A functional approach: individualizing the management 2

Perhaps the place to start the exploration of a functional management is to identify the goal of this rehabilitation approach. A person's functional capacity or "functionality" is seen as the ability to perform daily activities effectively, efficiently and comfortably. This capacity can be affected by various musculoskeletal and pain conditions. The aim of a functional rehabilitation is to enable the individual to regain their pre-injury capacity by using their own movement repertoire.

Imagine a session in which two patients are prescribed exercise for a similar knee injury. One patient is a keen tennis player and another a strength and conditioning enthusiast. How do we construct a functional exercise management? What would be similar and what would be different between the two presentations? How do we individualize the management? Can individualizing the exercise improve outcome? To start this exploration, we first need to look at what an exercise is.

WHAT IS AN EXERCISE?

Which of these activities would be considered an exercise: climbing a flight of stairs, walking home with shopping bags, pushing a baby carriage up a hill, repeated bending to clear clutter off the floor, cleaning the house, laying bricks, or gardening? Or would these set of activities be considered exercise: lifting weights in the gym, walking or running on a treadmill, or stretching in a yoga class?

Most people are likely to consider the first set of daily activities as undesirable daily chores. An activity would often be considered an exercise when it reaches some level of exertion and is performed in block repetitions. We also associate exercise with particular gear or sportswear, or a dedicated space and time, such as a gym. In this mindset, exercise and sports activities are believed to confer health and fitness benefits which are not provided by daily, non-recreational activities.

From a rational point of view, all human activities provide some form of physiological, physical, and psychological challenge. What we consider to be an exercise and therefore different from daily activity is more about a mindset and context, rather than a true physiological or physical difference. From the "body's point of view," lifting a basket of washing could provide similar physical challenges to lifting a dumbbell in the gym. What forms an exercise may also depend on how incapacitated a person is. A seemingly unchallenging daily task, such as rolling out of bed, can be an exhausting exercise if the patient is very old or has been bed-ridden for several weeks. Similarly, getting in and out of a chair or walking would be a demanding challenge to a person who is recovering from lower limb surgery.

So, is there a physical activity which is not an exercise? Yes: resting or quiet sitting is considered a low metabolic activity that places minimal physical demands on the body;[1] hence, it is an activity that is unlikely to contribute to movement rehabilitation (although it is important to our well-being). However, a slow walk, which is also low on metabolic demands, could be an essential physical challenge in post-stroke or post-surgery rehabilitation. From a musculoskeletal rehabilitation perspective, it seems that all physical activities can be used to maintain, recover, or enhance performance, as well as providing wider health benefits. These considerations form the basis for broad definitions of exercise and remedial exercise:

Chapter 2

Exercise is the behavior a person adopts in order to maintain or enhance their physical performance or health.

Remedial exercise is the behavior a person adopts in order to recover their physical performance or health.

These definitions encompass the notion that all human activity, including mundane daily tasks, can be considered remedial exercise and therefore beneficial for recovery. But is there any evidence for this?

THE BENEFITS OF THE MUNDANE

The first question that comes to mind is how individuals who do not engage in a structured recreational exercise regime maintain their physical capacity to carry out daily activities. How do we maintain our ability to climb a flight of stairs without special exercise? It seems that, by simply performing daily tasks, we attain and maintain our capacity to perform them (Fig. 2.1A&B). Walking maintains walking; getting in and out of chairs maintains this ability; bending, twisting, and reaching maintain our

