the provision of an appropriate level of friction between shoe soles or bare feet and floors. Given the difficulty of controlling the types of shoes people wear, the development of tests for measuring the slip-resistance of pedestrian surfaces is regarded as the more important of the two and received priority attention from Standards Australia from the mid-1990s. The Australia/New Zealand Standard Guidelines for Safe Housing Design (ANZS 4226-1994) rates most of the typical flooring materials currently used in domestic homes as very poor to fair in terms of general slip-resistant characteristics when wet[9] (although the source of data for the ratings is not specified). This suggests that an effective strategy for preventing injurious slips could be to require, by way of regulation, the installation of slip-resistant flooring and surfaces in ëwetí indoor areas (the kitchens, laundry and bathroom including baths and shower bases) and pedestrian outdoor areas of new houses, and in existing houses when renovations involving wet areas are being carried out. Australian Standard AS 4299 ñ 1995[10] on adaptable housing requires floor surfaces in bathrooms, laundries, toilets, kitchens and all external paved surfaces to be slip-resistant to comply with AS/NZS 3661.1[11]. AS 1428.1[12] and AS 1428.2[13] on design for access and mobility also require slip resistant surfaces for disabled access.

Standards Australia Handbook 197: 2005 (in preparation), a revision of Standard of Australia Handbook 197:1999[14], *An introductory guide to the selection of slip resistant surfaces* will establish a basis for specifying pedestrian surface materials for various locations based on

wet slip resistance classifications that are obtained when testing surface materials to the newly published standard AS/NZS 4568: 2004 *Slip resistance classification of new pedestrian surface materials*[15]. The revised handbook will include new recommendations for domestic residences and balconies. AS/NZS 4568: 2004 provides manufacturers with a range of test methods that can be used to classify slip resistance of their materials. The Standard for measuring the slip resistance of existing pedestrian surfaces (AS/NZS 4663: 2004 *Slip resistance measurement of existing pedestrian surfaces*) has also been revised and recently published[16].

The updated Standards provide a sound basis for developing building regulations to require the installation of slip-resistant surfaces in internal wet areas and external pedestrian areas of new and renovated homes. The Local Government and Shires Associations of NSW are considering action to require that residential premises meet minimum levels of slip resistance and have taken the position that it is unacceptable to issue certificates of occupancy where new and renovated buildings have floors that pose a slip hazard[17]. The Associations are seeking to have the recommendations for residences in the revised HB 197 referenced into the Building Code of Australia (BCA)[17]. The effectiveness of these standards and codes should be evaluated.

Extending the slip resistance requirements to all housing by adopting a universal design approach will not only make homes friendly for the elderly and disabled, but also reduce injuries for all users.

A strategy to encourage owners of existing homes to increase the slip resistance of existing *in situ* surfaces should also be developed. Hard floor materials such as tile, granite, and terrazzo are popular in domestic kitchens, laundries, dining rooms, toilets and bathrooms. These floors are widely used in public places such as restaurants, building lobbies and shopping malls as well because of appearance, resistance to wear, and ease of maintenance. However, these smooth surfaces offer little slip resistance, particularly when wet, unless especially treated in the manufacturing process. Falls on these hard surfaces can result in severe injuries because they do not offer any impact absorption.

Methods such as safety grooving, acid etching, blasting, grinding, paint and sand, and a number of proprietary chemical treatments can be used to improve the slip resistance of existing flooring[11]. Safety grooving technique involves making permanent, shallow, circular groves using a diamond tool into existing tile or concrete floors to channel water away from the surface to minimize hydroplaning and improve traction[18]. One disadvantage of this process is that it changes the visual appearance of the floor.

Acid etching and some proprietary chemical treatments improve the slip resistance by creating micro-pits on the surface[19] or by growing tiny abrasive crystals onto the floor surface[18]. These chemical treatments may not be suitable for all hard surfacing materials[11] and the effectiveness of these treatments may depend on the strength of the solution, the time of exposure, and the temperature. Because liquids are susceptible to gravity they tend to flow down slopes and grout joints. The raised portions of floors that people tend to walk on may receive less treatment than depressed areas (Personal communication, Richard Bowman, CSIRO, December 2004).

Microscopic pits may become plugged by sediment particles, which can impair slip resistance and visual appearance of the surface. The roughened surfaces created through chemical treatment may make the previous cleaning processes less effective. Some proprietary treatments require the use of expensive cleaning products to maintain the slip resistance (Personal communication, Richard Bowman, CSIRO, December 2004).

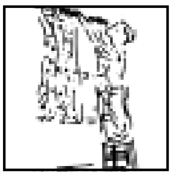
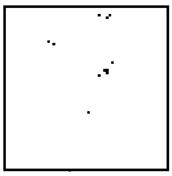
While many proprietary chemical treatment processes claim to improve the slip resistance of tile, stone, terrazzo, and concrete surfaces, these claims of effectiveness need to be verified using independent systematic scientific studies. The longevity of treatments, cost, maintenance requirements etc. also need to be assessed before these products can be recommended.

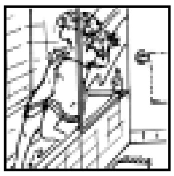
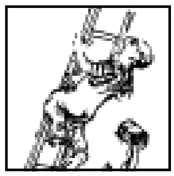
According to the ABS *Safety in the Home* Melbourne survey in 1992, 114,700 (35.4%) households with older residents and 193,000 (24.3%) households without older residents had slip-resistant surfaces in the bath or shower[20]. Serious consideration should be given to the development of a standard and associated regulation to ensure that only slip resistant baths and shower bases are installed in Victorian homes. Local and overseas manufacturers would then be encouraged to develop design solutions that make all bath and shower bases slip resistant.

2. Installation of impact absorbing floor surfaces

The properties of surfaces associated with falls are a major determinant of injury severity. Hard, non-resilient surfaces produce large impact forces and cause severe injuries. Soft impact absorbing surfaces tend to cushion a fall and reduce injury severity.

Information on the types of surfaces involved in injurious falls can provide some useful clues about the safety implications of different floor types. However, this information is not systematically entered in Victorian injury surveillance databases. The only current source of surveillance data on fall surfaces can be found in text narrative data entered in the VEMD. Analysis of home fall injury narratives recorded on the VEMD between July 2002 and June 2003 showed that the specific surfaces on which injurious falls occurred was identified in only 6% of ED presentations for falls (*n*=1,355/24,608), so reliable data are lacking. Table 2 shows the specific surfaces as a percentage of all records where a surface could be identified. Concrete (*n*=421, 31%) and tiles (*n*=220,

Fall surfaces identified in home falls case narratives, VEMD July 2002-June 2003 (n=1,355) — Table 2

	N	% (of known surfaces)
Concrete	421	31
Tiles	220	16
Wood	142	11
Carpet	138	10
Glass	121	9
Brick	91	7
Metal	58	4
Floorboard NFS	52	4
Mat	29	2
Deck	26	2
Slate	23	2
Timber	23	2
Lino	9	1
Vinyl	2	<1
All known surfaces	**1,355**	100

Source: VEMD July 2002 to June 2003.

16%) were the most prominent of the identified specific surfaces. We conservatively estimate from these data that two-thirds of injurious home falls requiring hospital treatment are onto hard, non-impact absorbing surfaces. There is no exposure data on hours of pedestrian use of the various surfaces in the home.

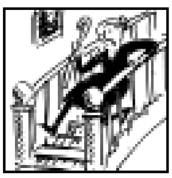
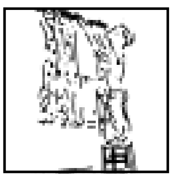
Maki and Ferni studied impact forces on a number of common floor covering materials using a fall simulator[21]. The simulator height and weight were chosen to simulate a 50th percentile elderly (aged 65-79 years) female. The drop height was selected to simulate a fall from an erect standing posture. This study indicated that linoleum, vinyl, vinyl composition, terrazzo, and wood tile floorings have the poorest impact attenuation. Padded carpet provided the best impact attenuation. A clinical study based on 864 falls and 18 hip fractures for five types of floor coverings, conducted by Booth et al showed that carpet results in fewer hip fractures in proportion to the number of falls, and that vinyl and concrete floors result in higher proportions of hip fractures[22]. These researchers also confirmed this dependence of fracture incidence on floor covering type experimentally, using an impact transducer[23].

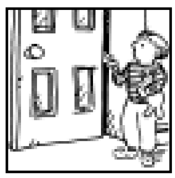
Carpet can attenuate impact during a fall and reduce severity of injury. In addition to providing more comfort than hard floor covering, carpet also reduces noise, glare, and slipperiness. If incontinence is an issue, then maintaining carpet becomes difficult. Urine and other spills penetrate through the backing into the subfloor causing odours. Because carpet tends to encourage dust mites, its usage may be problematic for persons who have asthma and allergy. Movement of wheeled equipment, including wheel-chairs, require larger push and pull forces on soft surfaces such as carpet and Flotex compared to those on hard surfaces such as tile or vinyl[24].

