

Our view is that lifting has the same effect independent of where it happens, and to study physical loading at work, we need to know something about all physical loading exposures (one would never consider studying the pathophysiological effects of smoking at work, without having gauged total smoking). The body weight–discordant monozygotic twin study was simply a novel way to obtain, perhaps for the first time, relatively accurate long-term loading data, while minimizing possible confounding. Table 1 of our article summarizes lifetime physical loading data at work and sport and isokinetic lifting capacity based on a comprehensive interview and isokinetic testing [4]. Although a range of physically demanding occupations and leisure activities were represented in the study group, a strength of the study, resulting from the exposure-discordant monozygotic twin study design, was the high degree of similarities in physical activity exposures between heavier and lighter co-twins. The study results suggest that discs are not anomalous musculoskeletal structures for which greater routine physical loading is detrimental. However, we agree that new or rapidly increased physical loading without physiological adaptation time often leads to musculoskeletal symptoms.

Perhaps we should resolve this paradox of sport and occupational medicine and stop looking at cumulative and repetitive loading in the occupational setting as a negative exposure and, instead, focus on adaptation and factors that facilitate or hinder its occurrence. This would involve attention to both individual and exposure characteristics.

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A response to Videman et al., “Challenging the cumulative injury model: positive effects of greater body mass on disc degeneration”

To the Editor:

We were interested to read that Videman et al. [1] found no convincing influence of body weight on degenerative disc disease (DDD) in monozygotic male twins discordant for weight by at least 8 kg per pair. The discordant monozygotic design is powerful, adjusting as it does for numerous known and unknown confounders, and it has been used successfully to identify environmental risk factors for bone mineral density [2,3].

Degenerative disc disease is characterized by changes in the disc, including loss of hydration, loss of disc height, disc bulge, and osteophyte formation. It is thought to be similar in men and women. Our population sample of twins having magnetic resonance imaging of spine is one of the largest in the world. Spine magnetic resonance imaging scans performed 10 years ago have been scored (0–3) for four traits (disc height, disc signal, disc bulge, and anterior osteophytes) as reported previously [4]. A summary score was derived from the sums of the four phenotypes over the five lumbar disc levels. In addition, in an extended sample of twin volunteers, previous episodes of severe and disabling back pain were ascertained using the modified Medical Research Council back pain questionnaire as reported previously [5].

Multiple regression analysis considered the magnetic resonance imaging data set ($n=896$) of which 860 were female. No significant difference in DDD was detected between men and women. Adjusting for age, sex, zygosity, and relatedness of twins, we found an independent effect of body mass index on DDD summary score ($p=.006$), which was attributable to significant contributions from both disc signal intensity and disc height ($p<.001$ and $p=.02$, respectively). In each case, higher body mass index was associated with worse changes in disc degenerative score, and the results were even more convincing if weight, rather than body mass index, was used. Furthermore, considering the twins as affected ($n=546$) or unaffected ($n=1710$) by back pain, those reporting episodes of pain were likely to be significantly heavier (67.8 vs. 64.9 kg, $p<.001$).

The large sample size of our twin study offers, perhaps, greater power for the detection of an effect of body weight on disc degeneration. The twins have been shown to be representative of singletons drawn from the general population [6], and perhaps this is not the case for the twins reported in the earlier study [1]. It is possible that in women, the intervertebral disc is more influenced by the effects of body weight and differs significantly in the manifestation of DDD. This seems unlikely—no difference in DDD could be detected between the sexes in our sample. We conclude that increasing body mass is associated with disc dehydration and loss of disc height and, of still greater

importance, with reported episodes of severe and disabling low back pain.

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Reply:

We appreciate the points raised in this letter to the editor and believe that much could be learned from understanding the reasons for the discordant findings. Our study was planned to further investigate perplexing findings from an earlier investigation (N=575 men), in which higher routine loading was associated with slightly better magnetic resonance imaging disc signal and worse visually assessed disc space narrowing [1]. To test the veracity of the association, we conducted a weight-discordant monozygotic twin study focusing on the upper lumbar levels to maximally control confounding factors, using quantitative measures of co-twin differences in disc signal and height. We found no indication that carrying 15 kg more body weight, in mean, was harmful to the discs [2].

An explanation for the discordant results of our study and those of Spector and colleagues may lie in differences in the prevalence and magnitude of obesity and different genders. They studied almost exclusively women, with little power to detect gender differences because only 36 were men. The relative contribution of fat mass and muscle mass at any given level of body mass index differs by sex, with women having relatively more fat mass. In our study of men, co-twin weight discordance ranged from 8 to 23 kg (18–51 lbs), representing substantial differences. However, there was little extreme

obesity in our sample, with the highest body mass index being 35.6 and the highest body weight 109 kg. Furthermore, the association of greater weight with modestly less degeneration, as indicated through signal variation, was less clear when discordance was most extreme [1]. If other samples, such as that of Spector and colleagues, include grossly obese subjects, the effects of these extremes may lead to different results. It is important to note that our study was not about the effects of obesity but about the effects of carrying substantially more body weight.

The studies also differ in how disc degeneration was defined and in the lumbar disc levels examined. We used quantitative measures of disc signal and disc height narrowing, whereas Spector and colleagues used a combined measure including qualitatively rated disc signal, bulging, narrowing, and osteophytes. Our earlier study that did not involve co-twin comparisons also used qualitatively rated disc narrowing [1]. When rating various findings, it may be difficult to judge one aspect of disc degeneration without being influenced by another. Furthermore, qualitative disc height narrowing can be influenced by the proximity of the inferior and superior corners of the vertebrae and osteophytes. Yet, mean disc height (area divided by diameter) in such cases can remain relatively unchanged because of expansion of disc height in the middle of the disc as bone remodeling leads to vertebral concavity, such that mean disc height may remain unchanged. Quantitative mean disc height measurements adjust for such phenomena.

Finally, inadequate control of confounding is always a possible explanation for differences observed between studies. Spector's group did not examine intrapair weight differences in relation to intrapair differences in monozygotic pairs for disc parameters but did an overall phenotypic regression, which leaves open the major confounding effect of genes.

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