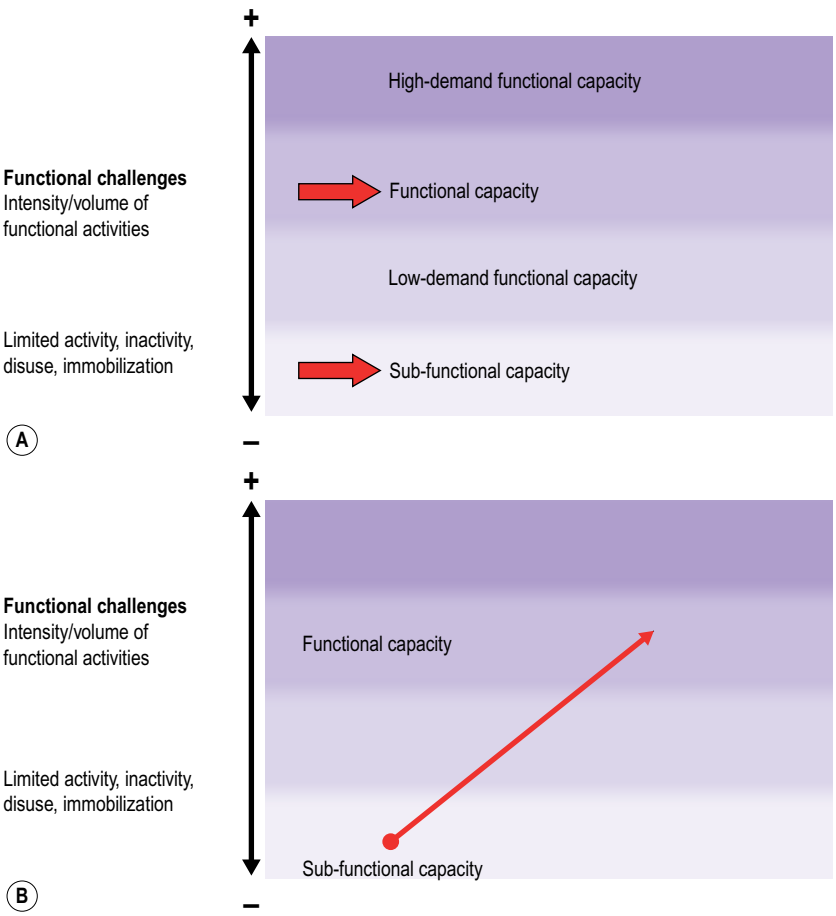

FIGURE 2.1
Functional activities maintain functional capacity. (A) In conditions such as immobilization, disuse, and neglect, functional engagement is lowered to a "sub-functional" capacity. (B) Often, movement rehabilitation revolves around recovering functional capacity from the sub-functional level. Importantly, this can be achieved simply by gradually increasing the intensity and volume of the individual's functional activities.

agility, and so on. Most of these daily tasks are usually performed within a comfort zone. Occasionally, we might experience discomfort, such as fatigue when we over-exert ourselves – say, with a long walk. On the other hand, sports-related activities are largely associated with physical exertion, discomfort, and even pain, such as when we experience "muscle burn" or become acutely and painfully out of breath. On the whole, daily tasks do not provide this exertion experience to the same extent, and hence most individuals would not consider them to be health-enhancing activities (think vacuuming). This distinction, however, is far from the physiological reality.

It is well established that many of our daily activities provide substantial challenges which maintain our physical capacity. This is exemplified in Figure 2.2, which demonstrates the physical forces imposed on the knee by daily and recreational activities. A basic daily activity such as walking, loads the knee by 2.6 times our body weight (BW), getting up from sitting by 2.5xBW,