A new material called PowerBond RS, which combines the benefits of soft-surface floor covering with the durability of sheet vinyl, is gaining popularity in nursing homes in USA[25,26]. Powerbond RS has a superdense surface constructed of single filament tufted nylon carpet loops and a solid sheet of cushioned vinyl backing[27]. The manufacturer claims that Powerbond RS is easy to install, improves thermal and acoustic qualities, reduces glare, provides good slip resistance while reducing the resistance to wheeled equipment, and is easy to maintain. While soil and spills can seep through regular carpet or the edges of VCT, leading to breeding of bacteria, Powerbond RS eliminates this and the possibility of trapped moisture under the floor covering by providing a non-flow-through vinyl backing and chemically welded seams. However, this product needs to be independently evaluated to determine the validity of the claimed benefits and the suitability for domestic use.

Casalena et al have reported, in 1998, a concept of a safety floor called Penn State Safety Floor (PSSF) that attempts to simultaneously achieve two competing design goals necessary for preventing fall injuries[28,29]. The first design goal is that the flooring system needs to remain relatively rigid during normal daily living activities such as walking. The second design goal is that the floor should effectively minimize peak forces experienced by a femur during a fall-related impact. These researchers used computer simulation and experimentation using a fall simulator to measure peak femoral neck force during a fall impact on the PSSF. A prototype surface achieved a 15.3% reduction in peak femoral neck force while exhibiting less than 2mm deflection during normal walking. Furthermore, the top surface of the PSSF returned to within 0.2mm of its pre-impact configuration after 5min from the impact, demonstrating that this surface is resilient and need not be replaced after experiencing a fall related deflection. Although this safety floor system seems to be a promising approach for preventing hip injury, further developments of this product could not be found in the literature or on the Internet.

Independent testing should be undertaken to substantiate the claims made by the manufacturers of innovative floor covering and flooring including invest-igations of their suitability for domestic use, especially in housing developments

aimed at the seniorsí market. Also, further research is required to develop impact-absorbing flooring that can attenuate sufficient energy to consistently reduce peak impact forces transmitted to the femur to levels below fracture threshold.

3. Improving the design and construction of stairs and steps

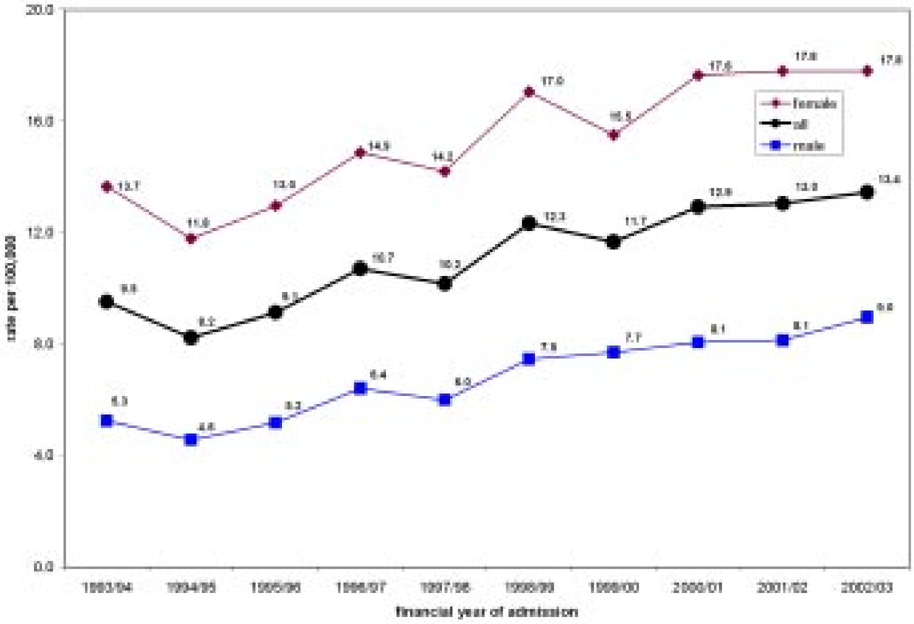
According to *Safety in the Home* surveys conducted by the ABS in 1992 and 1998, the number of households in Melbourne with inside steps or stairs increased from 270,000 to 354,800 between the two surveys, and the proportion of houses with steps or stairs also increased, from 24.1% to 28.6%[20,30]. Furthermore, the number of households where older people were resident with steps or stairs increased from 62,000 to 78,700 from 1992 to 1998[20,30]. It is probable that the exposure of the population to steps and stairs in domestic dwellings has increased since 1998 as the trend toward higher density housing has continued, with a concomitant increase in the risk of falls on and from stairs and steps. This trend towards higher density housing is also predicted to continue in Melbourne.

Pattern and trend in stair and step home fall injury

Although the deaths, hospital admissions, and hospital presentations for fall injury on and from stairs and steps in the home are fewer in number than same level falls (Table 1), when extent of usage (exposure) is taken into account, stairs are clearly a relatively hazardous structural feature of the home[31].

Analysis of Victorian home falls data for 2002, showed that there were 7 deaths (23% of home fall deaths) caused by falls from stairs and steps (Table 1), four adult males aged over 35 years and 3 females aged over 70 years. Stair and step fall injury also accounted for 7% (*n*= 894) of home fall hospital admissions and at least 6% (*n*=1,493) of home falls ED presentations (Table 1).

Trend in stair and step home fall hospital admission rates, by gender, Victoria July 1993- June 2003. **Figure 5**



Source: VAED July 1993-June 2003

The frequency of stair and step fall injury hospitalisations increased by more than 70% over the decade 1993/4 to 2002/3 (from 373 admissions per year on average in 1993/6 to 639 admissions per year on average in 2000/3). In males, their frequency increased by 95% (from 103 admissions per year on average to 202) and in females by 62% (from 270 admissions per year on average to 438).

Age-adjusted rates were calculated to examine the trend in hospital admissions for stairs and step falls (Figure 5). Same day records were excluded to reduce the influence of changes to admissions policies over the period. To reduce the effect of year-to-year fluctuations due to relatively small numbers, the analyses compare the 3-year average admission rate at the start of the decade to the 3-year average at the end.

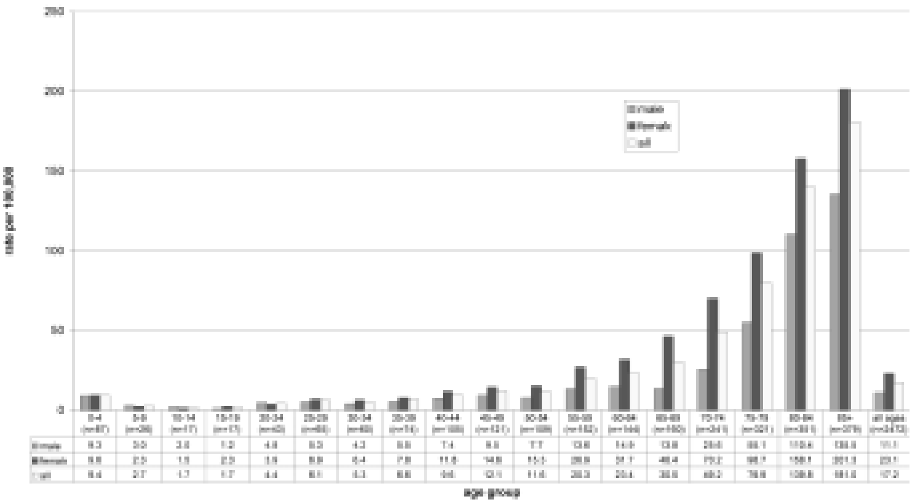
The all-persons stair and step fall injury hospital admission rate increased by 47% over the decade, from 9 admissions/100,000 population per year on average in 1993/6 to 13.1 admissions/100,000 population in 2000/3. The male injury hospital admission rate increased by 68% (from 5/100,000 to 8.4/100,000) and the female rate increased by 39% (from 12.8/100 to 16.2/100,000).

How much of the increasing trend is due to increased exposure to steps and stairs in the home is not known. However, the major escalation in both the frequency and rate of stair and step home fall injury in Victoria over the past decade highlight the importance of designing and constructing safer stairs and steps in Victorian homes.

The crude mean annual rate of hospital admissions for stairs and steps fall injury increases almost exponentially with age beyond 40 years (Figure 6) similar to the all-cause home falls injury rate. Older females were over-involved in hospital admissions for stair and step falls compared to males. Other studies have consistently reported that older females form a greater proportion of hospital admissions for stair and step fall injury than older men[32-34].

