The University of Sydney
Faculties of Health Sciences and Architecture
The Home Modification:
Information Clearinghouse Project

Evidence Based Research:

Selecting Coatings for Tiled Floors

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Abstract:

Objectives: To determine the occupational risk and safety factors surrounding the prescription of coating products to improve the slip resistance of glazed tiles surfaces particularly bathroom surfaces within the homes of persons with mobility impairment.

Design: Systematic review of electronic and other published literature concerned with the effectiveness of ceramic tile coatings and treatments designed to improve slip resistance.

Main outcome measures: Currently, the co-efficient of friction (COF) recommended for tiled surfaces is equal to or greater than 0.5. The majority of unglazed tiles (i.e. Stoneware and the like) meet these criteria, where glazed tiles do not. No legislation or regulation directly pertinent to in-home application of tile coatings currently exists. However, within the US for those with mobility impairments a COF 0.6 is considered better practice. The performance outcomes of coatings vary depending on tile type, coating components, the application process, the cleaning process and the maintenance regime. Correct coating selection and application as needed are critical factors believed to improve slip resistance performance outcomes.

Results: The results include information from 35 published sources. In addition, 54 manufacturer product specifications and 14 legislative and regulatory documents were reviewed independently. No information was found regarding the suitability of surface coatings for reducing the frequency of falls for people with mobility impairment; however, one study concluded that a higher level of slip resistance than previously believed acceptable was required for safe walking on a level surface for people with an impairment of mobility.

Conclusions: While no empirical evidence was found to demonstrate that surface coatings reduced the frequency of falls, product testimonials suggested that coatings reduce fall frequency. Chemical coatings and abrasive coatings that contain domestic grade aluminium oxide or synthetic particles had the most information in support of their effectiveness.

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Problem Statement:

How effectively do various coatings improve the slip resistance of tile floors for people with mobility impairment?

Area of concern:

Use of appropriate materials, prevention of slips and falls, liability

Background:

In Australia, personal injuries at home, including falls, result in annual health related costs of about $2.3 billion for older persons (Hill, et al., 2000; Hill, et al., 2004) and $660 million for children (Atech Group & Minter Ellison Consulting, 2001). Negotiating slippery surfaces is difficult, particularly for people with mobility impairment (Lord, Sherrington, & Menz, 2001).

Slip resistant surfaces can reduce the likelihood of falls. Resistance that the floor surface offers the shoe, sole, prosthetic or walking aid tip when it makes contact with the floor surface is known as slip resistance (Bowman, 2003). Slip resistance is expressed as a surface coefficient of friction (COF) value (Grammeno, 2001), ranging from 0.0 (slippery) to 1.0 (not slippery) (Di Pilla & Vidal, 2002). While glazed tile offers lower slip resistance than other surfaces, it is the most common surface used in wet areas of the home, particularly bathrooms, toilets and kitchens. Information about the effectiveness of different slip resistant coatings is critical to ensure that the most effective tile coatings are used.

Three methods are used to increase the slip resistance of a tiled floor: surface coating, surface etching, and surface blasting. Surface coating products sit on the tile surface above the tile glaze (Sloane, 1989). These coatings can be either chemical or abrasive (Porter & Bryan, 1991). Chemical coatings are made from a plastic or resin base to which slip resistant chemicals are added (Porter & Bryan, 1991). Abrasive coatings contain grit or other granular particles that provide tread for friction between the sole and surface during contact (Maynard, 2002).

Etching and blasting increase surface roughness by chemically or physically changing the structure of the surface. Etching agents, such as hydrochloric acid (Gibson & Sloane, 1994), react with the glaze and the silica composition of the tile and decompose microscopic amounts of silica to form valleys and ridges on the surface (Maynard, 2002). Surface blasting entails shooting abrasive materials onto the tiled surface at high pressure (Grambole, Herrmann, Behrisch, & Hauffe, 1999) or using laser technology to restructure the surface in order to dimple the individual tiles (Hauptmann & Wiedemann, 2003).

The process of surface etching involves applying an etching agent such as hydrochloric acid to the tile surface (Gibson & Sloane, 1994). The etching agent reacts with the glaze and the silica composition of the tile decomposing microscopic amounts of silica to form valleys and ridged grooves on the surface (Maynard, 2002). This improves the overall roughness of the tile (Roberts, 2003). However this process damages the tile glaze that can compromise the porosity of the tile making it less waterproof. Additionally, etched tiles can easily lose their effectiveness if they are not cleaned frequently and properly (Maynard, 2002).

Blasting is uncommonly used in homes as it is a very aggressive treatment that roughens the tile surface. It can make the tiles more susceptible to water damage by increasing tile porosity and therefore making the tiles less suitable for use in wet areas such as a bathroom. Blasting entails shooting abrasive materials onto the tiled surface at high-pressure speeds (Grambole, Herrmann, Behrisch, & Hauffe, 1999), or using laser technology to restructure the surface in order to dimple the individual tiles (Hauptmann & Wiedemann, 2003). The dimpling process increases the coefficient of friction (Chang, 1999). However, there are often difficulties in maintaining a uniform appearance (i.e. the resultant surface often appears uneven and patchy) as in sandblasting.

The latter two of the above processes, etching and blasting, damage the tile glaze (Maynard, 2002). This has implications for the waterproofing (Atkins, 2000). Surface coating does not damage the tile glaze and is therefore preferable in areas where exposure to water is likely. Figure 1 allows for visual comparison between each of the interventions for increasing the COF of the tile.

