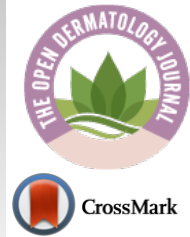




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## REVIEW ARTICLE

### Preliminary Observations on Soaps Increasing Slipperiness and Bathroom Injuries

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#### Abstract:

Every year, about 235,000 people over the age of 15 suffer from falls in the bathroom and visit the emergency room, with 37.3% being related to bathing or showering. While various approaches exist to minimize these risks, the core etiology of slipping is often overlooked by consumers, producers, and physicians.

The foremost contributor to the cause of slipping in the shower or bath is the use of soaps and bathing products. These products can accumulate on the floor of the shower or tub and consequently alter its surface properties, such as decreasing friction or hindering the body's natural ability to sense position. Two of the major contributors to this increased slipperiness found in many bath products are oils and surfactants. This brings to light the question of using less dangerous substances in the products, as well as educating the consumer about the inclusion of properties that predispose to slipping. Overall, the consumers' safety needs to be considered when products are created and marketed.

With such a high incidence of slipping occurrences related to bathing or showering, there is a need for more research in this specific area. The high-risk environment due to soaps, coupled with the lack of research regarding this topic, warrants further evaluation from the product producers. It is imperative that further research is required on the specific chemical properties and their effect on surfaces and how they contribute to consumers' safety.

**Keywords:** Bathroom injuries, Soap, Soap oils, Surfactants, Bathing, Showering.

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## 1. INTRODUCTION

Every year about 235,000 people over the age of 15 suffer from falls in the bathroom and visit the emergency room [1]. Of these falls, 37.3% are related to bathing or showering [1]. While various different approaches exist to minimize these risks, the core etiology of slipping is often overlooked by consumers, producers, and physicians. A major contributor that is often not discussed is the use of different body care products, such as shampoo, conditioner, body soap, and skin emollients. These products can accumulate on the floor of the shower or tub and consequently alter its surface properties, such as decreasing friction or hindering the body's natural ability to sense position. This could be a major inciting factor for slipping in every age group, as well as even contributing to the increased risk of falls and hospitalization in the elderly. This

preliminary observation highlights the overlooked influence of the emulsion pharmacology behind each bathing product and the critical impact it can have on the consumer. This is an important consideration that is often not discussed, analyzed, or researched by the product developers. Additionally, the consumer is often unaware of the importance of slipperiness as a property of soap contributing to their safety. Further research could guide physicians on how to effectively educate their patients on product composition to prevent possible adverse events from bathing soaps.

### 1.1. Analyzation of Different Bathing Products

Dermatology has always placed a large and important emphasis on emulsion pharmacology, with a special significance on compounding products in daily practice as a dermatologist. With this particular subset of dermatology often being overlooked, the American Academy of Dermatology has placed particular stress on compounding products in the office setting. In today's market, there are many unique types of soap

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products outside of the specific realm of dermatology that can be used for washing the hair, body, or both. These products are further stratified into the type of vehicle for soap administration, consistency of the product, and additional targets of the product. Soap can be provided in liquid or bars. Soap can also be of a bubbly consistency or more of a liquid non-foaming texture. Lastly, soap can be imparted with different materials to further specify the use of the product. Some examples of the different supplementation added to soaps include glycerin for sensitive skin, moisturizer for dry skin, or medication for different dermatologic concerns. In particular, moisturizers vary significantly in their chemical nature depending on their targeted consumer use. The four broad classes of moisturizers are emollients, humectants, occlusive, and protein rejuvenators [2]. These different additions to the soap, especially moisturizers, can further expand the degree of variability in the soap's chemical properties. These chemical and pharmacological properties can contribute to the slipperiness of the floor of showers or baths and are often overlooked by different producers of these products. Even more concerning is that consumers are unaware of the slipperiness of the products they are purchasing. The current lack of research in this field warrants extensive evaluation.