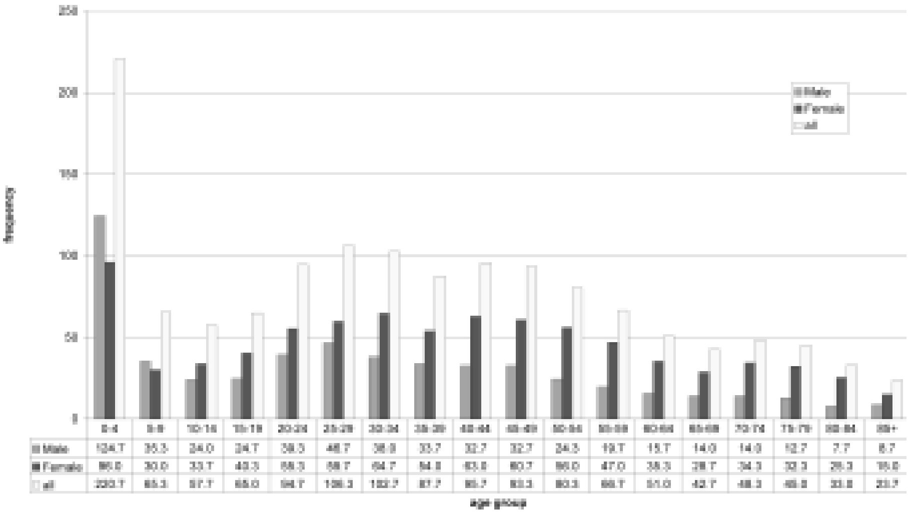
The frequency and rate of hospital admissions for stair and step fall

Crude mean annual rate (per 100,000 population) of stair and step home fall hospital admissions by age and gender, Victoria July 2000-June 2003 — Figure 6



Note: Frequencies are total frequencies over the three-year period not mean annual frequencies.
Source: VAED July 2000-June 2003

Mean annual frequency of stair and step home fall hospital ED presentations by age and gender, Victoria July 2000-June 2003 — Figure 7



Source: VEMD July 2000-June 2003

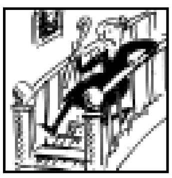
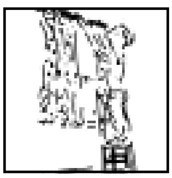
The pattern of hospital-treated stair and step fall injury among children and adults, separately, is summarised in Tables 3 and 4. Among children aged 0-14 years, males were over-represented in both admissions and ED presentations data and the hospital admission rate and frequency of ED presentations was much higher in 0-4 year olds compared to older children. Head and neck injuries predominated in both admissions and presentations. Fractures and open wounds were the most common injuries.

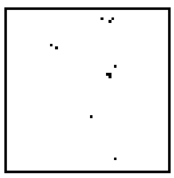
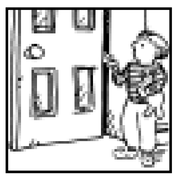
Amongst adults aged 15 years and older, females were much more likely than males to be hospitalised or present to ED with injuries from stairs and step falls. Hospital admission rates increased with age, as did the frequency of ED presentations. By far the most common injury among admitted cases was head injury, followed by upper extremity injury, whereas lower extremity injury (mostly to the ankle and foot) was the most common injury among ED presentations. Fractures were the most prominent injury among admitted cases, whereas dislocations/sprains and strains predominated in ED presentations.

Victorian injury surveillance systems record only sparse detail on the circumstances of the fall. Research indicates that most stair falls occur during descent and these tend to cause relatively serious injuries such as fractures[35]. Many falls during descent occur when the user misses the next lower tread or catches their heel on the nosing or the riser, which pushes the user forward causing a forward fall. A fall during descent may result in a large initial impact followed by several smaller subsequent impacts on a number of steps as the user descends the full flight[35].

Falls that occur during ascent are usually less severe because they tend to be towards the higher steps and involve relatively small impacts[35]. Some of these falls occur as a result of the toe tripping on the stair nosing as the foot swings upward. Another possible fall scenario during ascent is the user misjudging the

hospitalisation increase as age increases from age 15 years until persons aged 75 years having the highest frequency and rate of all age groups (Table 3+4). Among child hospitalisation the youngest children have the highest frequency and rate of stair and step falls hospitalisation. This indicates that very young children and older adults should be the special target of stair and steps falls intervention. Importantly, however, Tables 3 & 4 show that when frequency is considered, 57% of admitted cases of step and stair related fall injuries and 93% of ED presentations were less than 75 years of age. This clearly indicates that step and stair injuries are not only a problem of the very young and the very old.

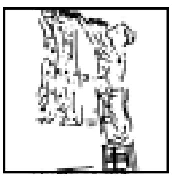




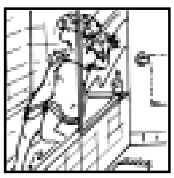
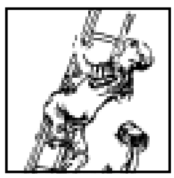




Frequency and pattern of hospital-treated home injury caused by stair and step falls, children 0-14 years, July 2000 to June 2003 **Table 3**

Characteristics	VAED admissions (*n*=130)		VEMD presentations (non-admissions) (*n*=1031)	
	N (Average rate per year)	%	N	%
Gender				
• Male	69 (4.7/100,000)	53%	552	54%
• Female	61 (4.3/100,000)	47%	479	46%
• All child cases	130 (4.5/100,000)	100%	1031	100%
Age groups				
• 0-4 years	87 (9.4/100,000)	67%	662	64%
• 5-9 years	26 (2.7/100,000)	20%	196	19%
• 10-14 years	17 (1.7/100,000)	13%	173	17%
• All child cases	130 (4.5/100,000)	100%	1031	100%
Body site injured				
• Head/neck	78	60%	586	57%
- head	*-78*	*-60%*	*-286*	*-28%*
- neck	*-0*	*-0%*	*-294*	*-29%*
- face			*-6*	*-<1%*
• Trunk	3	2%	28	3%
• Upper extremity	27	21%	155	15%
- shoulder/upper arm	*-10*	*-8%*	*-21*	*-2%*
- elbow/forearm	*-14*	*-11%*	*-90*	*-9%*
- wrist/hand	*-3*	*-2%*	*-44*	*-4%*
• Lower extremity	20	15%	197	19%
-hip/thigh	*-11*	*-9%*	*-7*	*-<1%*
-knee/lower leg	*-8*	*-6%*	*-56*	*-5%*
-ankle/foot	*-1*	*-<1%*	*-134*	*-13%*
• Unspecified/missing	2	2%	30	3%
• Multiple body regions	-	-	10	<1%
• No injury detected	-	-	25	2%
Nature of injury				
• Fracture	50	39%	135	13%
• Open wound	36	28%	277	27%
• Intracranial	12	9%	51	5%
• Dislocation/sprain & strain	6	5%	166	16%
• Superficial	5	4%	189	18%
• Other	15	12%	141	14%
• Unspecified	6	<1%	72	7%

Sources: Hospital admissions: Victorian Admitted Episodes Dataset (VAED) July 2000 to June 2003
Emergency department presentations (non-admissions): Victorian Emergency Minimum Dataset (VEMD) July 2000 to June 2003

Frequency and pattern of hospital-treated home injury caused stair and step falls, adults 15 years and older, July 2000 to June 2003 **Table 4**

Characteristics	VAED admissions *n*=2342		VEMD presentations (non-admissions) *n*=3108	
	N (Average rate per year)	%	N	%
Gender				
• Male	716 (12.7/100,000)	31%	1093	35%
• Female	1626 (27.5/100,000)	69%	2015	65%
• All adults	2342 (20.3/100,000)	100%	3108	100%
Age groups				
• 15-29 yrs	125 (4.1/100,000)	5%	798	26%
• 30-44 yrs	239 (7.2/100,000)	10%	858	28%
• 45-59 yrs	382 (14.2/100,000)	16%	721	23%
• 60-74 yrs	545 (33.4/100,000)	23%	426	14%
• 75+ yrs	1051 (121.8/100,000)	45%	305	10%
• All adults	2342 (20.3/100,000)	100%	3108	100%
Body site injured				
• Head/face/neck	402	17%	376	12%
- head	*-366*	*-16%*	*-210*	*- 7%*
- neck	*-36*	*- 1%*	*- 23*	*- < 1%*
- face			*-143*	*- 5%*
• Trunk	319	14%	247	8%
- thorax	*-115*	*- 5%*	*-101*	*- 3%*
- abdomen/lower back/ lumbar spine/pelvis	*-204*	*- 9%*	*-146*	*- 5%*
• Upper extremity	478	20%	681	22%
- shoulder/upper arm	*-210*	*- 9%*	*-207*	*- 7%*
- elbow/forearm	*-223*	*-10%*	*-168*	*- 5%*
- wrist/hand	*-45*	*- 2%*	*-306*	*-10%*
• Lower extremity	1103	47%	1641	53%
-hip/thigh	*-439*	*-19%*	*- 33*	*- 1%*
-knee/lower leg	*-570*	*-24%*	*- 172*	*- 6%*
-ankle/foot	*-94*	*- 4%*	*-1336*	*-43%*
• Other	31	1%	127	4%
• Unspecified	9	<1%	36	1%
Nature of injury				
• Fracture	1445	62%	774	25%
• Open wound	220	9%	295	10%
• Intracranial	108	5%	27	<1%
• Dislocation/sprain & strain	104	4%	1323	43%
• Superficial	141	6%	257	8%
• Injury to muscle/tendon	28	1%	182	6%
• Other	99	4%	176	6%
• Unspecified	197	8%	74	2%

Sources: Hospital admissions: Victorian Admitted Episodes Dataset (VAED) July 2000 to June 2003
Emergency department presentations (non-admissions): Victorian Emergency Minimum Dataset (VEMD) July 2000 to June 2003

next tread position resulting in an under-step and miss, or slip-off the edge of the upper step.

