

Use of Daily Activity Data to Assess Injury Potential in Low-Speed Motor Vehicle Crashes

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ABSTRACT

Human tolerance testing has established criteria for the risk of serious-to-fatal injury to specific body regions. Using these criteria, injury potential in motor vehicle crashes has been assessed in sled and full-scale car-crash tests using volunteers, anthropomorphic dummies, and cadavers. Based on these criteria, vehicle compliance testing is aimed to protect occupants from serious-to-fatal injury. However, there exists no threshold or minimum crash severity (e.g., delta V) that establishes a "no injury" v. "injury" condition. This study addresses efforts to establish such a condition and identifies confounding factors, the most confused of which may be injury pattern, severity, and symptom duration. Volunteer data was compiled from measurements made during *non-injurious* daily activities and compared to loading experienced by similarly-instrumented volunteers in low-speed sideswipe, angled-side, broadside, rear-end, and front-end impacts. These results support the use of daily activity data for comparisons of loading and provide additional data to establish *non-injurious* crash severities in low-speed motor vehicle accidents. However, for different types of impacts, additional work is still required to establish accepted thresholds above which "injury" is probable.

INTRODUCTION

Previous studies [Rosenbluth and Hicks, 1994; Allen et al., 1994; Szabo and Welcher, 1996] measured accelerations of volunteers during activities of daily living and compared responses to those experienced in low-velocity rear-end motor vehicle accidents in order to assess injury potential. Although limitations in these studies were identified, a methodology was presented with useful data. In other studies, sled tests have provided the majority of quantitative volunteer data from low-speed exposures in frontal, oblique, and side impacts.

No published data exists for volunteer exposures in sideswipe-type impacts.

In this study, results of more than 30 daily activity tests are presented. Activities included are listed.

- swinging a golf club
- hitting a baseball with a bat
- hitting a tennis ball with a racket
- weightlifting
- aerobics
- slap under chin
- slap to left side of head
- torso bobbing up and down
- pushed from behind
- walking sideways, bumping into a wall
- walking backward, bumping into a wall
- walking forward into a wall with hands outstretched
- sitting down onto a car seat
- sitting down onto a hard surface
- jumping from a 400-mm tall stool
- front edge of 20-kg door falling onto volunteer's upper back
- volunteer-occupied vehicle climbing curbs
- volunteer-occupied vehicle traversing parking lot speed bumps at 30° angle at about 40 kph

Using instrumentation described previously [Szabo et al., 1994; Khadilkar et al., 1995], head, neck, and lumbar spine accelerations were measured and filtered according to current SAE J211 recommended procedures. In selected cases, kinematics were documented with high-speed and/or real-time video. Volunteers experienced no discomfort, soreness, or pain during or after testing. No residual pathology resulted from these tests. Quantitatively, accelerations experienced by the volunteers during these daily activity tests were consistent with previously published data for similar events.

Low-speed car-to-car and car-to-barrier tests were conducted with human volunteers. In some cases, volunteers underwent repeated exposures in a single day and/or for several days. Instrumented as in the daily activity tests, head, neck, and lumbar spine accelerations were measured and filtered according to current SAE J211 recommended procedures. To date, there have been over 25 exposures in sideswipe, angled-side, broadside, rear-end, and front-end impacts. Headrest and seat positions, as well as occupant, sex, age, anthropometry, pre-existing pathology, belt usage, pre-impact body position, kinematics during impact, and post-impact injury patterns, severities, and symptom duration were documented. As a result of these tests, some volunteers experienced transient discomfort, soreness, and/or pain *lasting at most 24 hours*. No residual pathology resulted from these exposures. Quantitatively, accelerations experienced by the volunteers during these crash tests were similar in magnitude and duration to those experienced in the daily activity tests.

From a review of other previous work and the compilation of new test data, confounding factors were identified that affect efforts to establish a "*no injury*" v. "*injury*" threshold or minimum crash severity (e.g., delta V). Some of these factors include measurement techniques for acquiring volunteer kinematic data, collision types, vehicle interior design (e.g., headrests, seat), as well as the volunteer's sex, age, anthropometry, pre-existing pathology, belt usage, pre-impact body position, post-impact injury patterns, severities, and symptom duration. Magnitude, direction, type, and duration of loading are also important considerations in any comparison of daily activity data to crash test data. In some cases, the acquisition of only uniaxial linear acceleration data provides a limited picture of the overall loading experience.

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