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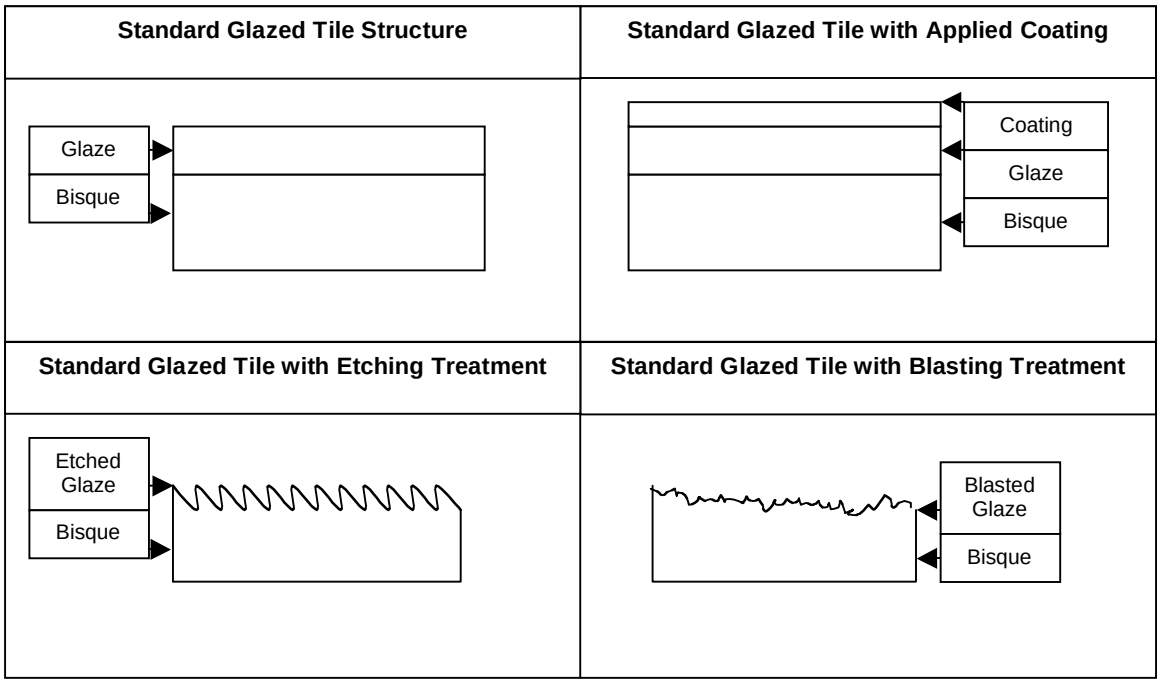

Figure 1: Interventions that increase the COF of a standard glazed tile.

Types of Surface Coatings

Surface coating requires the application of a coating product, which sits on the tile surface above the tile glaze (Sloane, 1989). Several slip resistant surface coatings are available to the general public from hardware stores or on the Internet. Coatings can be chemical or abrasive (Porter & Bryan, 1991). Chemical coatings are made from a plastic or resin base with the addition of slip resistant chemicals (Porter & Bryan, 1991). Abrasive coatings contain grit or other granular particles that provide tread for friction between the sole and surface during contact (Maynard, 2002). Surface coatings are generally easy to apply, however, they wear off with general ageing and increased pedestrian traffic and hence, need to be reapplied (Pierce, 2001).

Tile coating products can be classified by their application method:

- pre-formulated surface coatings;
- dry products that are added to surface coatings or glazes; and
- dry products that are sprayed, sprinkled, dusted or swept over the surface coatings or glazes.

Pre-formulated surface coatings do not require the addition of any other product (Porter & Bryan, 1991) and are painted, sprayed or trowelled onto the tiled surface over the existing glaze (Jolly, 1987). These coatings typically are made of a resin or plastic/polymer base to which hard granular material or chemicals have been added to provide friction. Common additives include bauxite, corundum, aluminium oxide, sand/silica sand, carborundum, rubber, fibreglass, and plastic pellets.

Consumers can also purchase dry products to add to surface coatings or tile glazes (Marletta, 1989). The final category of products is swept across or sprayed, sprinkled, dusted or onto the coating or glaze while the coating or glaze is still wet (National Safety Council, 1965). Surface coatings are generally easy to apply; however, they wear off with the passage of time and pedestrian traffic and need to be reapplied periodically (Pierce, 2001)

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Legislation/Regulation relevant to tile coatings in residential construction and retrofitting:

Disability Discrimination Act 1992

The Disability Discrimination Act 1992 (DDA) makes it unlawful to discriminate against a person based on his or her disability. Section 23 prohibits discrimination in access to premises, unless the premises are constructed as to be inaccessible and alterations to provide access would impose unjustifiable hardship. The DDA recommends compliance with AS/NZS 1428, which in turn recommends that accessible paths of travel be slip resistant. AS/NZS 1428, however, does not apply to private homes.

Building Code of Australia (BCA)

The Building Code Of Australia Part D1 Clause 1.3.3 (d) (Australian Building Codes Board, 1996) states that for paths of travel that are just an extension of a building, the BCA may be entirely appropriate. The BCA, requires all access routes to "have adequate slip-resistant walking surfaces under all conditions of normal use". Clause A2 of the code defines an access route as "a continuous route that permits people and goods to move between the apron or construction edge of the building to spaces within a building, and between spaces within a building". The acceptable solution D1/AS1 (28 Feb. 1998), in providing examples of areas meeting this definition, includes decks, patios and steps on the approach to the main entrance to housing and common areas of communal residential and multi-unit dwellings (BRANZ, 1998).

Volume two of the BCA recommends that ramps and stairway treads be slip resistant, but it does not specify the methods to be used. The BCA does not require any specific level of slip resistance in private homes.

Australian Standards

AS 1428 (2001), design standard for access and mobility, requires that accessible paths of travel be slip resistant, but does not require slip resistance within private homes. It identifies flooring materials that are considered satisfactory, including smooth flooring that has been “suitably treated.” It does not, however, identify suitable treatments. It refers to AS 4586 (see below) and Handbook 197 (An Introductory Guide to the Slip Resistance of Pedestrian Surface Materials) for guidance regarding slip resistance.