Preventing stair and step home fall injury

There are at least three major factors in stair falls: user behaviour, maintenance, and design[35]. User behaviour-related falls include those caused by running on stairs or tripping on objects placed on steps. Maintenance-related stair injuries comprise injuries caused as a result of broken treads or handrails, loose stair coverings or nosings, or slips due to excessively polished stairs. Although educational programs such as safety campaigns can target user behaviour and maintenance-related falls, these have limited effectiveness as they require consistently applied changes in user behaviour. Design solutions, on the other hand, have the potential to be more effective in preventing stair injuries. Priorities for improved safety and usability of stairways are: appropriate step geometry, visibility of the steps, and provision of functional handrails[31].

Improving stair and step geometry

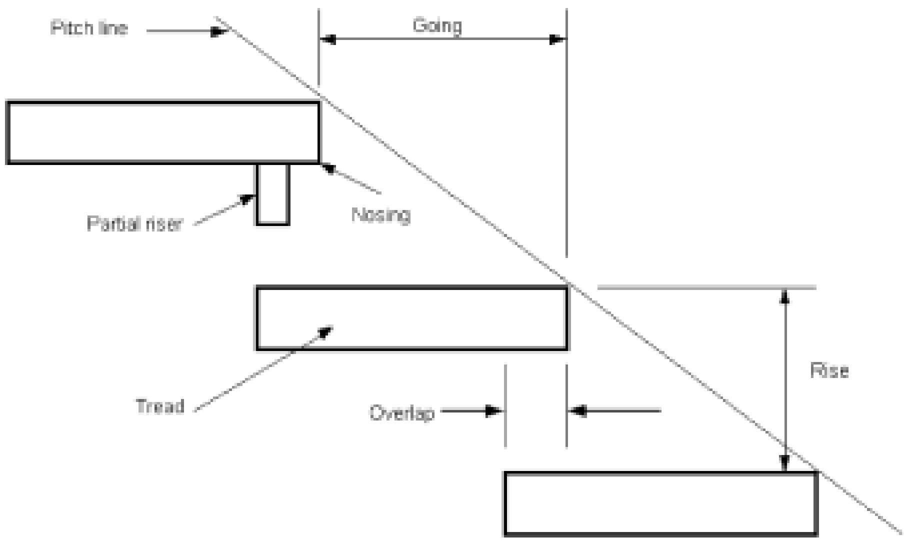
The number of steps or risers is an important design parameter that affects fall risk on stairs. Several researchers have found that a disproportionate number of falls occur on stairways that have a small number of risers. Fifty percent of 40 stair falls investigated by Jackson and Cohen[36] occurred in stairs with four or fewer risers. Of those 20 cases, 60% were on stairways with only one or two risers. Templer also found that fall risk was low on stairways with more than 6 risers[32]. One leading cause of stair falls is the failure to notice a one- or two-riser stairway in the path[37]. Therefore, safe home design guidelines recommend grouping steps for better visibility[9]. Each group is recommended to have at least three steps, and single steps should be avoided.

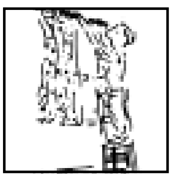
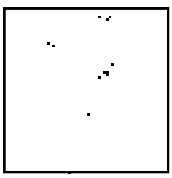
While building codes specify certain design guidelines on stair design, some of these are not based on scientific evidence[32]. Some recent research attempts to provide scientific evidence to improve stair design guideline[38-40]. Roys at Building Research Establishment (BRE) in England recently investigated the effect of the size of risers and goings (Figure 8) on stair use[38,39]. An experimental rig with eight sliding carpeted steps whose rise and going sizes were adjustable was used for these experiments. Subjective opinions of 24 males and 36 females who walked up and down the stairs with different rise and going dimensions were collected using a set of questions. Hesitations, glances at feet, use of handrails and missteps were observed. The foot angle and overhang were measured. A series of experiments where the rise was fixed at 175mm and the going dimension varied between 150mm to 425mm demonstrated that smaller goings increase the likelihood of subjective dissatisfaction, observed increase in missteps and use of handrails, increased foot angle, and the maximum overhang. Based on his research, Roys recommends a minimum going size of 275mm - 280mm for private stairs and a minimum going size of 300mm for public stairs (Personal communication, Mike Roys, BRE, November 2004). The full results and recommendations from this study will be presented at the Ergonomics Society Conference in April 2005. A second paper discussing the theoretical relationship between foot overhang and slip will also be presented at this conference.

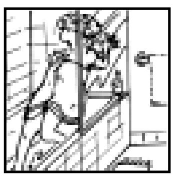
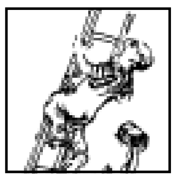
Roys and Wright investigated how the going size and the uniformity of the going dimension affect the occurrence of large oversteps on a flight of stairs[41]. Interventions, such as the installation of proprietary nosings, are recommended for stairs that are frequently used, have large dimensional non-uniformities, and have goings smaller than 350mm. Having a step with a smaller going immediately following a larger one makes the stair dangerous during descent. Pauls recommends maintaining close tolerances preferably 5mm between adjacent treads and between adjacent risers with no more than twice this tolerance within a stair flight[31].

Building codes give guidelines on rise and going sizes that are acceptable for public, semi-public, and private stairs[35,42]. These guidelines are based on the following criteria: risers should not be too large as to make the climb excessive or too small as to make the steps a tripping hazard; the combination of riser and going dimensions should allow a user to maintain a comfortable stride on the stairs; and the going should allow sufficient room for the user to place the foot.

Stair definitions and dimensions **Figure 8**



Pauls recommends using the larger going size required for public stairs for domestic stairs as well[31]. Because many users, especially older persons, may not have sufficient physical control to negotiate stairs with reduced goings, they have a high risk of a fall from stairs with smaller goings. The building industry has resisted to increasing the size of goings claiming that it takes extra space for the staircase and, hence, increases cost[43]. However, innovative design may overcome this by utilizing the space under the staircase for a toilet or storage. Mandating this change would potentially provide a level playing field for the whole industry.

A 1992 report published by National Association of Home Builders Research Centre[43] questioned the validity of previous studies calling for deeper treads and smaller risers alleging that these studies were based on stair incidents, such as missteps, rather than actual stair accidents that caused injury. Jackson and Cohen responded to these allegations by conducting a survey of 40 in-depth stair accident cases[36]. They concluded that the strongest pattern for stairway accidents lies in dimensional inconsistency within stairways. Jackson and Cohen also cite several previous studies that found dimensional inconsistencies of treads and risers to be a major risk factor for stair falls. Even a 5mm irregularity, particularly at the top or bottom of a stairway, can disrupt foot movements to cause a fall. In building inspections for stair dimensions and irregularities, the finished step dimensions with carpeting or other floor finishes must be considered, rather than the unfinished stairs, because the floor covering thickness cannot be ignored[31].

Stairway lighting

Proper lighting is required near stairways so that the user can see the treads easily. Self-illuminating strips[44] are available that allow stair edges to be seen in the dark. Automatic dawn/dusk lights that respond to ambient light levels and turn on when it is dark or sensor lights that turn on for a preset duration when a personís presence is detected can be installed near stairways to ensure that they are adequately lit. These lights may also be useful for bathrooms and other locations where lack of illumination can create a hazard.

Floor coverings

The covering used on tread affects the risk of slipping on stairs. The risk of slipping on stairs is increased if the tread surface is smooth, if the steps are wet, or if the nosing is rounded[41]. Smooth materials such as glazed ceramic tiles, polished terrazzo, and finished timber do not provide enough protection against slipping, especially if the treads are wet. A study by Roys found that falls were three times more likely on stairs with other floor coverings compared to carpet[45]. Thin carpet that is secured tightly to the step is, therefore recommended for stairs. The slight impact absorbing effect of carpet may prevent lacerations in a fall but may not be effective in preventing fracture. Thick carpets or carpet with underlay are not recommended for use on stairs[31]. If carpeted stairs are heavily used, the carpet on the nosing can become smooth and wear through, creating a trip hazard[41]. Non-domestic stairs that are exposed to wet conditions and contamination call for rough materials such as clay tiles with a carborundum finish, cork tiles, asphalt, and resin-based products with enhanced slip resistance[41].

Non-slip coatings and covers are available for a variety of industrial, commercial, and residential applications on steps, stairways, decks, ramps, etc. These products are applied over existing steps, walkways, platforms, etc to improve their slip resistance. Furthermore, these are available in high visibility colours to make stair nosings more visible. Non-slip stair covers are mainly used in industrial and commercial settings that have higher traffic and high levels of contamination. However, these may be useful for outside steps in private dwellings, where many falls occur. Falls on outside steps can cause severe injury if the victim falls onto concrete paving. Rubber-based impact absorbing material (commonly used as playground surfacing) or similar materials could be used instead of concrete paving around outside steps to reduce injury.

