C25 Utilized Friction During Bathtub Entry/Exit Under Dry and Wet Conditions

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After attending this presentation, attendees will understand how the friction used while entering and exiting a typical bathtub varies under dry and wet conditions between young, middle, and old age individuals.

This presentation will impact the forensic science community by providing forensic slip and fall investigators with baseline information on the friction levels used when entering and exiting a dry or wet bathtub.

Bathtubs and showers are a common source of unintentional slips and falls. Entering and exiting a bathtub requires an individual to step over the tub's apron as they transition between two different and potentially slippery surfaces. The goal of this study was to quantify the friction used by barefoot subjects entering and exiting a typical bathtub/shower enclosure under dry and wet conditions. It is hypothesized that the complexity of simultaneously stepping over the bathtub apron and dealing with a potentially slippery surface would produce lower frictional demands in older subjects than in young and middle-aged subjects, particularly under wet conditions.

Sixty subjects (30F, 30M) distributed equally in three age groups (20-30 yrs, 40-50 yrs, 60-70 yrs), entered and exited a slip-resistant bathtub using six movement patterns simulating actual use (three entering and three exiting the tub). Each subject repeated each movement pattern five times under blocked dry and wet conditions, yielding 60 trials per subject. For bathtub entry, the first movement consisted of a single forward step over the tub's apron starting and ending in a standing position; the second movement consisted of a single forward step combined with a 90º left rotation to stand facing the faucet; and, the third movement consisted of multiple forward steps approaching the tub combined with a 90º left rotation on the last step over the tub apron to stand facing the faucet. The three exiting movements were the reverse of the three entry movements. Force plates (*Bertec 4060, Columbus, OH*) installed in the slip-resistant tub floor and the slip- resistant deck immediately outside the tub measured ground reaction forces, from which utilized friction and double support times were calculated. Force plate data were acquired at 1 kHz and peak utilized friction during heel strike and toe off of each limb was obtained from a 50ms running average of the instantaneous ratio of shear force to normal force.

Subjects completed all trials without tripping, falling, or reaching for either of two grab bars. No obvious slips were observed and no subjects reported slipping. Overall, utilized friction varied from 0.102 to 0.442 (0.235 ± 0.057) and was 0.058 ± 0.040 lower in wet conditions than in dry conditions across all movement patterns ($p<0.0001$). Older subjects used less friction than young subjects during exiting movements only ($p<0.006$). Utilized friction did not vary between genders ($p>0.14$). Double support times were longer in older subjects than in both young and middle-aged subjects for all movement patterns ($p<0.0009$) and longer under wet conditions than under dry conditions for all entry movements ($p<0.0001$).

The combination of lower friction and longer double support times in wet conditions suggests that subjects regard the wet condition as more hazardous than the dry condition and adapt their utilized friction accordingly. The results also suggest that older subjects are more cautious than young subjects when confronted with the dual task of both stepping over the tub's apron and transitioning to a surface perceived to be more slippery.

Slip and Fall, Friction, Bathtub

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