### 1.2. Why Is There Slipping?

There are many aspects that contribute to the action of slipping. Aside from using products that can alter surface properties, the inherent material of the surface itself may predispose to slippings, such as glazed ceramic tile or a smooth bathtub surface [3]. Along with this baseline, three major contributors to slipping in the shower or tub include the amount of friction between the foot and the surface, the ability of the individual to sense their position on the surface, and the layer that is between the foot and the surface, such as a biofilm. Friction utilization allows individuals to prevent sliding off their feet on the shower or tub surface. The utilization of friction can be augmented *via* the use of soap and other bathing products or contaminants [3]. This important physical determinant of slippage can also be altered if the subject is aware of the composition of soap or other products [3]. The ability of a person to be able to sense their position is accomplished *via* a complex interplay of many different sensory nerves. More specifically, the body is able to interpret and combine sensory information from sight, the vestibulocochlear apparatus, musculoskeletal system, and cutaneous sensory nerves in the feet to allow an individual to understand their position sense [4 - 6]. Slipping can be attributed to the loss of one or multiple of these important sensory contributors. Specifically, a soap film on the surface of the floor may cause changes in the distribution of pressure, contributing to the loss of effective proprioception *via* the skin receptors in the foot sole [7, 8]. Another aspect of showering that may contribute to the loss of position sense is that often people close their eyes while using soap or putting their head under the water, removing yet another sensory input. Lastly, the layer of the surface that is in contact with the skin can contribute to slipping. If a person uses a lot of soap that can build up, it could cause a film to develop on the surface. This

would prevent the individual's skin from having direct contact with the shower or tub surface. The thin film could also prevent the toes from having adequate grip to the floor surface and predisposing them to slippage [5]. A prevalent example of this is the film left on a surface from bubbles. Interestingly, the bathroom injury rate for women was found to be 72% higher than men [9]. This could possibly be attributed to the increased use of different shampoo, conditioner, and soap products used by women and the residue left from their usage creating a film. In a study performed by Strandberg (1985), it was concluded that the slipperiness of a lubricant increases as the viscosity increases [5, 10]. This can possibly be attributed to cosmetic products with higher viscosity containing higher relative concentrations of oils and surfactants, which decrease surface tension. Therefore, if an individual is using a more viscous shower product, his/her risk for slipping could also increase. These three issues are general consequences of soap usage, but each soap has its own unique properties and molecules that contribute to its individual risk elements. This highlights the importance of individual product analysis, rather than grouping all body care products into the generalized term "soap."

### 1.3. Slipping Properties of Bathing Products

The slipping surface properties of shower and bath products are often overlooked. This is especially concerning given the variety of different products tailored to specific consumer needs. Two of the major contributors to increased slipperiness found in many bath products are oils and surfactants. Non-emulsified oils are a common component in many products, such as coconut oils for massages. The use of this product as a lubricant to reduce friction between two surfaces is the same reason it contributes to slipping [11, 12]. Though reduced friction can be beneficial during a massage or shower, serious adverse consequences can occur if it is left on surfaces composed of materials that interact with the non-emulsified oil in a way that promotes increased slipping. Specifically, if the non-emulsified oil is left on the floor surface or on feet without being washed off, it will predispose to decreased friction and traction while in the shower or bath. Another possible negative consequence of the non-emulsified oils includes residual products remaining on the hands of a consumer that is not washed off. This could cause reduced friction between the rail and hand when utilizing handrails for safety while exiting the shower or tub, causing the individuals to slip and possibly injure themselves.

Surfactants contribute to slipping due to their mechanism of reducing the surface tension *via* accumulating at the interface between the oil in the bathing product and the water component [13]. A prevalent example of this property is commonly noted in many bathing products, which is commonly referred to as bubbles. When a surfactant comes in contact with air, it produces a sudsing bubble product. Though these bubbles may be appealing to visual and physical sensations for the consumer, they also predispose to film formation on surfaces, thus making the floor slicker due to decreased surface tension. Though this soap component can be identified as a contributor to falls, the removal of it from daily bathing products will be unreasonable. Producers of bathing products must use an excess of surfactant to make sure their

product remains viable from the time it is produced until the time it is finally utilized by the consumer. The excess surfactant is utilized so that the oil and aqueous components do not fully separate into their representative components and break down. Though surfactants are critical to the integrity of bathing and showering products, their fundamental properties also provide a major contribution to slipping in the bathroom.

