Although musculoskeletal disorder causation is multi-factorial, strong links have been established epidemiologically between occupational low-back loading demands, pain reporting, and injuries [1]. Controlling low-back loading exposures in the workplace could therefore play an important role in the prevention and management of low-back disorders (LBD).

While logical in principle to regulate peak or cumulative low-back loading demands through job (re-)design, it is currently impractical to acquire load-time histories in most work environments given current knowledge and technology. As a consequence, occupational biomechanists and ergonomists must rely on information garnered from relatively short-duration observations or experiments, often conducted in artificial laboratory settings, wherein data from a limited number of subjects are aggregated to yield “representative” exposure data. However, internal musculoskeletal loading demands are highly sensitive to personal movement strategies [2], and thus inter- and intra-individual variability in low-back loading patterns is commonly observed [3], even when external task and environmental characteristics are held constant [4]. In dynamic and unpredictable work (e.g., emergency response operations), the number of available movement solutions could vary considerably as changing personal, environmental, and task constraints interact to shape and guide movement behaviour [5]. Data from an unpublished study are included in Fig. 1 to illustrate the degree to which peak low-back loading levels can vary between and within individuals under fixed task and environmental constraints.

Given inherent links between movement strategies and internal musculoskeletal loading patterns, it is not surprising that low-back loading demands vary within and between individuals performing identical tasks. The human movement system is endowed with numerous biomechanical degrees-of-freedom, and thus motor task objectives may be satisfied using many different patterns of coordination and control. This flexibility is advantageous because task goals can be achieved even if characteristics of individual performers (e.g., fatigue) or their surroundings (e.g., ambient light/temperature) are fluctuating [5]. The variability in low-back loading patterns that would result from such flexible and adaptable movement behaviour, however, poses a challenge for occupational biomechanists and ergonomists in that representative exposure data becomes more difficult to define. Indeed, even in a laboratory setting with standardized measurements and instructions, there may be few performers who exhibit a consistent or “average” low-back loading response to fixed task demands (Fig. 1).

Viewed differently, appreciating that movement and low-back loading patterns are variable may encourage novel analyses and alternative interpretations of work-related mechanical exposure data. It has been hypothesized, for instance, that variable movement behaviour could aid in the maintenance of musculoskeletal health by reducing the likelihood of suffering chronic injuries [6]. From this perspective, it may be that characteristics of the low-back loading variability itself are important to consider in the prevention and management of LBD; there are a variety of analytical tools that may be suitable for this purpose [7]. Future studies incorporating such techniques are warranted, especially in cases where data aggregation results in an average response that is different from those of the individual subjects [e.g., 8].

REFERENCES

ACKNOWLEGEMENTS
David Frost, Stuart McGill, and Jack Callaghan contributed to the unpublished research presented in Fig. 1. Funding for the research was provided by the Centre of Research Expertise for the Prevention of Musculoskeletal Disorders (CRE-MSD).