

Debunking comparative acceleration analyses in rear-end collisions

Accelerations experienced during activities of daily living rarely equal the accelerations felt during low-impact rear-end collisions

By Mike Kelly and Nicholas Flowers

Defense attorneys often rely upon the "biomechanical approach" in moderate-impact, soft-tissue (MIST) injury cases resulting from minimal property damage crashes." A recent article from the International Journal of Environmental Research and Public Health titled, *Is acceleration a valid proxy for injury risk in minimal damage traffic crashes? A Comparative Review of volunteer, ADL and real-world studies*[1], debunks the "biomechanical approach."

This approach starts with a reconstruction to allegedly determine the acceleration experienced by the injured automobile occupant. Next, the acceleration from the reconstruction is compared to hypothetical accelerating experienced in activities of daily living (ADLs) like walking, jumping, and sitting down to dinner. The defense "expert" then postulates that the acceleration from the crash is no different than the acceleration the plaintiff experiences each day doing normal activities of daily living. The defense then argues that since healthy adults do not get injured from sitting down to eat, there could have been no injury in this collision. Too frequently this flawed syllogism is admitted in evidence as science-based opinion.

Enter real scientists. Writing in Environment Research, Nolet et al. demonstrate the scientific invalidity of the "biomechanical" defense approach.

Their aim was to evaluate whether using an occupant's acceleration during a collision is a scientifically valid method for determining risk of injury. In their article, they analyze three sources of published literature: (1) volunteer rear-impact crash testing studies, (2) ADL studies, and (3) observational studies of real-world rear impacts.

For volunteer rear-impact crash test studies, they searched for studies that recorded: (1) "delta V" greater than 2 mph, (2) participants 18 years of age or older, and (3) cited data from individual crash tests. That search yielded 33 applicable studies. From those 33 studies, the authors then sourced data from 408 individual crash tests. Data from the crash tests included age, gender, height, ethics approval or formal consent, occupants braced or unbraced for impact, presence of post-crash symptoms, linear acceleration of the head, angular acceleration of the head, and acceleration at L5 and T1.



Next, the authors used a previously published review paper by Miller et al. to identify recorded linear and angular head acceleration data during activities of daily living (ADLs).[2] Walking, sitting, head nod, running, chair plopping, jumping down from a stair, and vertical leaping, appeared across the studies. The vertical and angular accelerations from these activities were then compiled for comparison to the accelerations seen in the volunteer crash tests.

Finally, the authors culled studies containing injury data from real-world collisions, using only studies that relied on airbag sensors to objectively measure average and maximum vehicle acceleration, duration of crash pulse, and delta V. Studies using crash reconstruction were purposely not used because of the potential for large margins of error in calculating acceleration.

In the real world

The researchers next utilized two studies containing real-world crash data for 114 injured occupants in real-world rear-impact collisions.[3,4] These injuries were analyzed and categorized

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as follows: (1) injury vs. no injury, (2) cervical disk injury (the most severe) vs. any other injury severity, and (3) injury lasting more than six months vs. all other injury durations.

Reviewing volunteer rear-impact crash tests, the authors found positive relationships between delta V and all acceleration measurements (linear head, angular head, L5 and T1) and between delta V and Neck Injury Criterion. The larger the difference in speed before and after the crash (delta V), the larger the expected acceleration and score on the Neck Injury Criterion index. The results also indicated a positive relationship between delta V and risk of post-crash test injury symptoms.

Finally, the paper's authors compared the accelerations recorded during real-world collisions to the claimed acceleration experienced during activities of daily living most often used by insurance defense biomechanical "experts."

Not surprisingly, Nolet et.al. found that during a crash with a delta V of as little as 6.8 mph, linear and angular head acceleration were three and 13 times greater than the highest average linear and angular head acceleration recorded in any activity of daily living. This comparison showed that accelerations experienced during low-speed rear crashes are far higher than the ADL values presented to jurors by defense bio mechanists and that defense claims regarding vehicle collision and ADL acceleration similarity are simply false. The data from real collisions, whether from crash tests or actual traffic collisions, makes manifest that these acceleration rates are not comparable.

The authors looked for valid studies that were supportive of insurers' claims about the similarities of acceleration rates but could not locate any. They offered that this finding was not surprising because ADLs do not cause injuries in healthy people. They used examples of forces experienced while walking and sitting to prove their point.

Using the average steps taken per day (3,000) and average number of times someone sits down and stands up per day (10-20), the authors calculated that the risk of injury during either of these ADLs would be less than one time per year. The calculated annual risk of injury from walking or sitting was less than one time per 1,095,000 steps and less than one time per 3,650 acts of sitting down or standing up. Using real-world crash study data, they forecasted the likely risk of injury from a crash with a delta V of 6.8 mph as 54%, orders of magnitude higher than the typical defense analysis predicting a risk of injury of 0.027% (1/3650). Put another way, using data from reliable sources, the actual likelihood of being injured in a crash with a delta V of 6.8 mph is 2,000 times more likely than suffering an injury performing typical ADLs.

Indeed, even when the delta V of a crash is as low as 2.5 mph, the authors' modeling shows the risk of experiencing a neck injury, is 20%, not .027%. The "biomechanical approach" of comparing the risk of injury during an activity of daily living to the risk of injury during a rear-impact collision is wholly invalid. The acceleration of activities of daily living simply cannot be used as a proxy for risk of injury.

