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## **Narrowing the Gender Gap in Whiplash**

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While it has long been known that females suffer more from the ravages of whiplash than males, the real reason behind this apparent difference has remained opaque to science. Theories were tendered which suggested the answer was as simple as differences in health care choices; males as more stoic was another hypothesis. These were disproved, of course, leaving the best explanation in the form of an intuitive best guess. Women have smaller necks, which makes them more vulnerable to injury. It has seemed to me too easy and too simple of an explanation, and thus not entirely satisfying. Only just recently has the denouement of this puzzle been delivered.

In both small and large-scale epidemiological studies, women are always shown to suffer higher injury rates from CAD (cervical acceleration/deceleration) trauma than men.<sup>1-11</sup> They also appear to be over-represented in the late whiplash (i.e., chronic) group.<sup>9-12</sup> Even the most recent study by Dolinis<sup>5</sup> reported an odds ratio of 2.08 for risk of injury for being female. It seems clear that females are injured more often, but why?

The answers come from two sources: 1) full scale volunteer crash tests, and 2) a large case-control study of chronic neck and low back pain sufferers. Siegmund et al.,<sup>13</sup> subjected a large number of males and females to 2.5 mph and 5 mph rear impact crash tests. A significant proportion of these subjects reported minor temporary injury (29% and 38%, respectively). The authors reported that the females experienced greater horizontal head and C7-T1 accelerations relative to the earth than male subjects. Females experienced greater and earlier acceleration of both head and C7-T1 centers, males experienced later and larger peak head extension, owing probably to their height in relation to the head restraint and their added mass and its effect on the frequency response of the seat back.

A recent paper by van den Kroonenberg et al.,<sup>6</sup> reported differences between female head acceleration and male head acceleration were large, with males clustering at about 6-8g and females at about 12g in low

speed crashes. A linear negative correlation was found between head x-acceleration (forward) and neck circumference in the 4 mph tests, such that occupants with thick necks (~16 inches) experienced about 3g, while those with thin necks (~12 inches) experienced about 8g -- a very large difference ( $R^2=0.85$ ). They also reported a significant correlation between BMI (body mass index) and head acceleration.

The authors theorized two possible explanations for the observed differences between males and females: 1) The smaller, "less resisting" necks of females allow for higher impact velocities with the head restraint, which in turn result in higher accelerations; or 2) The heavier males deflected the seat back more, resulting in less T1 acceleration and correspondingly less head acceleration. This latter explanation seems in tune with their data since they did get higher mean values for T1 accelerations in females.

The other work is our own.<sup>14</sup> In a large case-control study using chronic neck pain patients as cases and chronic low back pain patients as controls, we explored the relationship between motor vehicle crashes (MVC) and chronic neck pain, finding that about 45% of persons with chronic neck pain will attribute it to MVC. We also found BMI to be an important variable.

Surprisingly, however, we did not find an increased risk for late whiplash among the female population -- a finding which, at first blush, appears to contradict many other studies. Upon reflection, though, and with the benefit of the two crash test studies mentioned (and several that I did not mention), it all becomes quite clear.

The true variable is body mass and neck circumference, and females have generally smaller necks and less mass. As to why many authors seem to have erroneously arrived at the conclusion that females are more likely to develop late whiplash, it is merely an illusion of disparity of incidence rates.

Since females generally have smaller necks, and since that is a key factor in injury potential, we expect to see not only more acutely injured females than males, but also more late whiplash cases among the female group. However, it now appears from our research that once the threshold for injury has been breached and an acute injury has occurred, males are just as likely as females to develop chronic symptoms.

While we do appear to have come merely around in a circle, we really have gained something here with this new understanding. Why? While it did turn out that the reason women were more often injured than men was indeed neck girth, with that more simple answer, we tended not to give men their due. Men, we might have said, should be less likely to be injured and to develop chronic sequelae. But the differential injury rate

is not true of men with thin necks, and the difference between the genders in terms of tendency for late whiplash is merely a mirage. Also, any notions that femaleness itself is a factor in outcome -- and any of the related psychobabble arguments that frequently accompany that -- can be dispelled once and for all.

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