AS 4226 (1994), guidelines for safe housing design, applies to all residential buildings, but is not mandatory. The guidelines recommend that kitchen floors (§ 6.1.1.), bathroom floors (§7.1.1.), bath bottoms (§ 7.2.2), shower floors (§7.3.1.), toilet floors (§8), laundry room floors (§ 9), and step treads (§11.7.3) be slip resistant. The guidelines do not specify how to achieve slip resistance. Table 1 within AS 4226 rates various floor materials, but does not rate different slip resistant coatings.

AS 3661.2 (1994), Slip resistance of pedestrian surfaces. Part 2: Guide to the reduction of slip hazards, is the only standard that specifies how to improve the slip resistance of an existing surface. AS 3661.2 applies to domestic, public and commercial buildings. It provides guidelines for the selection and installation of pedestrian surfaces, improvement of existing surfaces, and care and maintenance of pedestrian surfaces. Section 4.4 recommends that “a granulated effect of raised areas 1-2mm in diameter and a similar distance apart is most effective” and states that larger diameters and spacing are “progressively less effective”. Section 6 outlines maintenance best practices for ensuring slip resistance, and Section 7 outlines methods to reduce slip hazards on existing surfaces. Clause 7.1 describes some specific surface treatments that increase slip resistance. Part 1 of AS 3661, which specified the minimum coefficient of friction values for pedestrian surfaces, was superseded by AS 4663 and 4586.

AS 4586 (2004), Slip resistance classification of new pedestrian surface materials, provides a means of classifying surface materials, including surface applications such as sealers, polishes and etchants, according to their slip resistance

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when tested by the methods set out in the standard.

AS 4663 (2002), slip resistance measurement of existing surfaces, outlines methods to measure the frictional characteristics of pedestrian surfaces in wet and dry conditions, seems to recommend a COF of 0.4, but offers no method to achieve this COF.

Other Relevant International Legislative and Regulatory Documents

United States of America:

Americans with Disabilities Act Accessibility Guidelines (2002)

The Americans with Disabilities Act 1990 (ADA) is the United States' corollary to Australia's DDA. In accordance with the ADA, the United States Department of Justice produced the Americans with Disabilities Act Accessibility Guidelines (ADAAG) for Buildings and Facilities. Section 4.5.1 of the ADAAG states that all accessible routes "shall be stable firm and slip resistant", and Appendix 4.5.1 recommends COF values to accommodate people with mobility impairments: a static COF of 0.6 for safe walking on a level surface and a static COF of 0.8 for safe walking on a ramp.

American Society for Testing Materials (ASTM) Slip Resistance Standards

ASTM is a private sector organisation that has developed a series of technical standards, including a series of slip resistance standards for surfaces.

Note: Summaries of these standards are available at http://www.astm.org

Table 1: Relevant ASTM standards (ASTM, 2004)

Standard Code	Standard Name
ASTM D4103	Practice for Preparation of Substrate Surface for Coefficient of Friction Testing
ASTM E303	Test Method for Measuring Surface Frictional Properties Using the British Pendulum
ASTM F609	Test Method for Static Slip Resistance of Footwear, Sole, Heel or Related Materials using the Horizontal Pull Slipmeter (HPS)
ASTM C1028-96	Standard Test Method for Determining Static Coefficient of Friction of Ceramic Tile and Other Like Surfaces as Measured by the Horizontal Dynamometer Pull-Meter Method
ASTM F1679	Standard Test Method for Using a Variable Incidence Tribometer (VIT)
ASTM D2047-04	Standard Test Method For Static Coefficient of Friction of Polish Coated Surfaces as Measured by the James Machine

Only ASTM D2047-04 states a value for slip resistance, which is a static COF of 0.5. All other standards outline the procedures for testing slip resistance.

Underwriters Laboratory

UL 410 Standard for safety for slip resistance of floor surface materials requires that floor surface materials that are tested using the methods specified in the standard meet or exceed a COF of 0.5; however, the full version of this standard was not accessible for review.

United Kingdom (UK):

Code of Practice on Access and Mobility (2002)

Like the DDA and the ADAAG, the United Kingdom Code of Practice on Access and Mobility outlines accessible design guidelines for people with mobility impairments. Section 5.1 requires that pedestrian surfaces be "non-slip in both wet and dry" conditions (Sect. 5., cl. 1., p. 5). The Code does not apply to private homes.

The Building Regulations 2000

Part M of the British Building Regulations 2000 was also reviewed. No sections relevant to slip resistance specifically within the home were found.

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Evidence Based Practice Methodology:

Question refinement strategy

The research question was refined into an operational format that could be researched systematically by application of appropriate search criteria as illustrated in Table 2 (Bridge & Phibbs, 2003; Taylor, 2000). Table 3 contains the search terms used for each component of the research question.

Table 2: Question component breakdown

Problem	Intervention	Comparison	Outcome	Target Population
Slipperiness of the tile measured as a *coefficient of friction* value.	*Slip Resistant Coat*	Applied coating vs. *Standard glazed tiles*	*Effect* on slips trips and falls *Effect* on COF *Effect* on Installation & Maintenance *Effect* on bare skin	*Ambulant with Mobility Impairment*

Table 3: Complete list of search terms used

Problem	Intervention	Comparison	Outcome	Population
Friction* Rough* (Anti slip*) (Non slip*) (Anti skid*) (Non skid*) (Slip resist*) Anti-slip* Non-slip* Anti-skid* Non-skid* Slip-resist* Antislip* Nonslip* Antiskid* Nonskid*	Coat* Finish* Glaze* Paint* Product* Treatment*	Tile* **Surface*** Floor* Ceramic*	Fall* Slip* Trip* Misstep* Stumble* **Accident*** Safe* Hazard* Prevent*	Mobility* Gait * Impairment* Disab* Disorder*

Inclusion criteria

Relevant material was included if it was (a) accessible through either the University of Sydney Library network or the World Wide Web Internet, (b) written in English, and (c) printed after 1960, as slip resistance products now on the market were not available before 1960 (Bowman & Bolhken, 1997).

Choice of databases

Wide ranges of databases were selected to assess their relevance to the above problem that is a technical one and quite specific. A variety of searches were done using keywords, synonyms, truncation and connectors.

