

OBESITY DOES NOT INCREASE LIKELIHOOD OF SLIPPING WHILE DESCENDING RAMPS

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INTRODUCTION

Over the past several decades, there has been an increasing prevalence of adult obesity in the U.S. (22.9% in 1988-1994 [1] and 34.9% in 2011-2012 [2]). Obese individuals have a 27% annual fall rate compared to 15% for those of healthy weight [4]. The effects of obesity on the likelihood of slipping during level walking has shown mixed results [5,6]. Descending ramps has been found to increase the likelihood of slipping [7], and may influence how obesity affects the likelihood of slipping.

The purpose of this study was to investigate the effects of obesity on likelihood of slipping during ramp descent. Because obese individuals exhibit a higher annual fall rate [4], we hypothesized that the likelihood of slipping would be higher among obese participants. Understanding how obesity affects slipping could help guide the development of effective fall prevention strategies.

METHODOLOGY

Twenty-three young male adults were recruited from the university population including thirteen healthy weight (age 21.8 ± 2.1 years, BMI 22.1 ± 2.0 kg/m²) and ten obese (age 23.9 ± 3.5 years, BMI 32.0 ± 3.6 kg/m²) individuals. Participants descended five randomly-ordered ramp angles, including 0, 2.5, 5, 10, and 15 degrees, at a walking speed of 1.1-1.6 m/s. Five trials were performed at each ramp angle. Prior to the session, participants donned athletic compression shorts and standardized athletic shoes in their respective size, and were told that they were not at any risk of being slipped.

The ramp was 0.9-m-wide and 1.8-m-long, and covered in vinyl flooring. A force platform (Bertec, Columbus, OH) was integrated in the ramp and located halfway down the length of the ramp. A hand railing was attached to the left side of the ramp for safety, but was not used in any trials analyzed. Ground reaction force data were sampled from the force platform at 1000 Hz and processed using a customized Matlab program (The Mathworks Inc., Natick, MA). Acromion marker data and force platform data were filtered using 4th order low-pass Butterworth filters with cutoff frequencies of 5 Hz and 25 Hz, respectively. Walking speed was calculated as the mean velocity of the acromion marker while traversing the ramp. Resultant RCOF was calculated as the resultant shear force divided by normal force.

A four-way mixed-model ANCOVA was used with walking speed as a covariate. Independent variables included obesity group, ramp angle, ramp order, and trial number (an obesity group x ramp angle interaction was also included). Post hoc pair-wise comparisons were performed using Tukey's Honestly Significantly Different test. Analyses were performed with JMP v7 (Cary, North Carolina, USA), and statistical significance was concluded when $p \leq 0.05$.

RESULTS & DISCUSSION

RCOF exhibited an obesity group x angle interaction ($p=0.043$). Pair-wise comparisons indicated RCOF increased as ramp angle increased within each group, but no effects of obesity group at each ramp angle (Figure 1).

The RCOF values obtained in this study compared well with results from past studies.

Cham and Redfern [8] investigated gait during ramp descent on a vinyl surface for healthy weight subjects, and found RCOF values of: 0.18 (current: 0.19) for 0 deg, 0.26 (current: 0.27) for 5 deg, and 0.32 (current: 0.33) for 10 deg. Redfern and Dipasquale [7] and McVay and Redfern [9] also observed positive trends in RCOF with increasing ramp angles.

It should be noted that slip risk (which requires measuring the difference between the available COF and RCOF) was not directly measured. However, because the available COF was the same in all conditions, RCOF as reported here does indicate relative slip risk.

CONCLUSIONS

Although the risk of slipping increases as ramp angle increases, obese individuals are not at an increased risk of slipping while descending ramps. This result, combined with previous

results [5,6,10], suggest modest, if any, increase in risk of slipping while walking among individuals who are obese.

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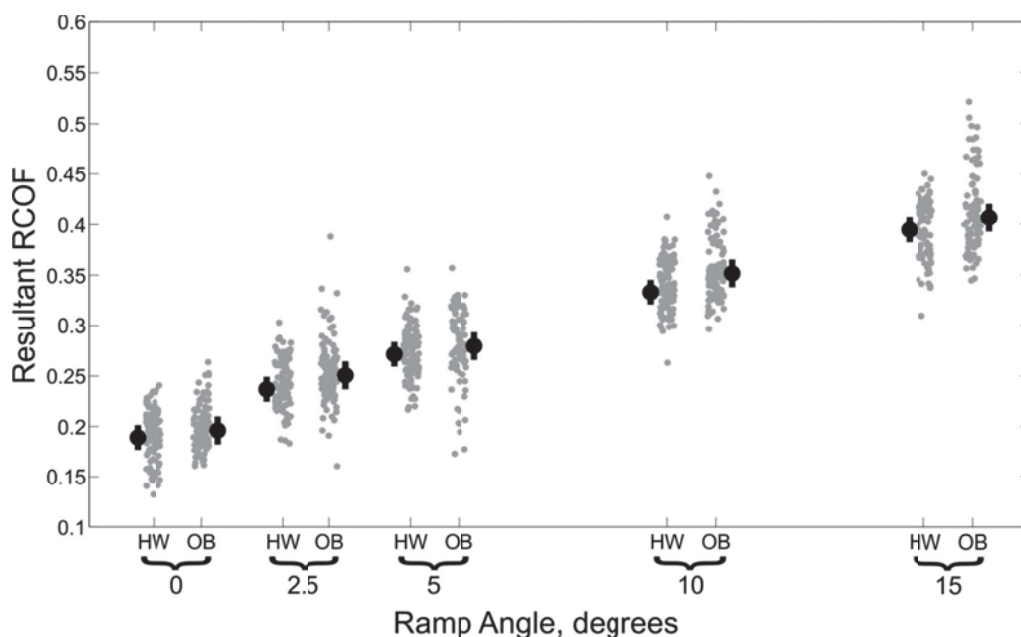


Figure 1: Black dots with black vertical lines represent least squares means and 95% confidence intervals, respectively. Gray dots represent all calculate RCOF values. HW refers to healthy weight participants, whereas OB refers to obese subjects.