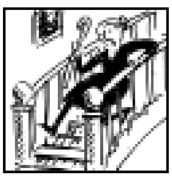
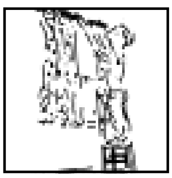
Handrails

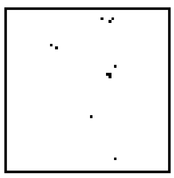
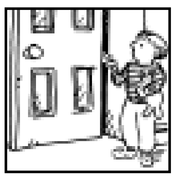
A substantial proportion of stair falls has been attributed to the lack of handrails[32]. A study by Roys found that fall risk on stairs doubles if just walls are on both sides of the stairway compared to having handrails or barriers on both sides[45]. The risk increased four fold when there was nothing to hold onto on at least one side[45]. The absence of handrails is especially hazardous for the elderly users of staircases[32]. Handrails are used for guidance and balance or simply used in a fall to grab and break the fall.

Australian standard AS 1657:1992 requires provision of a handrail throughout the length of each stairway flight[46]. Handrails must be provided on each side if the stairway width exceeds 1000mm[46]. Provision of handrails is important even when there are only one or two risers, as such stairs cause a disproportionately large number of falls[31]. In addition to providing support during stair use, handrails also provide a useful visual clue about the presence of the stairs. Handrails should be able to withstand the weight of a person. The Australian Standard AS 4226-1994 recommends that handrails should be able to resist a 1.5kN load applied at any point[9].

As a sudden discontinuity in a handrail could make the user lose balance during descent AS 4226-1994 recommends that handrails should continue around landings[9]. Handrails should extend 300mm beyond the end of the flight of stairs and have a downward sloping end, which helps people with impaired vision know that the end of the stairs has been reached[47].

Maki et al conducted biomechanical studies of handrail use to inform more effective design guidelines[48]. An experimental study involving human subjects on a mock stairway showed that subjects can grab a handrail and generate

sizeable stabilizing force very quickly in response to a postural disturbance, even when the hand is distant from the rail when the loss of balance occurs. Trials where handrails were absent resulted in significantly more falls compared to those where handrails were present, indicating the functional significance of handrails for preventing falls[48]. The researchers suggest that the influence of stance position on the trajectory of the arm, and the angle of attack of the hand on the rail may have implications for designing the shape of the rail. While the angle of attack is not critical if the handrail has a circular cross section, it becomes important for handrails with edges or more complex shapes.

If the hand cannot easily conform to the shape of the handrail or if the shape and the size do not provide sufficient finger purchase on the rail, the userís hand may not be able to generate sufficient stabilizing force. A handrail with a circular cross section and a diameter of about 30mm-50mm allows an adult to have a power grip where the thumb and index finger can encircle the rail. This type of grip optimises grip forces in the hand[32]. Based on biomechanical tests on staircase handrails, Maki et al suggest the optimal handrail to be a cylindrical shape with a diameter of 38mm[49]. To maximize grip forces for children, a smaller diameter is recommended. Dual handrails provide one solution to the different needs of adults and children.

Rectangular shaped boards tipped on the narrow edge are commonly used as handrails because of their decorative effect and ease of attachment to the wall. However, with such handrails, the userís grip is limited to a pinch grip, which is the weakest type of grip[32]. Many new homes use architectural decorative handrails that have large diameters making them difficult to grip, especially for children. Such decorative handrails must be augmented with functional handrails. Balustrades with ornamentation containing sharp edges can cause serious injury if a stair user falls on them[50]. Templer suggests using smooth flat surfaces or gentle curves and also firm but compressible material on balustrades and walls onto which a fall victimís body may forcibly strike.

The Australian Standard AS 4226-1994 recommends installing handrails between 865mm-900mm above the pitch line. This positions the handrails at about adult elbow height. Based on recent human subject testing conducted using a moving-platform system, Maki et al[51] recommend a handrail that is considerably higher than many existing building codes suggest and also mounted farther from the wall. These changes are suggested to increase the rail reaction force relative to the feet and to allow the hand to attack the rail with fingers fully extended. These biomechanical study findings have resulted in the development of a handrail system, which is mounted above and parallel to the regular handrail of a stair and shaped so it can be grasped similarly to an underarm crutch, for the benefit of stair users with poor hand strength[51].

It is important to offset handrails at least 50mm from the wall[9] and to avoid rough walls behind handrails to prevent injury to knuckles of the gripping hand. Current UK guidelines increase this offset to 60-75mm from the wall (Personal communication, Mike Roys, BRE, November 2004).

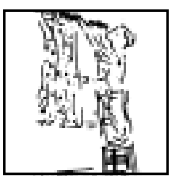
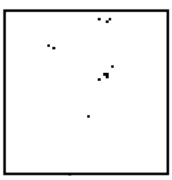
Ishihara et al[40] conducted a study in Japan to determine the optimum handrail diameter, handrail height, and the horizontal extension suitable for elderly Japanese people. Based on this study, the handrails were recommended to be 33-35mm in diameter, 670-780mm in height, and have approximately 400mm horizontal extension. They also developed a regression model for choosing the optimal handrail height for an individual based on the body height and body weight. Because of the difference in size of average Japanese and US persons, these dimensions are smaller than those recommended in corresponding US studies, which shows the importance of choosing appropriate design guidelines to suite the target population of users. While the dimensions for the mainstream Australian population may agree with the American results, these may not be appropriate for the increasing overseas-born population. Universal design approaches such as incorporating multiple or adjustable handrails may allow all users, regardless of their height, to get the full benefit of handrails.

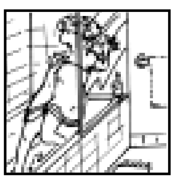
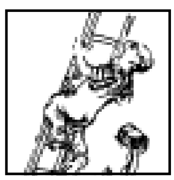
Just as handrails can help to prevent falls on stairs, handrails and grab bars can prevent falls in other locations within the home. Several such products that can be installed by the bed or toilet to help older persons to stand up are commercially available (eg. SturdyGrip[51], SuperPole, and SuperBar[52]). The effectiveness of these and similar products in preventing falls must be evaluated.

Stair gates

Child safety stair gates at the top and bottom of stairs are a useful intervention against stair falls for infants and toddlers. The Australian Standard AS 4226-1994 recommends any stair gate to be the same height as the handrail or balustrade[9]. It further recommends easy-to-operate hinged stair gates over sliding or telescopic gates, as there is a temptation for adults to step over the latter types of gates, which may pose a fall hazard to adults. However, accordion type stair gates are not safe as they may pose a strangulation or entrapment hazard to children[53]. Stair gates that are mounted using an expanding pressure bar are not recommended for use at the top of a flight of stairs as these gates can pop out if a child pushes on them causing the child to fall down the stairs[53].

One innovative stair gate has a fixed section and a hinged section that can be opened by an adult for passing through the gate easily[54]. Once the child has grown to an age that he learns how to open the gate, it can be used in a tumbler-stopper mode. That is, the two stair gate sections are separated and one part is mounted on one side of the stair and the other section is mounted on the opposite side of the stair at a lower height. Now the gate allows the child to walk on the

stairs and provides a means to break a fall and prevents the child from descending the full flight if the child falls on the stairs. While this tumbler-stopper mode seems to be useful to break falls and reduce injury severity in adult falls as well, it needs to be investigated whether the presence of these partial stair gates themselves would actually act as a hazard. Another potential aid to the use of stair gates would be the routine provision of fixed attachment points on domestic stairs, allowing ease of fitting and transfer of these barriers to homes visited.

Another stairway design feature recommended by Roys is having a landing or hall at the top of the stairs. He found that having a room at the top of stairs increased the likelihood of a fall by 1.75 times compared to having a landing or hall at the top[45].

4. Preventing falls from windows and balconies

Hospital admissions data do not disaggregate falls from balconies and windows as the code covers all falls out of or through buildings and structures. Hospital emergency department presentation data for the period July 2000 ñ June 2003 in Victoria show at least 140 falls from verandas or balconies and 216 falls from windows. These data do not give information on exactly how the person fell from the balcony or window.

A Dallas, Texas study reported on 98 child falls from buildings where 39 fell from windows and 34 from balconies[55]. In 65% of balcony related falls, the child fell from between the rails, which were more than 100mm apart, and in 29% of cases the child had climbed over the rails. The results of a 1998 UK study suggests that stair guarding of 900mm height presents no difficulty to the majority of active children aged between four and six years to climb onto or over the guarding[56]. The Australian Standard AS 4226-1994 recommends providing balustrades with at least 1000mm height with no clear gaps larger than 100mm between balusters[9]. Solid balustrades or balustrades with only vertical balusters should be used, as horizontal or decorative elements provide footholds for children to climb. These design features should be included in Australian building standards, regulations, and codes. The allowable fall height before which a balustrade is required should be decreased in Australian building regulations and codes. While adherence to these design guidelines can prevent many falls, they cannot eliminate all balcony related falls as other items such as furniture placed on balconies may allow a child to climb over a balustrade and fall. Kid Shield banister guard is a clear and almost invisible banister shield made of shatterproof and flexible plastic which can be used to prevent children from trying to squeeze through balusters[57]. Another product, Kid Safe deck netting, is a plastic mesh that can be attached around the balustrade of a deck to prevent falls[57].

Apart from falling over or through balustrades of a balcony, people can also be injured or killed due to balcony collapses[58]. Because balconies are exposed to the elements, they can fail unless they are constantly monitored and regularly maintained. Decay of timber and rusting of steel bolts and brackets in timber balconies and rusting of steel reinforcements in concrete balconies may cause collapse (Figure 9). The suitability of weather resistant products such as recycled plastic lumber for construction of balconies should be investigated to prevent balcony collapses.