The following were searched using the above terms for relevance

- HMinfo Clearinghouse library
- AGELINE 1978- via Silver platter
- All EBM Reviews: CDSR, ACP Journal Club, DARE, CCTR
- AMED - Allied and Complimentary Medicine via Ovid
- AMI: Australasian Medical Index
- ENGINE: Australian Engineering Database
- API: Architectural Publications Index
- ARCH: Australian Architecture Database
- AVE: Avery Index to Architectural Periodicals
- BUILD: Australian Building Construction and Engineering Database

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- CAB abstract
- CINAHL via Ovid
- Compendex Plus
- Expanded Academic Index ASAP
- Medline via Ovid
- Oshrom: All Oshrom databases
- ProQuest
- Journals@Ovid
- Science Direct
- Web of Knowledge
- Current Contents
- Web of Science
- UoS Theses
- WWW via Google
- Legislative and regulatory document search

Truncation symbols

? , : , * (depending on which database was searched).

Connectors

And, Or, Not, Near / Next, With

Exclusion criteria

Material that did not meet the inclusion criteria and whole of subject textbooks were excluded. Figure 2 illustrates the search process.

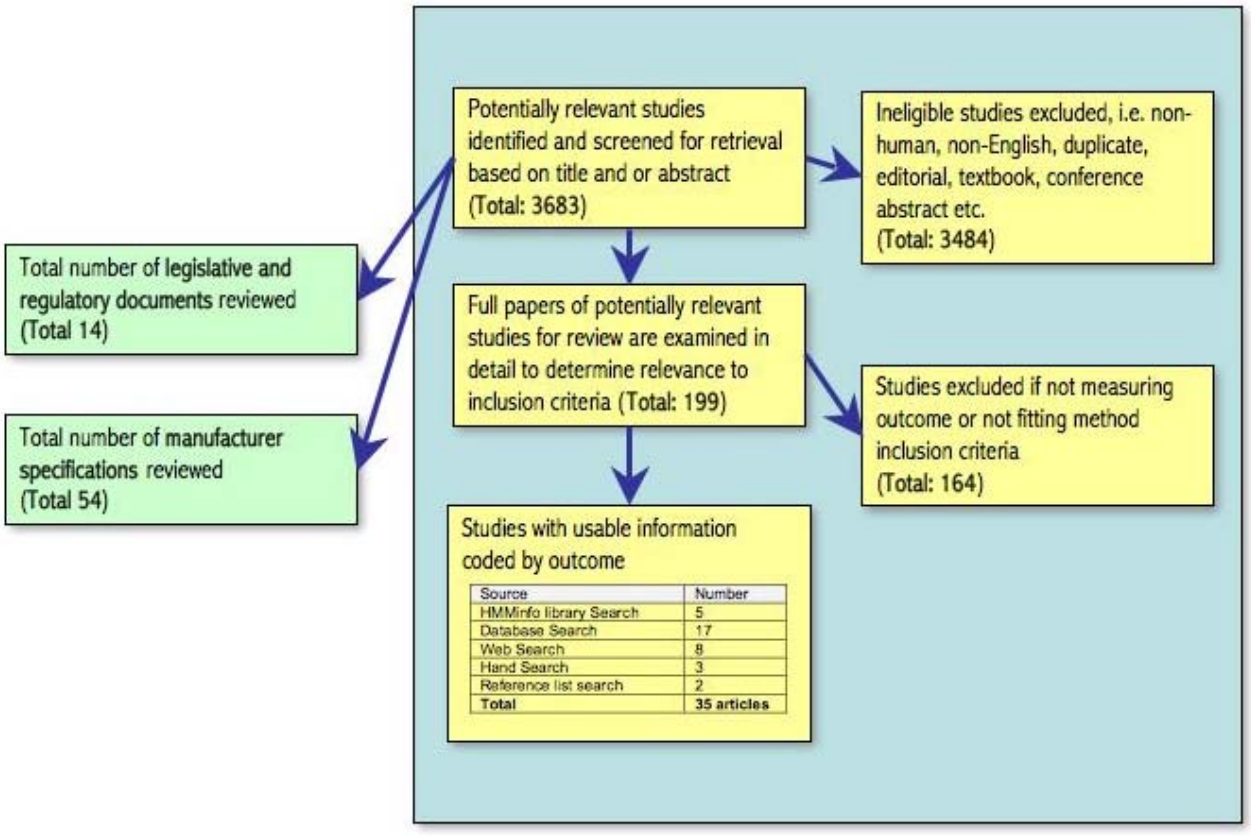

Figure 2: Number of articles included during searching

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General outcomes

The following databases produced relevant material that was included in this review: AMI-Australasian Medical Index; API-Architectural Publications Index; AVE-Avery Index to Architectural Periodicals; BUILD; Expanded Academic; OSHROM; ProQuest; Science Direct; and Web of Knowledge. This study reviewed 35 sources and 54 manufacturer specifications. The material covered a span of 34 years, and the earliest paper was written in 1971. None of the material included in the review directly addressed the effectiveness of slip resistant surface coatings specifically for people with mobility impairments. Material did, however, address the sub questions.

Nationality of Authors

Authors from the United States, Australia and the UK wrote the majority of the material reviewed. Figure 3 shows the material reviewed by author nationality.

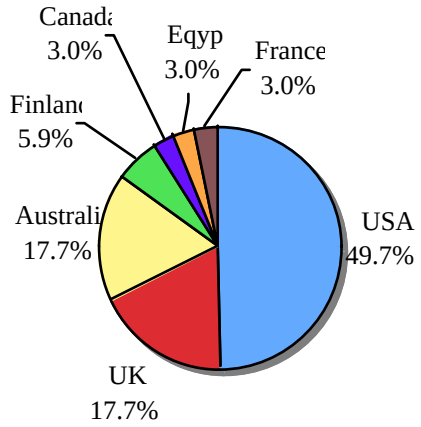

Figure 3: Nationality of authors of material reviewed

Quality of Evidence

The strongest research evidence included in this review comprised quasi-experimental studies, accounting for over one quarter (28.6%) of material reviewed. Nearly two thirds (62.9%) of the material included in the review came from expert evidence. Approximately one tenth (8.6%) of all material reviewed was anecdotal evidence from communications on the home modification list serves and product testimonials. No direct observational or case control studies were identified in this review. Figure 4 depicts the quality of evidence.