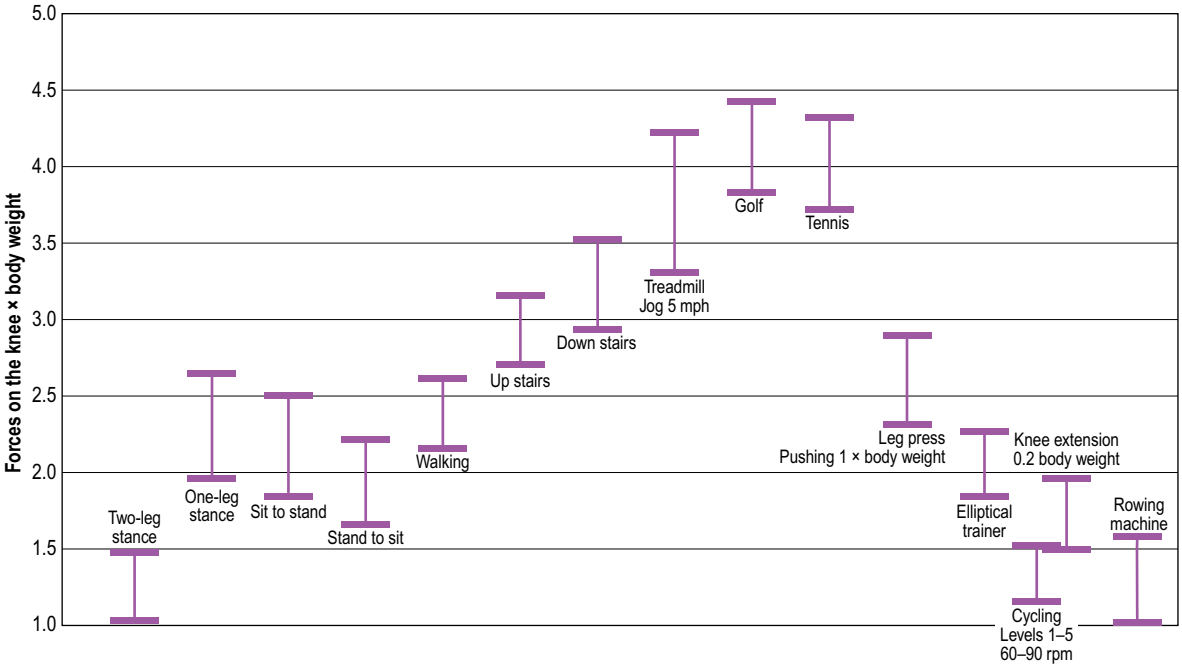

FIGURE 2.2
Forces exerted on the knee during daily and recreational activities. (Adapted from Kutzner I, Heinlein B, Graichen F, Bender A, Rohlmann A, Halder A, et al. Loading of the knee joint during activities of daily living measured in vivo in five subjects. J Biomech. 2010;43:2164–73; and D'Lima DD, Steklov N, Patil S, Colwell CW. The Mark Coventry Award: in vivo knee forces during recreation and exercise after knee arthroplasty. Clin Orthop Relat Res. 2008;466:2605–11.)

and descending stairs by 3.5xBW.[2–5] Such loading forces are also seen in other areas of the body. In the glenohumeral (GH) joint, lifting a kettle weighing 1.4 kg loads the joint by 1xBW: the equivalent of the whole of our body weight passes through that joint (Fig. 2.3). A simple activity such as combing our hair produces loads of 0.6–0.9xBW in the GH joint.[5] Similarly, in the lumbar spine, when comparing loading forces of standing to other daily activities, it was found that walking increases vertebral loading by 1.7 xBW, ascending stairs by 2.6 xBW and descending stairs by 2.2 xBW, getting out of a chair by 3.8 xBW, and turning from side-lying to a supine position, and vice versa, by 2.2xBW.[6,7] In the metacarpophalangeal joint, a simple daily task such as gripping a pen can generate dramatic loading stresses equal to forces observed in some hip activities.[8] Such loading patterns are expected in many other joints during a variety of daily tasks.

The health benefits of daily activities can be observed beyond the musculoskeletal system. This phenomenon has been shown in studies that explore the benefits of moderate-intensity activities of daily living (active transportation, occupation, or domestic duties) and recreational physical activities (sports, gym, and so on) on overall mortality and major cardiovascular disease.[9–12] In one major study with 130,000 participants, it was found that both moderate recreational and non-recreational activities are associated with a lower risk for mortality and major cardiovascular events, regardless of the type of physical activity.[10] Longer weekly exposure to moderate non-recreational activities was shown to confer cumulative cardiovascular health benefits, surpassing even those observed in moderate recreational sports activities (Fig. 2.4A&B).

The above research findings highlight the importance of daily activities in maintaining both systemic and musculoskeletal health. These benefits are seen even in individuals who are not engaged in recreational exercise or sports activities. This suggests that engaging in daily activities can provide adequate physical challenges to maintain their performance.

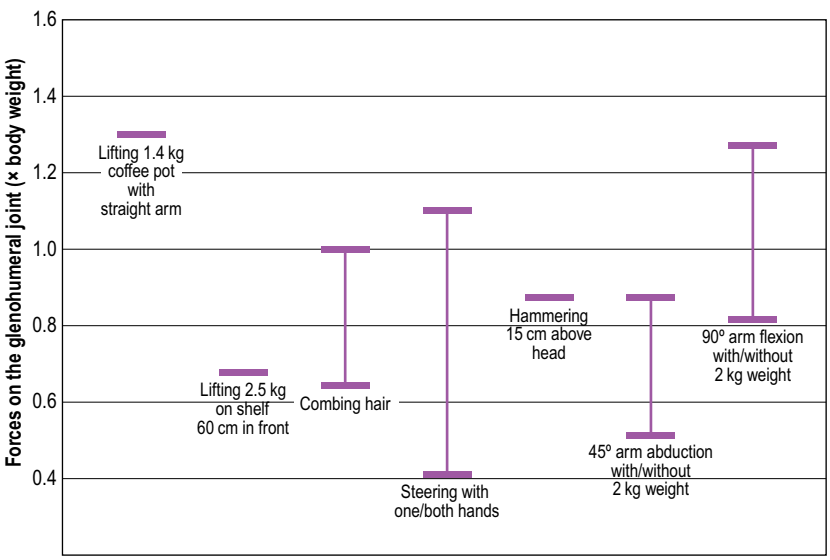

FIGURE 2.3
Forces exerted on the glenohumeral joint during daily activities. (Adapted from Bergmann G, Graichen F, Bender A, Kääb M, Rohlmann A, Westerhoff P. In vivo glenohumeral contact forces: measurements in the first patient 7 months postoperatively. J Biomech. 2007;40:2139–49.)