Several design solutions have been suggested for preventing falls from windows. One strategy is to use windows that cannot be opened more than 100mm if the window is over 1200mm above the floor[59]. The installation of window guards is a proven preventive strategy that resulted in a dramatic reduction of child window falls in multi-story dwellings in New York City[60]. This intervention was opposed in some US states on the grounds that window guards limit fire egress[61]. However, the advice from fire services to residents in multistorey buildings is not to egress through windows and emergency services have the equipment to break through window guards.

An alternative to fixed window bars is the use of operable window guards that can be removed by an adult without excessive force or a special key in an emergency, but is difficult for a child to open[60]. An innovative design solution would be to have a bimetallic strip-based locking pin that can automatically bend and release the window guard if the temperature of the room rises to dangerous levels.

Recommendations

Slip resistant surfaces for homes

ï Use recently updated slip resistance standards to develop building codes and regulations requiring installation of slip-resistant surfaces in internal wet areas and external pedestrian areas of new and renovated homes.

ï Victorian Local Government Associations should adopt the fall injury prevention initiative of the Local Government and Shires Associations of New South Wales, which would make it unacceptable to issue

A collapsed timber balcony (Photo courtesy *Archicentre*) **Figure 9**

certificates of occupancy where buildings have flooring that does not meet recommendations on slip resistance of pedestrian surfaces in the revised Standards Australia Handbook HB 197: 2005.

- Consider the introduction of building regulations to ensure that only slip-resistant baths and shower bases are installed in new and renovated homes.
- Manufacturers and retailers of flooring materials, baths, and shower trays should provide comparative information about slip resistance to assist customers to choose safer products.
- Conduct scientific studies to evaluate the effectiveness, longevity, cost of application and maintenance, and harmful by-product generation of various proprietary treatments that claim to improve the slip resistance of tile, granite, terrazzo, and other flooring materials.

Impact absorbing surfaces for homes

- Undertake independent scientific studies to substantiate the claims made by manufactures of innovative floor coverings such as PowerBond RS regarding their impact absorbance and other properties to assess their suitability for domestic use, especially in the dwellings of older residents.
- Encourage the use of rubber-based impact absorbing material (commonly used as playground surfacing) or similar materials as paving outside the home in high risk pedestrian areas (e.g. at the base of steps or high use pathways) instead of concrete, to reduce injury severity in falls.
- Further research is required to develop impact-absorbing flooring that can attenuate sufficient energy to consistently reduce peak impact forces transmitted to the femur to levels below fracture threshold.

Steps and stairs

- Avoid unnecessary changes in levels in homes wherever possible.
- Single steps should be avoided, as they are difficult to notice. Steps should be grouped for better visibility, with each group having at least three steps.
- Stairs in private buildings should use a minimum going size of 275 mm ñ 280 mm and a minimum going size of 300 mm should be used in public buildings.
- Stair construction should maintain close tolerances preferably 5 mm between adjacent treads and between adjacent risers with no more than 10 mm within a stair flight.
- Building inspections for stair dimensions and irregularities must consider the finished step dimensions with carpeting or other floor finishes rather than the unfinished stairs because the floor covering thickness cannot be ignored.
- Thin carpet that is secured tightly to the steps without underlay is recommended for domestic stairs.
- Provide at least one handrail, preferably one on each side, throughout the length of each stairway flight, even when there are only one or two risers in the stairway.
- Handrails of a circular cross section with a diameter of between 32 mm and 50 mm should be used to improve the grip. Decorative handrails with larger diameters should be augmented with functional handrails.
- Balustrades with ornamentation containing sharp edges should be avoided and smooth flat surfaces or gentle curves and also firm but compressible material should be used on balustrades and walls, which a fall victimís body may strike.
- Install hinged child safety stair gates at the top and bottom of stairs to prevent falls of infants and toddlers.
- Accordion type stair gates should not be used as these may pose a strangulation or entrapment hazard. Stair gates that are mounted using an expanding pressure bar must not be used at the top of a flight of stairs.
- Avoid having a room at the top of stairs; providing a landing or a hall at the top reduces the likelihood of a fall.
- Automatic sensor lights, self-illuminating strips or other form of lighting should be provided to enable the user to see the stair treads easily.

Safer balconies and windows

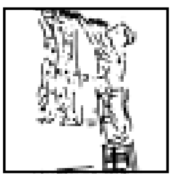
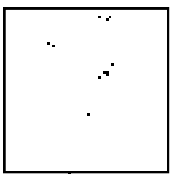
- Australian building standards, regulations and codes should address safe design of balcony and verandah balustrades.
- Provide balustrades with at least a 1m height with no clear gaps larger than 100 mm between balusters to prevent falls from balconies. Horizontal or decorative elements should be avoided to prevent children from climbing over.
- The suitability of weather resistant materials such as recycled plastic lumber for construction of balconies should investigated to prevent timber rot-related balcony collapse.
- Consider the introduction of building regulations requiring installation of window guards, which can be easily removed in a fire emergency, to prevent falls from windows of multistorey residential dwellings.

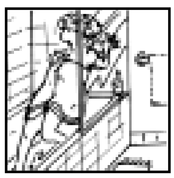
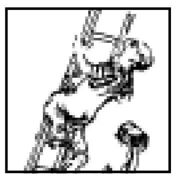
Other

- Provide grab bars in toilets and bathrooms, and by the bedside in bedrooms in homes of older persons.
- Educate architects, homebuilders and the community about safe design guidelines for preventing falls and other home injuries.

Surveillance and research

- Remedies should be sought by responsible government departments and hospitals to
    - reduce unspecified cause of fall data (3,067 cases in Victorian Admitted Episodes Dataset in one year)
    - increase the proportion of Victorian Emergency Minimum Dataset (VEMD) cases that include important aetiological information in narrative data (e.g. only 6% of VEMD fall cases indicated specific surfaces on which injurious falls occurred).

Acknowledgements

We are grateful to Mike Roys of Building Research Establishment, UK, Jake Pauls of Building Use and Safety Institute, USA, Robert Caulfield, Managing Director of Archicentre and Richard Bowman of CSIRO for providing valuable information and comments.

Box 1. Methods of extracting home fall cases from death and hospital-based injury databases

Fatality data

Fatality data were extracted from the Australian Bureau of Statistics (ABS) Death Unit Record File (DURF). ABS death data are coded using the World Health Organisation (WHO) International Classification of Diseases (ICD) coding system. Death records were selected if ëhomeí was recorded as the ëplace of deathí.

Falls deaths were identified using the following ICD-10 codes and related sub codes: ëFallsí (W00-W19). Deaths classified to X59 (exposure to unspecified factor) were recoded and considered falls deaths if they had at least one multiple cause of death coded as a ëfractureí.

Hospital data

Hospital-treated home injury data were extracted from the Victorian Admitted Episodes Dataset (VAED) and the Victorian Emergency Minimum Dataset (VEMD) using different methods due to database-specific coding issues.

Hospital admissions

The VAED records hospital admissions for all Victorian hospitals, both public and private. The three-year study period are coded to ICD version 10 with Australian modifications (editions 2 and 3). Injury records were selected if ëhomeí was recorded as the ëplace of occurrenceí.

Falls admissions were identified using ICD-10 codes and related sub codes: ëfallsí (W00-W19). Admissions classified to X59 (exposure to unspecified factor) were recoded and considered falls admissions if they had at least one diagnosis coded as a ëfractureí.

Hospital Emergency Department presentations

The VEMD currently records public hospital presentations to 28 EDs, representing approximately 80% of statewide ED presentations. Injury records were selected if ëhomeí was recorded as the ëplace of occurrenceí.

Falls records were extracted using the VEMD injury cause codes: *Fall- low (same level or less than 1 metre, or no information on height)* and *Fall (greater than one metre)*. Records were then matched to the ICD-10 cause codes in the ABS and VAED datasets.

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Report on the use of VISARís data and information request service, 2004

VISAR offers an injury data and information request service for research and prevention purposes that can be accessed by telephone or email. Victorian datasets that can be accessed through the service include Australian Bureau of Statistics deaths data for Victoria, the Victorian Admitted Episodes Dataset (hospital admissions to all Victorian public and private hospitals) and the Victorian Emergency Minimum Dataset (Emergency Department presentations to 28 Victorian hospitals).

In 2004 VISAR responded to 231 information requests. Regular VISAR clients include education bodies (undergraduate and post-graduate students and schools), organisations and individuals from the public health sector, government bodies (national, state and local), research groups (MUARC and external), media, industry/business and the community (Figure 1).

The most frequently requested topics over 2004 were: elderly fall injury, playground and play equipment injury, DIY home maintenance injury, home injury, dog bite, sports injury poisoning, nursery furniture and equipment injury, off-road vehicle injury (ATVs and motorcycles) and local community injury profiles (by Local Government Area).

ï Who can access VISAR injury data?

The VISAR data and information request service is open to government and non-government organisations, the higher education and schools sector, industry and business and community members. We are not able to provide a direct service to primary and secondary school students.