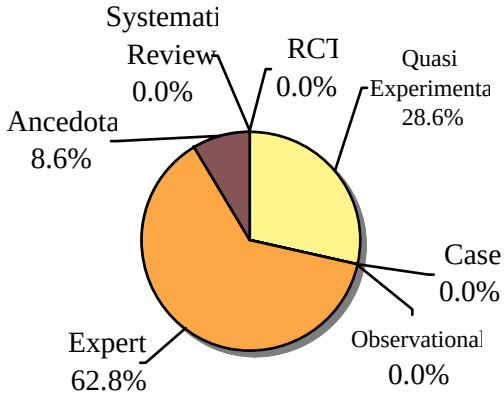

Figure 4: Quality of Evidence for Attributing Outcomes

Analysis outcomes

The variables in each source were coded as activity, person, or environment.

Activity Variables

Figure 5 depicts the percentage of material reviewed that included one of five activity variables. Most (62.9%) of material reviewed did not cite any form of activity. Of the five activity variables identified for review, cleaning and maintenance was the most frequently cited in the material reviewed (mentioned in 3l.4% of the material reviewed). None of the material reviewed related to transferring and pivoting, which were included in the “performing activity” category.

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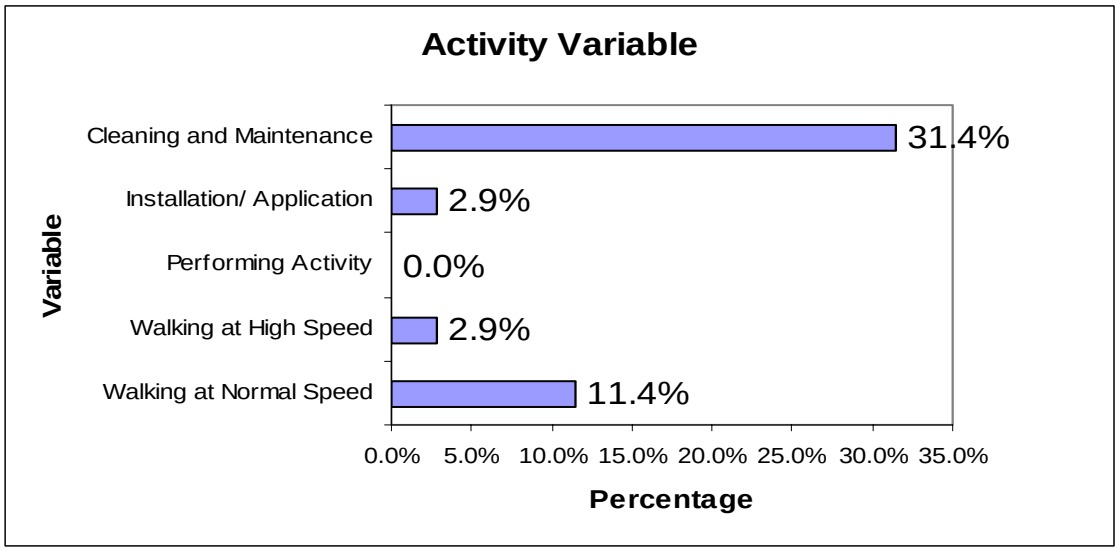

Figure 5: Bar graph of activity variables

Note: Some material cited more than one variable. Each variable cited in a piece of material was recorded.

Person Variables

Figure 6 depicts the percentage of material reviewed that included one of three person variables. Nearly one quarter (22.9%) did not refer to any person variable. Of the three person variables that were identified for study, the material reviewed cited “all users” significantly more often than “person with mobility impairment” or “person who uses a mobility aid”. The materials that cited people with mobility impairment was limited and not specific to surface coatings, but rather focused on the friction requirements for walking.

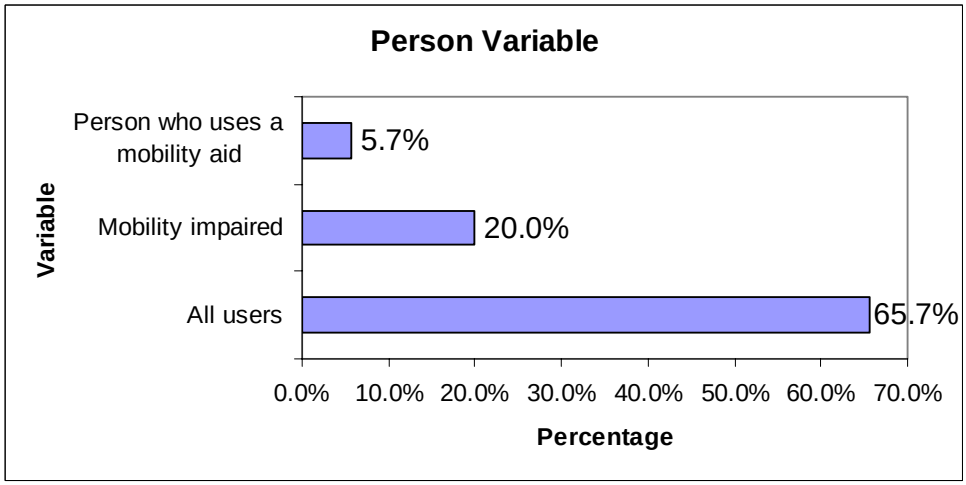

Figure 6: Bar graph of person variables

Note: Some material cited more than one variable. Each variable cited in a piece of material was recorded.

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Environment Variables

Figure 7 illustrates the percentage of material reviewed that included a variable in one of the five environment categories. “Active ingredient” was the most commonly cited (71.4%) environment category.