Studies indicate real injury

Other papers have also verified that low speed or minimal damage rear-impact collisions are associated with a substantial risk of injury. Chapline et al. identified injuries in 38% of women and 19% of men in 113 crashes with an average reconstructed delta V of just 4 mph.[5] Farmer et al. found that injuries occurred in 21% of crashes with less than $500 in damage.[6] Even volunteer crash-test data with healthy, prepared and mostly young male subjects shows that rear-impact collisions are not injury free.[7] Symptoms (ranging in duration from hours to days) were reported in 28% and 63% of crash tests with a delta V of 3.0 mph and 7.5 mph, respectively.[7] While none of the crash test volunteers reported significant injuries (i.e., spinal disk or fracture), the rate of symptoms is significant and far beyond the rate of symptoms seen in any ADL.

Insurers have promoted flawed approach since 1994

On the other hand, publications funded or supported by the insurance industry have consistently promoted the flawed ADL "biomechanical approach" while ignoring the difference in risk of injury between traffic crashes and ADLs.

The first insurer-friendly paper was published in 1994 and used accelerometers on bicycle helmets to measure acceleration during common ADLs. It claimed results showing that volunteers appeared to experience more acceleration during ADLs than in motor vehicle crashes.[8]

A 2006 paper compared accelerations of volunteers during low-speed bumper car amusement park ride impacts to the acceleration of volunteers during "vigorous" ADLs like hopping, skipping rope, falling into a chair, and running with an abrupt stop.[9]

Two later, flawed papers from 2007 and 2011 measured angular head acceleration of volunteers during what were labeled "benign" daily activities.[10,11] Those researchers misleadingly claimed these activities (head-shaking, plopping into a seat, striking a forehead with a hand and a soccer ball impact to the head) were biomechanically similar to rear impact collisions.

None of these industry papers acknowledged the lack of connection between the risk of sustaining an injury and the acceleration felt during an ADL with rear-impact collision because it is not scientifically possible. Life would be much different if human beings suffered a cervical spine injury every one in five times we plopped into a chair, coughed, or looked quickly to our left. The truth is that circumstances matter, no matter how much insurance companies spend to try and convince us otherwise.

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Conclusion

Accelerations experienced during activities of daily living (ADLs) rarely compare to accelerations felt during rear impact collisions, even at low speeds or in "no damage" scenarios. The data from actual collisions shows that the rate of injury during even minimal damage crashes is at least 20%, and thousands of times higher than the rate of injury from common ADLs.

The truth? Comparing accelerations felt during ADLs with rear impact collisions does not give a valid prediction of the risk of injury. The historic defense biomechanical "expert" methodology is not based in science, is not objectively supportable or consistent with common sense. It should be excluded.

Mike Kelly is the senior shareholder at Walkup Melodia Kelly and Schoenberger *in San Francisco. He has concluded more than 225 cases where the recovery by his client exceeded $1 million. Honored as the Cal-ABOTA 2014 California Trial Lawyer of the Year, he is a member of the Inner Circle, ACTL and IATL. He has been selected as a Nor. Cal. Super Lawyers "Top Ten" honoree for the last eight years. He has taught courtroom advocacy skills across the U.S. and in Eastern Europe, South America, Japan, Scotland and Ireland.*



Kelly

Nicholas Flowers is a third-year student at Loyola University Chicago School of Law in Chicago, who is externing in the Cook County Law Division and worked as a summer associate at Walkup, Melodia, Kelly, Schoenberger *in 2021.*



Flowers

Endnotes:

[1] Paul S. Nolet et al., Is acceleration a valid proxy for injury risk in minimal damage traffic crashes? A Comparative Review of volunteer, ADL and real-world studies, 18 International Journal of Environmental Research and Public Health 2901 (2021)

[2] Logan E. Miller et al., An envelope of linear and rotational head motion during everyday activities, 19 Biomech. Model. Mechanoniol. 1003 (2020)

[3] Tracy P. Ng et al., The effect of gender and body size on linear accelerations of the head observed during daily activities, 42 Biomedical Sciences Instrumentation 25 (2006).

[4] Maria Krafft et al., Influence of Crash Pulse Characteristics on Whiplash Associated Disorders in Rear Impacts – Crash Recording in Real Life Crashes, 3 Traffic Inj. Prev. 141 (2002

[5] Janella F. Chapline et al., Neck pain and head restraint position relative to the driver's head in rear-end collisions, 32 Accid. Anal Prev. 287 (2000)

[6] Charles M. Farmer et al., Relationship of head restraint positioning to driver neck injury in rear-end crashes, 31 Accid. Anal Prev. 719 (1999)

[7] Rebecca Moss et al., Injury Symptom Risk Curves for Occupants Involved in Rear End Low Speed
Motor Vehicle Collision, SAE Technical Paper 2005-01-029 (SAE International: Warrendale, PA, USA,
2005)

[8] Murray E. Allen et al., Acceleration perturbations of daily living a comparison to whiplash, 19 Spine 1285 (1994)

[9] V. Vijayakumar et al., Head Kinematics and Upper Neck Loading during Simulated Low-Speed Rear-End Collisions: A Comparison with Vigorous Activities of Daily Living, SAE Technical Paper Nr. 0247, at 155-66 (SAE International: Warrendale, PA, USA, 2006)

[10] James R. Funk et al., Head and Neck Loading in Everyday and Vigorous Activities, 39 Accid. Anal. Prev., at 766-76 (2011)

[11] James R. Funk et al., An Evaluation of Various Neck Injury Criteria in Vigorous Activities (International Research Council on the Biomechanics of Injury Conference, September 19-21, 2007), https://brconline.com/publications/an-evaluation-of-various-neck-injury-criteria-in-vigorous- activities/

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