

Appendix 1.

General training principles, and specific objectives of the key exercises and their progression.

General training principles:

In each exercise the participants were instructed to concentrate on (1) the maintenance of neutral spine posture using light co-contraction of the trunk muscles, and (2) neutral alignment between body parts.

The selection of exercises targeting to increase spinal stability was based on the knowledge on (3) the level of muscular activity vs. the load on lumbar spine. High activity vs. low load was preferred especially at training level 1.

Most of the exercises performed in upright positions followed (4) the principle of a closed kinetic chain.



Specific objectives and description of the corresponding key exercises in the three performance levels

1. To increase spinal stability using exercises which minimize the load on spinal structures but induce high muscular activity

<p>Modified curl up (“McGill curl up”) Supine lying, one knee in flexion, other leg stretched out, hands under lumbar lordosis. Low curl-ups without pressing the lumbar spine down.</p> <ul style="list-style-type: none"> • 6–8 repetitions to each side 	<p>Level 1: Elbows on the floor</p> 	<p>Level 2: Elbows off the floor</p> 	<p>Level 3: Elbow towards opposite, flexed hip joint</p> 
<p>Bird dog Four point kneeling, pressing the hands and shins towards the floor (stable shoulder region, neutral lumbar spine).</p> <ul style="list-style-type: none"> • 6–8 repetitions to each side 	<p>Level 1: Stretching one leg out on the floor</p> 	<p>Level 2: Lifting the leg to same level with the trunk</p> 	<p>Level 3: Lifting the opposite arm simultaneously with the leg. Progression: hold up for two breaths</p> 

Side bridge or Mermaid

Side-lying with bent knees, pressing supporting forearm on the floor, or side sitting with upper knee upwards, pressing supporting hand down (shoulder stability).

- 6–8 repetitions to each side

Level 1: Lifting the pelvis up



or alternatively



Level 2: Longer lever arm by stretching the lower leg



Level 3: Longer lever arm with straight legs



or



2. To improve endurance of the trunk musculature

Single leg stretch

- 8–10 repetitions to each side

Level 1: Supine crook lying. Stretching one leg on the floor and drawing it back, maintaining neutral spine.



Level 2: Head and shoulders off the mat, drawing one leg to the chest and stretching the other leg on the floor. Switching the position of the legs, maintaining neutral spine.



Level 3: As in level 2, but stretching the extended leg above the floor.



<p>Shoulder bridge</p>	<p>Level 1: Supine crook lying. Lifting up the pelvis while maintaining neutral spine.</p> <ul style="list-style-type: none"> • 6–8 repetitions 	<p>Level 2: Maintaining the bridge position and neutral spine, lifting one heel of the floor without rotation in pelvis.</p> <ul style="list-style-type: none"> • 5 repetitions with both legs 	<p>Level 3. As in level 2, but lift the leg up to 90 degrees angle in hip and knee joints.</p> <ul style="list-style-type: none"> • 5 repetitions with both legs
			

3. To improve balance, postural control and co-contraction of the stabilizing muscles around lumbar NZ in various up-right postures and movements

<p>Weight transfer, side lunge and one leg stand</p>	<p>Level 1: Weight transfer from side to side, lining in the legs, maintaining neutral lumbar spine and light rotation in thoracic spine.</p> <ul style="list-style-type: none"> • 8–10 repetitions 	<p>Level 2: Side lunge maintaining the neutral spine. Weight shift to other side.</p> <ul style="list-style-type: none"> • 6–8 repetitions 	<p>Level 3: From side lunge taking off the bending leg to one leg stand. Progression: taking off the leg from the floor first from narrow position and minor side lunge to wider position and deeper side lunge.</p> <ul style="list-style-type: none"> • 6–8 repetitions to each side
	 	 	

“Tai chi warrior”

One leg squat stretching the other leg back → lifting the same leg to front of the body with flexed knee. Maintaining neutral spine throughout the movement, and control of the hip in supporting leg.

- 6 repetition to each leg

Level 1.



Level 2.



Level 3.



4) To increase muscular strength of the lower limbs in functional squatting movements

Lifting up an imaginary ball from the floor and reaching it out to the side, maintaining NZ of the lumbar spine.



Progression: deeper squat and range of motion.
• 8 repetitions to each side

5) To achieve normal range of motion in thoracic region, and hip and ankle joints

Active toestand and knee bend keeping heels on the floor.
• 8–10 repetitions



Examples, no progression (only increased range of motion).



Hip circumduction (emphasizing flexion and abduction), with help of the hands, maintaining NZ in low back.

- After 5 repetitions change direction and repeat 5 times



Hamstrings stretch, flexing and pointing the ankle 8 times, maintaining NZ in low back



Starting position: side-lying with flexed hips and knees, reaching up the upper arm, neutral spine. Rotating the thoracic spine backwards without movement of the pelvis.

- 6 repetitions



“Cat – cow – downwards facing dog”.

- 6 repetitions