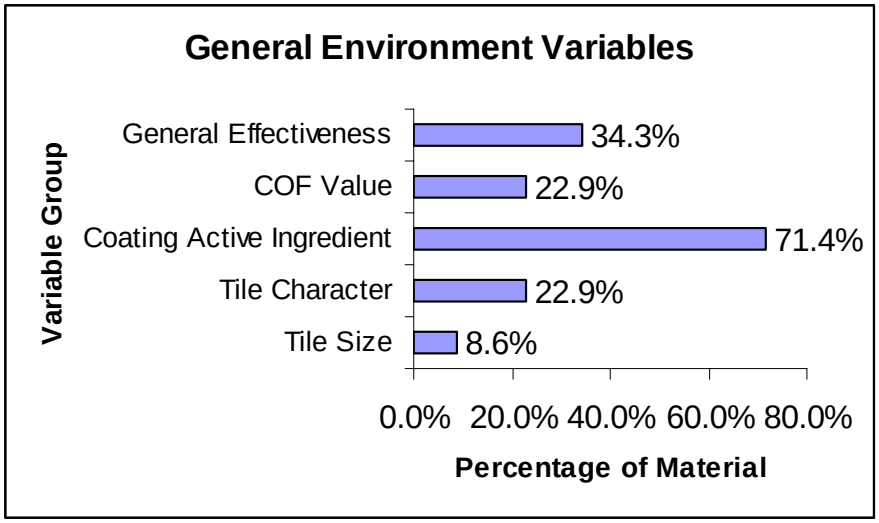

Figure 7: Bar graph of environment group variables

Note: Some material cited more than one variable. Each variable cited in a piece of material was recorded.

Each environment category included several individual variables. Figure 8 illustrates the percentage of material that included an individual environmental variable. One third (31.4%) of the material reviewed described coatings as “generally effective”; however, only 2.9% of material reviewed claimed that coatings reduce the frequency or severity of falls. Two coating ingredients, abrasives (54.3%) and chemical treatments (31.4%) were the most commonly cited variables.

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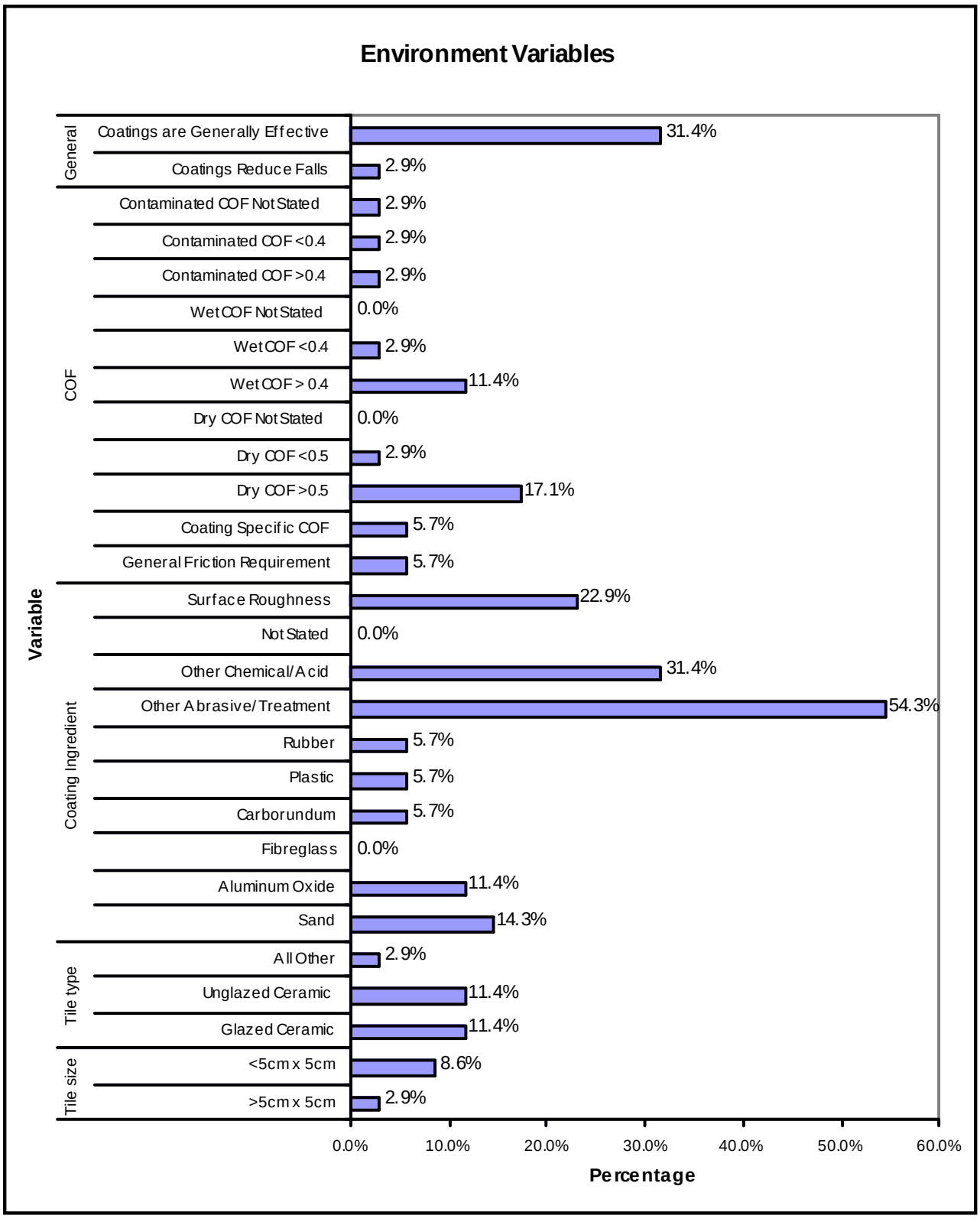

Figure 8: Bar graph of environment variables

Note: Some material cited more than one variable. Each variable cited in a piece of material was recorded.