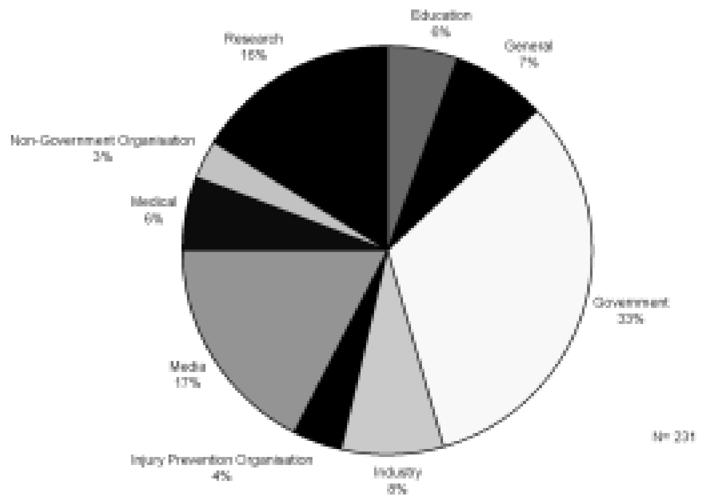
ï How do I make a request?

Data and information requests can be made by telephone (9905 1805) or email: visar.enquire@general.monash.edu.au

ï Any charges?

A standard format response is free-of-charge. Additional analysis may be purchased for a cost-recovery fee of $100 per hour, (GST exclusive).

Data & information requests 2004 **Figure 1**



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Preventing hand entrapment injury from doors

Ajith Gunatilaka
Erin Cassell
Angela Clapperton

Another common injury that occurs in the home that may be amenable to a design solution is entrapment of the hand (mostly the finger) in a closing door. These injuries usually occur when the hand/finger is either trapped between the opposing surfaces of the door and the frame or trapped in the hinged side of the door as the door is closed.

In Victoria in 2002/3, there were 145 hospital admissions for hand/finger entrapment injuries from doors in the home. Children (mostly 0-4 year olds) were over represented in these admissions, accounting for 72% of cases (n=105). Thirty seven percent of admissions (n=54) were finger/thumb amputations.

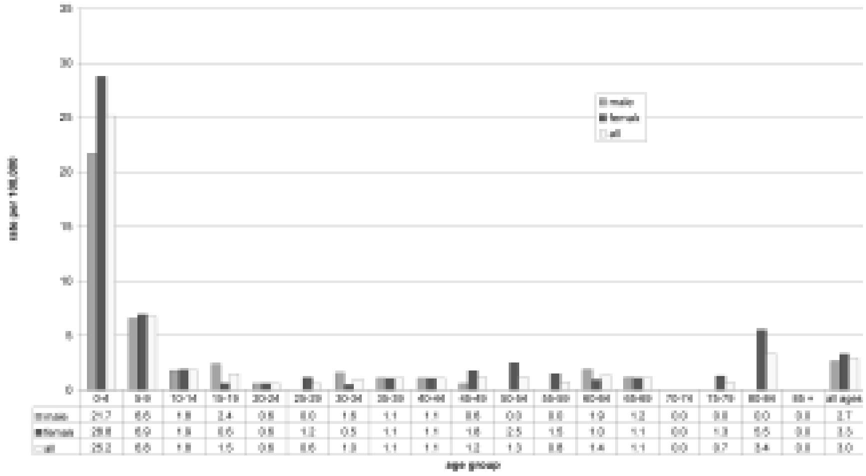
Figure 1 shows that the door entrapment hand/finger home injury hospitalisation rate was highest in 0-4 year olds, more than eight times the rate for all ages combined.

In addition, 475 ED presentations (non-admissions) for hand/finger entrapment injuries from doors were recorded on the VEMD in 2002/3. Rates cannot be calculated because not all hospitals with emergency departments contributed injury cases to VEMD in 2002/3. As shown for hospital admissions, children were over represented in emergency department presentations, particularly 0-4 year olds.

Tables 1 summarises the pattern of hand/finger entrapment injury from doors for both admissions and presentations.

- The youngest children (aged 0-4 years) were over-represented in each dataset, accounting for 72% of child admissions and 64% of presentations.
- The most common admitted injuries among children were finger amputations or partial amputations (40%) and open wounds (35%). Crushing injuries (25%), superficial injuries (22%) and open wounds (20%) accounted for the majority of presentations.
- Younger adults (aged 15-29 years) account for 42% of adult presentations, whereas they account for only 23% of adult admissions
- Females were over-represented in adult admissions (60%) whereas males were over-represented in presentations (55%).
- The most common admitted injuries among adults were finger fractures (48%) and amputations (28%). Open wounds (25%), crushing injuries (21%) and fractures (19%) accounted for the majority of adult presentations.

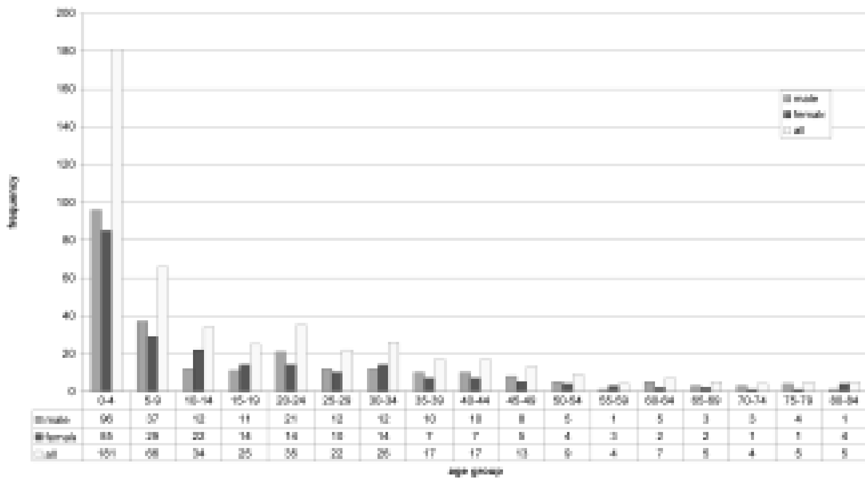
Age specific rates of home injury hospital admissions for hand and finger entrapment from doors by gender, Victoria July 2002-June 2003 (*n*=145) **Figure 1**



	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84	85+	all ages
male	21.7	6.6	1.8	2.4	0.6	0.0	1.6	1.1	1.1	0.6	0.0	0.0	1.9	1.2	0.0	0.0	0.0	0.0	2.7
female	28.8	6.9	1.9	0.6	0.6	1.2	0.5	1.1	1.1	1.8	2.5	1.5	1.0	1.1	0.0	1.3	5.5	0.0	3.3
all	25.2	6.8	1.8	1.5	0.6	0.6	1.0	1.1	1.1	1.2	1.3	0.8	1.4	1.1	0.0	0.7	3.4	0.0	3.0

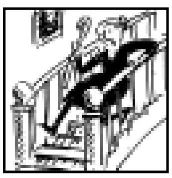
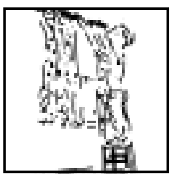
Source: VAED, 2002/3

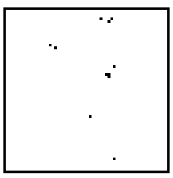
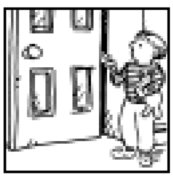
Frequency of home injury ED presentations for hand and finger entrapment from doors by age and gender, Victoria July 2002-June 2003 (*n*=475) **Figure 2**



	0-4	5-9	10-14	15-19	20-24	25-29	30-34	35-39	40-44	45-49	50-54	55-59	60-64	65-69	70-74	75-79	80-84
male	96	37	12	11	21	12	12	10	10	8	5	1	5	3	3	4	1
female	85	29	22	14	14	10	14	7	7	5	4	3	2	2	1	1	4
all	181	66	34	25	35	22	26	17	17	13	9	4	7	5	4	5	5

Source: VEMD, 2002/3

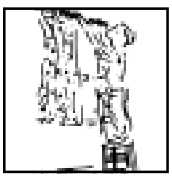
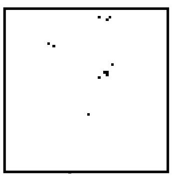




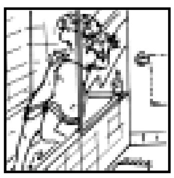
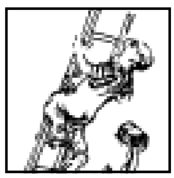




Frequency and pattern of hospital-treated hand and finger entrapment injury from doors, July 2002 to June 2003 — Table 1