Insight into the chemical properties of bathing products is fundamental for the development of preventative measures for slipping, especially in regard to including chemical properties that can prevent or minimize slipping. Some products that contribute to increased viscosity can also contribute to making the bathing product thicker and tackier, thus preventing slipping. Most viscosity-inducing agents utilized in modern cosmetic production are from plants (cellulose), fruit (pectin), vegetables (starches), and seaweed (alginic acid/ carrageenan). Other than chemical contributions to prevent slipping, there are other methods to prevent bathroom accidents, such as bathroom safeguards and pursuing research to keep physicians and consumers of products informed by educating them on what they are utilizing.

#### 1.4. Prevention of Slipping

There are two major avenues to minimize the risk of slipping in individuals using bathing products. The first strategy involves the consumer adding safety precautions to their bathroom. These aspects include active and passive methods. Some active methods for preventing slipping include utilizing a grip rail when entering and exiting the bathtub and making sure to use slower and more deliberate movements. Conversely, some of the effective passive methods to prevent slips consist of using a slip-resistant mat, purchasing a bathtub with a higher coefficient of friction, utilizing a walk-in shower, and using aerosol anti-slip sprays that increase surface traction [14]. Interestingly, research has shown that in the pediatric population, these passive methods are the most effective [14]. Another age-specific slipping preventative method is the use of a shower bench for an elderly individual to lift their legs over a bath ledge while sitting, rather than balancing on a wet or soapy surface.

The second method of reducing the slipping in bathing soap consumers would be the soap industry companies investing more effort into analyzing the chemical and material properties of their products, with a greater emphasis on fall risks. There are many ways that this can be accomplished. A study performed by Gröngvist *et al.* presented different methods for analyzing the slippage properties, such as perceived sense of slip and slip distance evaluations, slipperiness ratings, heel velocity measurements, heel and trunk acceleration and postural instability measurements, falling frequency estimations, as well as the kinematics and kinetics of slipping and falling [5]. These tests could be utilized to further evaluate the exact biomechanics and chemical properties of different soap products and their contribution to slipping. Another possible application of these tests would be using the results to create a “slipping scale,” which informs consumers of the slip risk of each product they are purchasing based upon a standardized scale. Furthermore, product

components should be displayed on the bottle to notify the consumer of the slip risk. This could significantly lower the risk of falls in the user through sheer awareness of the possibility to fall. Seigmund *et al.* (2010) demonstrated this through their study, revealing that subjects adjust their utilized friction when entering and exiting a shower or tub based on their perception of how slippery they think the surface is [3]. Notifying the consumer of the potential risk to slip could subconsciously alert them to adjust their approach to bathing, consequently preventing the risk of slipping.

The last prevalent target to prevent the slipping of consumers in the bathroom could be targeted at the level of the physician and how they educate their patients on different self-care products. Further research performed by the company producing the product could be shared with physicians, such as family practitioners who perform yearly health maintenance examinations, as well as dermatologists who may prescribe their patients specific skin products to be used in the shower or bath.

#### CONCLUSION

In conclusion, with 37.3% of slipping incidents being related to bathing or showering, there is a need for more research in this specific area. The common usage of this high-risk environment, coupled with the lack of research regarding this topic, warrants further evaluation from the bath and shower product producers. It is imperative that further research on the specific chemical properties and their effect on surfaces, as well as how that contributes to consumer’s safety, needs to be conducted.

#### CONSENT FOR PUBLICATION

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#### CONFLICT OF INTEREST

The authors declare no conflict of interest, financial or otherwise.

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