Clinician's Commentary on Crockett et al.¹

For decades, rising from a seated position has been recognized as an activity of daily living that is particularly important for people's independence in completing many household chores, activities, and personal hygiene tasks.^{2–5} The sit-to-stand transfer is one of the most demanding functional tasks of daily life, as it places greater demands on the lower-extremity musculoskeletal system than many other functional movements.^{6,7} Given these demands, it is not surprising that many people have difficulty getting out of a chair. Tests of functional ability such as the 30-second sit-to-stand test (30sSTS), assessed by Crockett and colleagues,¹ have been developed to evaluate the performance of this important functional task.^{8,9}

Using functional outcome measures to understand the relationships between activity limitations and the impairments that may underpin them is an integral component of physical therapy practice. As Crockett and colleagues note,¹ muscle strength, endurance, power, and mobility are important for the successful completion of the 30sSTS, but no conclusive data exist on which parameter is most likely to alter performance.^{9,10} This is not uncommon: many outcome measures provide little information on the mechanisms by which results are obtained. Crockett and colleagues' investigation into the mechanisms underlying the 30sSTS, therefore, is both novel and welcome. The authors provide a thoughtful introduction to the topic; their study's methodology is strong, and they offer a clear discussion with key points for the physical therapist wishing to know more about physiologic factors that contribute to the performance of the 30sSTS.

Crockett and colleagues' primary purpose was to investigate the association of knee-extensor strength and power to performance in the 30sSTS in healthy community-dwelling older adults.¹ Crockett and colleagues clearly articulate the knowledge gaps in our understanding of the 30sSTS to provide a foundation for conducting this investigation. By including working definitions for key variables studied (muscle strength and power), they provide a very clear context for interpreting results and understanding the limitations of this experimental design. In contrast, momentum – defined as the product of the total body centre of mass and its horizontal and vertical velocities – is not fully introduced, yet forms the basis for the authors' second exploratory hypothesis.

In general, initiating a sit-to-stand transfer requires generating horizontal momentum through trunk flexion, followed by a transfer to vertical momentum as the person rises to standing.¹⁰ Crockett and colleagues have calculated momentum to understand effective strategies during the 30sSTS.¹ In a recent study, Scarborough and colleagues¹¹ identified three strategies that older adults with self-reported functional limitations use to transition from a sitting to an upright standing position: (1) momentum transfer, (2) exaggerated trunk flexion, and (3) dominant vertical rise. Those that used the exaggerated trunk flexion strategy had a significantly slower sit-to-stand time.¹¹ This implies that it is important to understand sit-to-stand strategies when evaluating 30sSTS performance.

A study by Van der Heijden and colleagues found that in people with experimentally induced leg-muscle weakness, rising

from a chair was characterized by a shift from a momentum-transfer strategy to increased trunk flexion before rising from the seat (i.e., exaggerated forward flexion).¹² This finding supports those of previous studies¹³ and suggests that impairment in force-generating capacity of the lower-limb extensor muscles is a major determinant of this strategy shift. It would be interesting to know which strategy participants in Crockett and colleagues' study adopted when completing the sit-to-stand and whether this strategy altered over the course of the 30 seconds. In light of previous research, future investigations on this topic might help to strengthen the conclusion that there is an association between muscle strength and 30sSTS outcomes.

Crockett and colleagues' strength-testing protocol is well described and sufficiently detailed for readers to understand its implications for data interpretation. Their sit-to-stand protocol considered many of the sit-to-stand determinants¹⁴ in the experimental setup to minimize the potential confounding influences of foot position, chair height, arm- and backrests, and so on. While participants were instructed to reach full hip extension during the stand phase, in practice this can be difficult to attain or ensure over the course of 30 seconds, as clinicians can attest. Within the time limit of the 30sSTS, one can complete more cycles by not ascending and descending through the full range of sit-to-stand motion. In addition, as muscles fatigue over the course of 30 seconds, the ability to ascend fully may diminish. These factors have implications for understanding the role of muscle function in explaining variance in the performance of this task.

Crockett and colleagues produced many interesting results pertaining to concentric and eccentric strength, peak rate of torque development and momentum. The greatest variance in the 30sSTS performance was explained by high-velocity concentric knee-extensor strength (180°/s), eccentric strength, power, and peak linear vertical momentum.¹ In general, their results suggest that matching the speed and type of muscle contractions during a training bout to those required by the functional task may improve performance on the functional task. How often do our strength-training programmes for older adults target high-velocity contractions or muscle power? The ability to rapidly produce torque maybe beneficial for improving function, as many functional activities depend more on speed of contraction than on absolute strength.¹⁵ Crockett and colleagues' study provides support for this notion.

Finally, the authors cautiously discuss the importance of their results for fall risk and the use of the 30sSTS as a tool to assess this outcome. While the 30sSTS has been used to screen for fall risk, it is not clear that factors discovered by Crockett and colleagues to explain variance in 30sSTS performance are related to fall risk. As the authors note, these findings will help physical therapists design exercise programmes to improve 30sSTS performance; however, further investigation is required to ascertain the effectiveness of these interventions in attenuating fall risk.

Few functional outcome measures used by physical therapists capture the mechanisms by which task performance is impeded or enhanced. Crockett and colleagues sought to under-

stand the relationships between sit-to-stand and the muscle strength characteristics that may explain the number of sit-to-stand repetitions that can be accomplished in 30 seconds. While their study did identify these factors, further research to establish causation is still required to ascertain the expected benefits of targeting high-velocity concentric knee-extensor strength, eccentric strength, and rate of torque development to improve 30sSTS performance.

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