Characteristics	Child		Adult	
	VAED admissions (*n*=105) N(%) (rate per 100,000)	VEMD presentations (non-admissions) (*n*=281) N(%) (rate per 100,000)	VAED Admissions (*n*=40) N(%) (rate per 100,000)	VEMD Presentations (non-admissions) (*n*=194) N(%) (rate per 100,000)
Gender				
• Male	48 (46%) (9.8/100,000)	145 (52%)	16 (40%) (0.8/100,000)	106 (55%)
• Female	57 (54%) (12.2/100,000)	136 (48%)	24 (60%) (1.2/100,000)	88 (45%)
• All cases	105 (100%) (10.9/100,000)	281 (100%)	40 (100%) (1.0/100,000)	194 (100%)
Age groups				
• 0-4 years	77 (73%) (25.2/100,000)	181 (64%)		
• 5-9 years	22 (21%) (6.8/100,000)	66 (24%)		
• 10-14 years	6 (6%) (1.8/100,000)	34 12%)		
• All child (0-14 years)	105 (100%) (10.9/100,000)	281 (100%)		
• 15-29 yrs			9 (23%) (0.9/100,000)	82 (42%)
• 30-44 yrs			12 (30%) (1.1/100,000)	60 (31%)
• 45-59 yrs			10 (25%) (1.1/100,000)	26 (13%)
• 60-74 yrs			5 (12%) (0.9/100,000)	16 (8%)
• 75+ yrs			4 (10%) (1.3/100,000)	10 (5%)
• All adult (≥15 years)			40 (100%) (1.0/100,000)	194 (100%)
Nature of injury				
Admissions				
• Hand & finger injuries	105 (100%)		40 (100%)	
- finger, amputation	*-42(40%)*		*-11 (28%)*	
- finger, fracture	*-16(15%)*		*-19 (48%)*	
- finger, open wound	*-37(35%)*		*-7 (18%)*	
- finger, superficial	*-2(2%)*		*-1 (2%)*	
- finger, crushing	*-8(8%)*		-	
- finger, muscle/tendon	-		*-1 (2%)*	
- hand, crushing	-		*-1 (2%)*	
ED Presentations				
• Hand (including finger) injuries		281 (100%)		194 (100%)
- crushing		*-71(25%)*		*-41(21%)*
- superficial		*-63(22%)*		*-24(12%)*
- open wound		*-57(20%)*		*-48(25%)*
- sprain/strain		*-34(12%)*		*-26(13%)*
- fracture		*-21(8%)*		*-37(19%)*
- amputation		*-5(2%)*		-
- other		*-30(11%)*		*-18 (9%)*

Sources: Hospital admissions - Victorian Admitted Episodes Dataset (VAED) July 2002 to June 2003
Emergency department presentations (non-admissions) - Victorian Emergency Minimum Dataset (VEMD) July 2002 to June 2003

Discussion

Fingertip and nailbed injury caused by doors is common in children, particularly among 0-4 year olds[1-5]. Finger injuries cause disruption to the injured childís daily activities such as eating, playing and schoolwork, and anxiety in both children and parents about the possibility of deformity, disability and shortening.

There are a small number of published in-depth studies of child patients presenting with finger entrapment injury to emergency departments, and these provide more detail on the pattern, cause and circumstances of these injuries[1-5]. Children under 5 years of age, and boys[3,5] are generally reported as more frequently injured. The majority of finger entrapment injuries to younger children are reported to occur on the hinge side of the door, rather than the lock side[3,6,7] but this pattern appears to reverse with age[3,6,7]. Additional information provided from a prospective study of 283 child patients presenting to the Accident and Emergency Department of the Royal Hospital for Sick Children in Glasgow[2,3] indicates that the middle finger is involved most often in door jam injury, perhaps because it is the longest; the doors are commonly being closed by someone at the time of the injury, most often by the injured child; and that the living room and toilet/bathroom doors, rather than kitchen doors, are most frequently involved.

At present there are no regulatory requirements for safety measures to doors in Australia or any of the other countries that share a reputation for proactive injury prevention policies and regulations[2]. What preventive measures currently exist? Use of door stops, hooks, wedges and stoppers to hold doors open are common measures to prevent doors from slamming shut. The finger pinch guard, a U-shaped soft and flexible piece that can clip on to the front edge of a door also prevents the door from fully closing and jamming a finger. All of these measures are inexpensive but they rely for effectiveness on continuous vigilance and action by householders to ensure that their protective effect is maintained.

Plastic finger jam protector guards that fit over the hinge side of the door, developed in Australia, can prevent these injuries but their uptake has mainly been in child care centres as they are functional but aesthetically unappealing (Personal communication, Barbara Minuzzo, Royal Childrenís Hospital Safety Centre). Installing slow releasing door closers rather than spring operated ones is a relatively popular measure and potentially more effective, as it is permanent. However, slow closing doors may pose a safety hazard in that young children can slip out the door during the delayed closing period. Householders also deactivate them in winter as they let cold air into rooms.

A promising alternative is the Danish 'pinch free' door (40 mm KLG FD30)[2]. A rubber seal on the edge yields so the finger is not crushed between the wooden parts of the door when the fingers are caught between closing surfaces. This door type is not available in Australia and market access for this product should be investigated. Doors with integral round pivot posts that remove the gap between the door frame and the pivot post and eliminate the risk of finger entrapment at the hinge side are available for use in public buildings such as schools[8]. These may be adaptable for domestic use.

Another possible simple design solution to prevent or reduce damage to the fingers is to round the edges of doors[7]. Unlike finger jam protector guards and door closers, this solution does not require the addition of unsightly devices. A research study to evaluate the effectiveness of rounding and different levels of rounding in reducing injury severity and any adverse effects (such as letting in draughts) is recommended. Venema has recommended biomechanical studies to better understand entrapment forces and their effects on the human finger[7]. In addition to rounding of door edges, attaching an impact absorbing material such as rubber along the edge also has the potential to reduce injury severity. The use of compression material on door edges has been demonstrated in Australia in the Latrobe Valley safety house[9]. This innovation has not been evaluated.

In terms of higher technology, contact sensors are being installed in the surrounds of power windows in cars to reduce the risk of finger pinch injuries[10]. Sonic and infrared non-contact sensors are also being developed for use in car window surrounds (in the weather stripping or the doorframe) as consumers have shown preference for non-contact window retraction systems[10]. Similar sensor technologies are being applied outside the automotive industry to garage door openers, elevator doors and power sliding doors (and commercial and domestic water taps to turn taps on and off)[10]. Innovative applications of these technologies to retract closure of doors in domestic dwellings appear entirely feasible.

Recommendations

- A further study is required to update earlier evidence indicating that the hinged side of the door was involved in 60% of child door jam injuries.
- Further research is recommended to develop an acceptable safe house door that can prevent finger entrapment injuries or reduce their severity.
- There is a need to develop a bio-fidelic human finger model to investigate biomechanical forces involved in finger entrapment in different door and door jam configurations.
- Studies should be conducted to assess the feasibility and acceptability of using doors with an integral round pivot post in homes.

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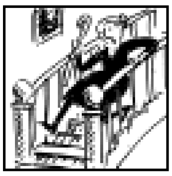
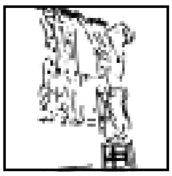


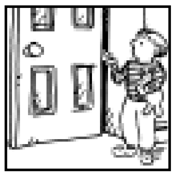

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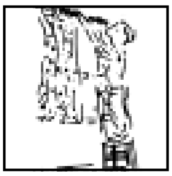
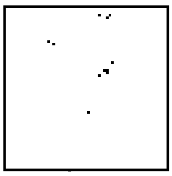


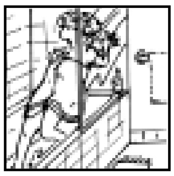
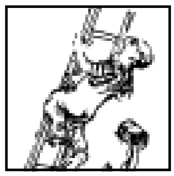

General Acknowledgements

Participating hospitals

From October 1995
Austin & Repatriation Medical Centre
Ballarat Base Hospital
The Bendigo Hospital Campus
Box Hill Hospital
Echuca Base Hospital
The Geelong Hospital
Goulburn Valley Base Hospital
Maroondah Hospital
Mildura Base Hospital
The Northern Hospital
Royal Children's Hospital
St Vincents Public Hospital
Wangaratta Base Hospital
Warrnambool & District Base Hospital
Western Hospital - Footscray
Western Hospital - Sunshine
Williamstown Hospital
Wimmera Base Hospital

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From December 1995
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Frankston Hospital

From January 1996
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Monash Medical Centre

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Coronial Services

Access to coronial data and links with the development of the Coronial's Services statistical database are valued by VISAR.

National Injury Surveillance Unit

The advice and technical back-up provided by NISU is of fundamental importance to VISAR.

How to access VISAR data:

VISAR collects and analyses information on injury problems to underpin the development of prevention strategies and their implementation. VISAR analyses are publicly available for teaching, research and prevention purposes. Requests for information should be directed to the VISAR Co-ordinator or the Director by contacting them at the VISAR office.

Contact VISAR at:

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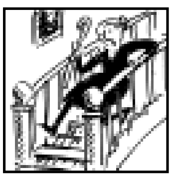
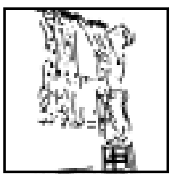


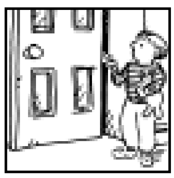

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Hazard was produced by the Victorian Injury Surveillance and Applied Research System (VISAR) with the layout assistance of Glenda Cairns, Monash University Accident Research Centre.
*Illustrations by Jocelyn Bell**

ISSN-1320-0593

Printed by Work & Turner Pty Ltd, Tullamarine