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The focus questions

Do coatings meet the friction requirements for safe walking for people with mobility impairment?

No studies claimed that a coating met the friction requirements of people with mobility impairment. Some manufacturer specifications, however, claimed that their surface coatings met the requirements of the ADAAG (COF >0.6). People with mobility impairment have a greater friction requirement than those without, and this places them at greater risk of falling (Buczek, Cavanagh, Kulakowski, & Pradhan, 1990; Taylor, Thorpe, & Lemon, 2001; Tile Association, 2004). On level surfaces a COF value of 0.64 would provide adequate friction near touch down for people with mobility impairment, regardless of walking speed (Buczek et al., 1990)

Do surface coatings reduce the frequency or severity of falls of people with mobility impairment?

No experimental studies were found that investigated the effectiveness of surface coatings in reducing the frequency or severity of falls within a population of people with mobility impairment. Several sources, however, emphasized the importance of slip resistant floors (e.g., BRANZ, 1998; Kohr, 1991).

Does one type of tile perform better than others when treated with a surface coating?

Individual tiles within one floor may have different COFs because warpage on individual tiles affects where material is deposited, which affects slip resistance (Bowman & Bolhken, 1997). Generally, unglazed tile has a higher average COF (0.5) than glazed tile (0.2), but slip resistant coatings can eliminate any significant difference between the COF for unglazed and glazed tiles (Gronqvist, Hirvonen, & Skytta, 1992). There is conflicting information about the role tile size plays in slip resistance (c.f., Brown, 2002; Simes, 2004; Turnbull, 1987).

What active ingredients in surface coatings are most effective in providing slip resistance for people with mobility impairment?

Only one item was found that related coating ingredients to mobility impairment. Blatterman (1996) reported that surfaces that are too tactile can cause a person with a mobility impairment or a shuffling gait to stumble.

This review found only one research article about the effectiveness of different ingredients in surface coatings (Ali & Khashaba, 1998). Several pieces of anecdotal evidence and expert opinion were also found. Riders (2003) reported that pre-formulated coatings may be more effective than coatings that consumers are required to mix before application or coatings that required particles to be broadcast into them while wet (Riders, 2003). Figure 9 outlines the most to least effective coating ingredients as determined through a combined analysis of research, expert opinion and anecdotal evidence reviewed.

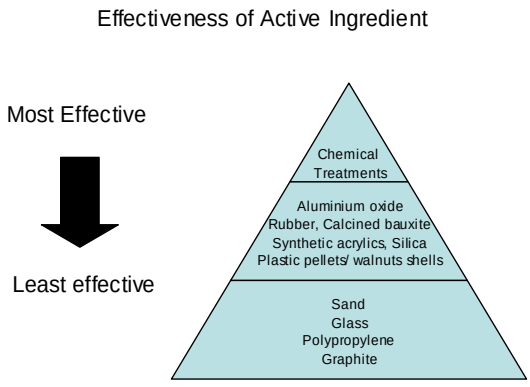

Figure 9: The effectiveness of different active ingredients found in surface coatings

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Based on the research, opinion and anecdotal information reviewed, chemical treatments had the most information substantiating their effectiveness followed by abrasive coatings containing aluminium oxide or synthetic particles. The least frequently recommended coatings contained sand, glass, polypropylene and graphite. These additives are heavy and difficult to suspend in a coating; in addition, they are more easily dislodged or crushed under heavy traffic (Nighswonger, 2000; Riders, 2003). Particle shape (BRANZ, 1998; Owen, 2002), particle size (Ali & Khashaba, 1998; BRANZ, 1998; Manning,1990; Watt, 1993), particle spacing (Dahir & Mullen, 1971; Owen, 2002), and the degree to which particles are submerged in the coating also affect slip resistance (Owen, 2002).

Can a person with a mobility impairment apply and maintain a surface coating?

No information was found about whether a person with a mobility impairment would be able to apply or maintain a coating. Correct cleaning methods and products, however, help to maintain slip resistance levels (Ceramic Tile Institute of America, 2004; Gronqvist et al., 1992; Kuhar, 1995; Macneil, 1998; Malkin & Harrison, 1980; Manning & Jones, 2001; National Safety Council, 1981; Schroder, Hubner, & Skiba, 1989; Tile Association, 2004).

Is a surface coating suitable for application in areas where shoes are not worn?

Coatings that contain abrasives recommended for use in industrial areas should not be used for domestic purposes because they can cause skin abrasion (Goodwin, 1997; Riders, 2003; Tile Association, 2004). One source suggested that to provide an adequate level of slip resistance, but avoid skin damage, ceramic tile with a protruding pattern could be used (Turnbull, 1987).

Is there evidence regarding the general effectiveness of surface coatings?

Two studies evaluated the effectiveness of different anti slip coatings for ceramic tiles. Neither study was specific to people with mobility impairment. Gronqvist, et al. (1992) found that an anti slip chemical treatment increased the COF of contaminated ceramic tiles by ~74%. Di Pilla & Vidal (2000) investigated the effectiveness of ten different ceramic tile coatings that were applied to tile and marble surfaces and found that all treatments increased the COF on the dry tiles. Under wet conditions, however, there was great variation between slip resistant coatings, and one treatment actually decreased the tile's COF (Di Pilla & Vidal, 2000).

Analysis of the manufacturers' specifications

In addition to the 35 sources summarized above, 54 coating manufacturer product specifications were reviewed. Figure 8 shows the percentage of manufacturer specifications that include each of the variables. The suggested life of coating products varied from 6 months to ten years, with an average of ~3 years. All coatings claimed to provide a slip resistant surface when dry. Most (85.7%) stated a dry COF value, but only 34.7% reported the method or apparatus used to measure the COF. Over half (65.3%) of the specifications claimed to provide a slip resistant surface when wet, but only 18.4% stated the method or apparatus used to measure the COF. Moreover, manufacturers carried out some testing "in house"; therefore, results should be accepted with caution. A number of product testimonials were located on manufacturer web sites indicating that particular products had been effective in reducing falls. Nearly half (44.9%) of the specifications reviewed did not state how to maintain the coating. For those that did state a maintenance method, most recommended regular sweeping and mopping.

