Supplementary file 2, Details of the core stability tests

Given that the core musculature is a complex, integrated system that functions synergistically to stabilise the spine (1), a battery of tests was deemed most appropriate to assess core stability. As the trunk flexors, extensors and lateral musculature are responsible for spinal stability during most activities (14), endurance was measured for all three muscle groups using the side bridge endurance test, the flexor endurance test, and the Sorensen test. The Star Excursion Balance test was selected to assess dynamic postural control due to the importance of the core musculature in providing a stable base for distal movement (1). In addition, the Sahrmann test was used to assess the ability of the deep core musculature to stabilise the spine during lumbopelivc motion (16). This battery of core stability tests aims to assess the important isometric endurance and dynamic control aspects of the core musculature.

The side bridge endurance test

This test was used to assess strength of quadratus lumborum and muscles of the anterolateral wall. The test was performed in accordance with McGill (14) with the lateral musculature tested with the subject lying in the full side bridge position. Feet are placed with the top foot in front of the lower foot for support with the legs extended. The participant supports themselves on their elbow and feet whilst lifting their hips from the floor to generate a straight body alignment from head to toe. The top arm is placed across the body with the hand resting on the supporting arm's shoulder. Failure arises when the subject loses the straight back posture and/or the hip touches the ground.

Figure S2.1 The side-bridge endurance test

The flexor endurance test

Endurance of the rectus abdominis and abdominal oblique muscles was evaluated through the abdominal fatigue test, which is an isometric contraction at an angle of 60° (18). The test is performed with the participant's hips and knees flexed at 90° with the feet fixed to the floor (18). The participant's hands are placed crossed the chest on opposite shoulders, while they lean against a wedge angled at

60°. The test begins when the supporting wedge is removed and terminated when the subject could no longer maintain the upper body at 60°, with the length of the hold being recorded in seconds (18).

Figure S2.2 The flexor endurance test

The Sorensen test

The Sorensen test has been validated as a simple and reproducible method for evaluating the isometric endurance of the trunk extensor muscles (23). During this test the participant lies on an examining table in the prone position with the upper edge of the iliac crests in line with the edge of the table. The lower body is fixed to the table by three straps, situated around the pelvis, knees, and ankles, respectively (23). With the arms folded across the chest, the participant is asked to isometrically sustain the upper body in a horizontal position (23). Failure occurs when the upper body drops from the horizontal position. The time during which the patient keeps the upper body straight and horizontal is recorded. In participants who experience no difficulty in holding the position, the test is stopped after 240 seconds (23).

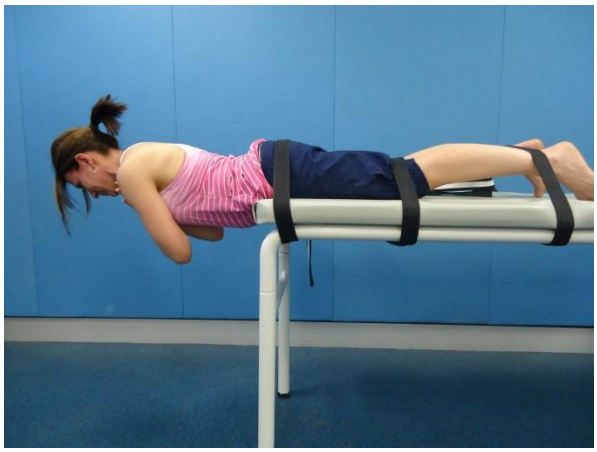

Figure S2.3 The Sorensen test

The star excursion balance test

Dynamic postural control was measured via the Star Excursion Balance Test (SEBT), which requires the participant to preserve their balance on a single limb while manipulating the opposite limb in one of 8 unilateral directions (24). This test requires the participant to stand at the centre of a grid on the

floor with eight lines projecting at 45° increments from the centre (24). The stance leg operates in the closed kinetic chain with movement taking place at the ankle, knee and hip joints as the opposite leg reaches down the line in the specified direction and contacts the line with the most distal part of their foot without using it for support (24). In accordance with Hertel and colleagues (27) only the anterior, posterolateral and posteromedial directions were measured to avoid capturing redundant information. Excursion distances are then normalised to leg length to provide a percentage of excursion distance in relation to leg length (25). Participants performed four practice trials before the actual testing to prevent learning effect influencing outcomes (26). Improvement in SEBT performance has been observed following core stability training indicating that this test is sensitive to change, which supports the use of the SEBT to assess the effectiveness of a core stability program (24).

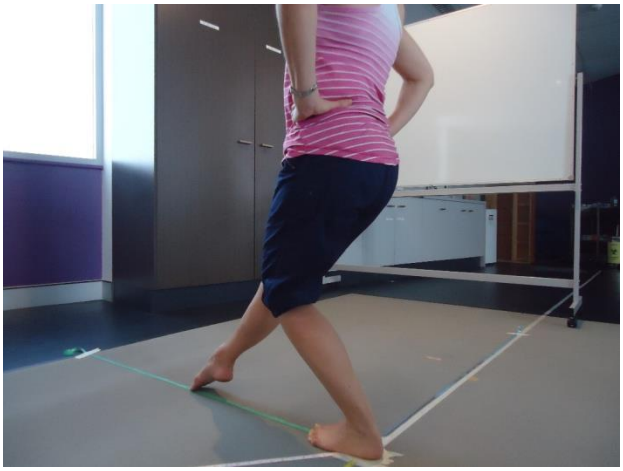

Figure S2.4 The anterior direction of the star excursion balance test

The Sahrmann test

Core stability was measured via the Sahrmann test. To perform this test the inflatable pad of a pressure biofeedback unit is placed in the natural lordotic curve of the back, and is inflated to 40 mm Hg whilst the participant is lying supine (21). The subject activates the stabilising musculature via the abdominal hollowing technique, and if performed correctly will result in either no change in pressure or a slight decrease in pressure from the initial 40 mm Hg (22). The test consists of five levels with each level increasing in difficulty (21). In order to attain each increasing level on the Sarhmann test, the lumbar spine position must be maintained by a change of no more than 10 mm Hg in pressure on the analogue dial of the pressure biofeedback unit (21). The ability of the core musculature to stabilise the spine can be indirectly measured by changes in the pressure applied to the biofeedback unit as the subject must maintain core activation during increased motion of the lumbopelvic complex with each level (16).

Level one: Abdominal presetting is performed with no movement being produced. The participant then raises one leg to 100˚ of hip flexion with comfortable flexion of the knee. The other leg is then brought to the same position. This became the initial position for subsequent levels. If the participant could maintain stability when raising one leg but not both, a score of 0.5 was awarded (21).

Level two: From the start position, the participant slowly lowers the heel of one foot to the floor, slides the leg out to fully extend the knee, and then returns to the start position.

Level three: The heel of one foot is lowered to 12 cm from the floor, the leg slides out to fully extend the knee and then returns to the start position.

Level four: From the start position, the participant lowers both heels to contact the floor, both legs slide out to fully extend the knees, and then return to the start position.

Level five: From the start position, the participant lowers both heels to 12 cm from the floor, the legs slide out to fully extend both knees, and then return to the start position (21).

Figure S2.5 The Sahrmann test (level 1)