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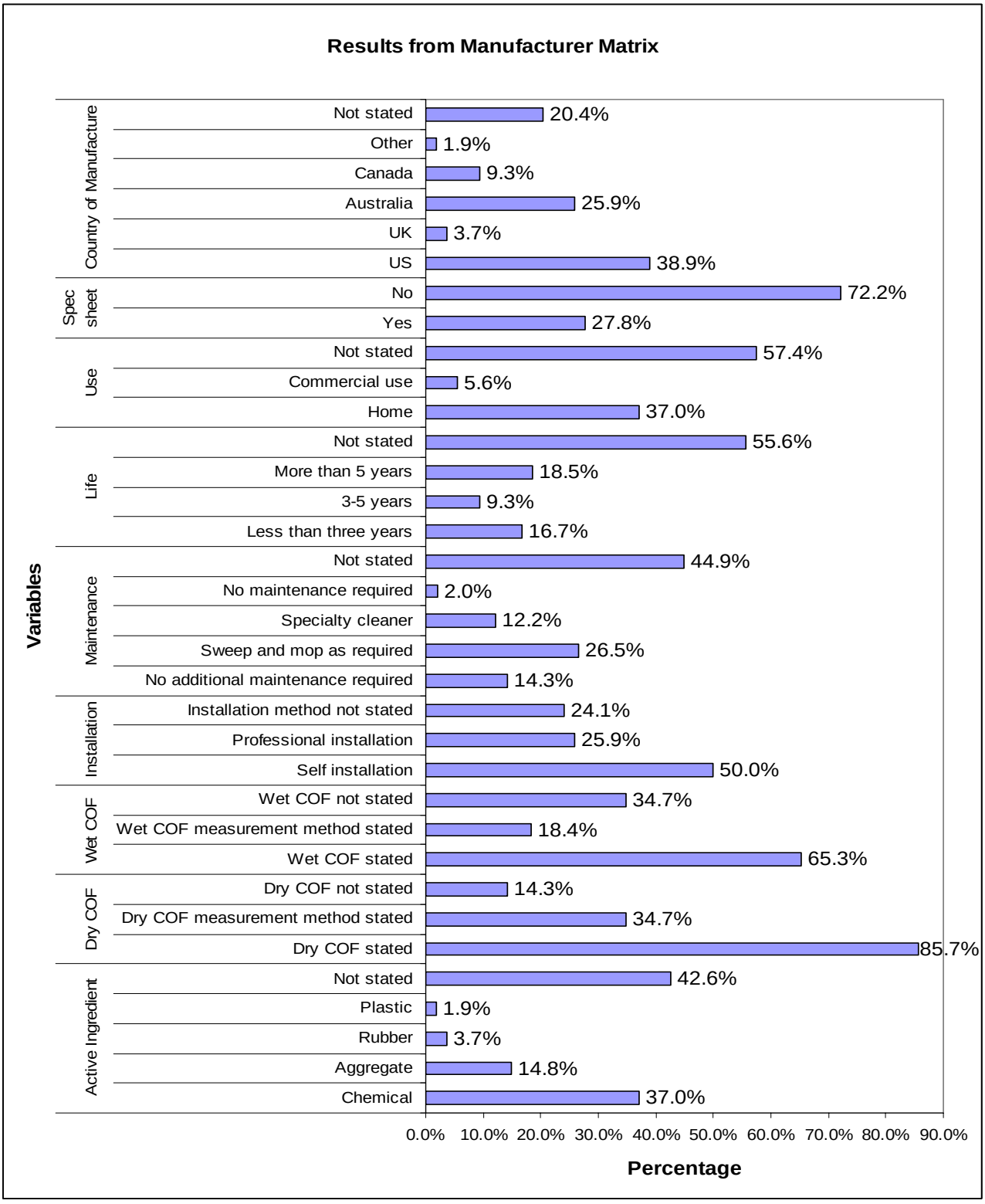

Figure 10: Results from manufacturer specifications

Table 4 lists the percentage of specifications that made the most common claims about endorsements or compliance with requirements or guidelines. The Findings column shows the results of an investigation into the claim. Consumers who are unaware of the precise nature of a manufacturer's claim could be misled (Di Pilla & Vidal, 2000).

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Table 4: Product claims made by coating manufacturers

Claim	Percentage	Findings
Compliance with the Americans with Disabilities Act Accessibility Guidelines	29%	ADAAG requirements for slip resistance are in an appendix and are therefore, not mandatory.
Meet or exceed Occupational Health and Safety Requirements	10%	OHS requirements are proposed non mandatory guidelines. The proposed COF value cited in the American Occupational Health and Safety Act is 0.5.
Endorsed by the Ceramic Tile Institute (CTI)	2%	This is an industry group that represents industry interests.
Satisfies the Requirements of relevant building codes and standards	6%	Australian building codes only require a COF 0.4. Most tiles meet this without having a coating applied.
ESIS approved	2%	ESIS is a risk management company that provides information to manufacturers about on how to lower costs.
Underwriters laboratory certified	4%	UL does not certify products; however, it will test and classify products as SR if they meet COF of 0.5 in dry conditions.
Meet ASTM specifications	18%	ASTM specifications are test method standards. Only one ASTM test method, D 2047, specifies a COF of 0.5.

Future Research

Research is needed to determine friction requirements for people with mobility impairment under various conditions, and different active ingredients should be evaluated to determine which ingredients meet those requirements. In addition, the extent to which warpage in individual tiles affects slip resistance should be evaluated.

Policy Development

An international standard for the measurement of slip resistance would permit reliable comparison between slip resistant measurements from different floor surfaces and different countries. A labelling standard for products that are marketed as effective in increasing slip resistance would allow consumers to make more informed decisions.

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