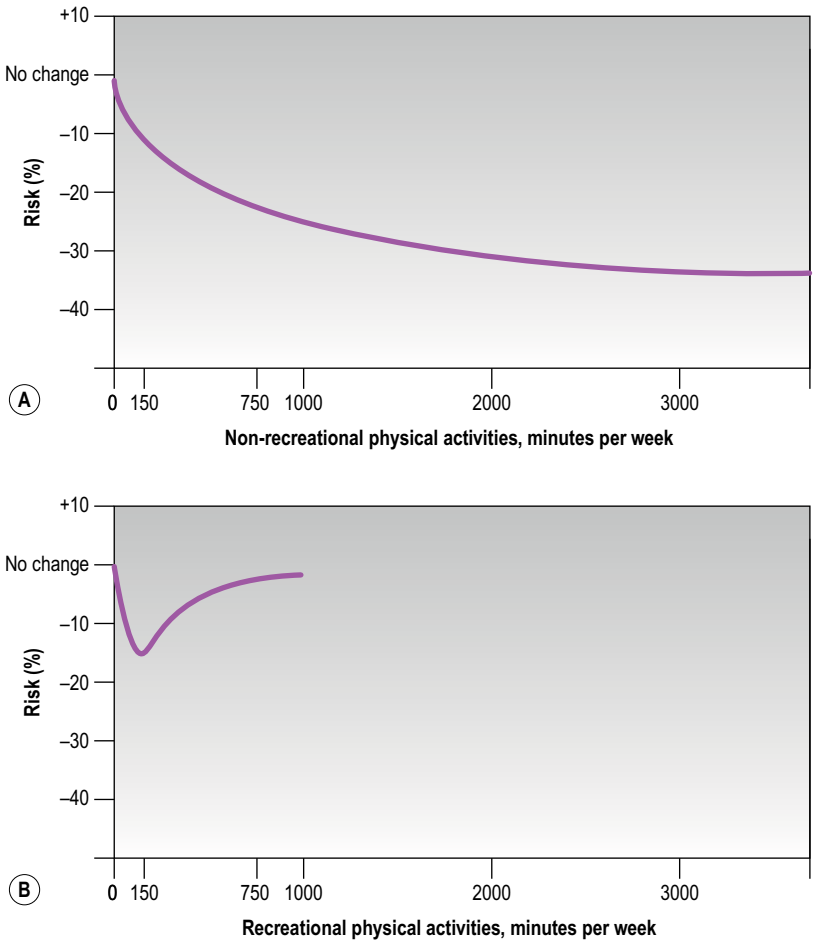

FIGURE 2.4
The effect of physical activity on mortality and cardiovascular disease. (A) Daily activities. (B) Recreational activities.

By walking we maintain our walking capacity, by daily bending, lifting, twisting, and reaching we maintain our agility and ability to perform these tasks – no other exercise is required. This phenomenon is seen throughout a person's functional repertoire. This notion provides us with a very important principle when constructing an exercise prescription program: start off the exercise management with the functional repertoire whenever possible (see exceptions below). Since functional activities maintain functionality, they also offer the elementary challenges to support recovery. This is the essence of a functional management. It engages the person in daily activities that challenge their functional losses. The message to the patient is simple and clear – practice what you aim to recover (or, practice *only* what you aim to recover?). We can observe that most people recover from most of their injuries, most of the time, by simply engaging in the activities that have been affected by their condition. So, if daily activities can potentially be such an effective therapeutic tool, how do we choose these challenges? Where do we start?

A FUNCTIONAL APPROACH TO EXERCISE PRESCRIPTION

The most immediate and accessible place to start an exploration into exercise prescription is within the individual's own movement repertoire: movement and activities that are familiar and have been experienced in the past. This form of management is termed a "*functional approach*" and is one of the key concepts underpinning the exercise prescription described in this book. *Functional exercise*, *functional rehabilitation*, and *functional challenges* are commonly used terms within this approach.

The functional movement repertoire of an individual can be divided into two broad categories: *shared* and *unique* activities (Fig. 2.5). Shared activities are associated with activities of daily living, such as feeding, dressing, commuting, and so on. They are what most people do within their shared sociocultural realm. The unique repertoire contains activities that are particular to the individual. These include specialized occupational and recreational activities such as playing a musical instrument, gardening, working out at the gym, and doing sports. Once a person learns a new movement or activity, it becomes a part of their movement experience and their functional repertoire.

Most individuals who experience musculoskeletal and pain conditions express a wish to be able to return to their pre-injury physical ability. Hence, a functional exercise prescription aims to help the person recover their movement capacity by using their own movement repertoire whenever possible. For a person who has had a shoulder injury or surgery, the exercise prescription will include daily activities such as reaching, lifting, carrying, and so on. Challenges from the unique repertoire can be added, depending on

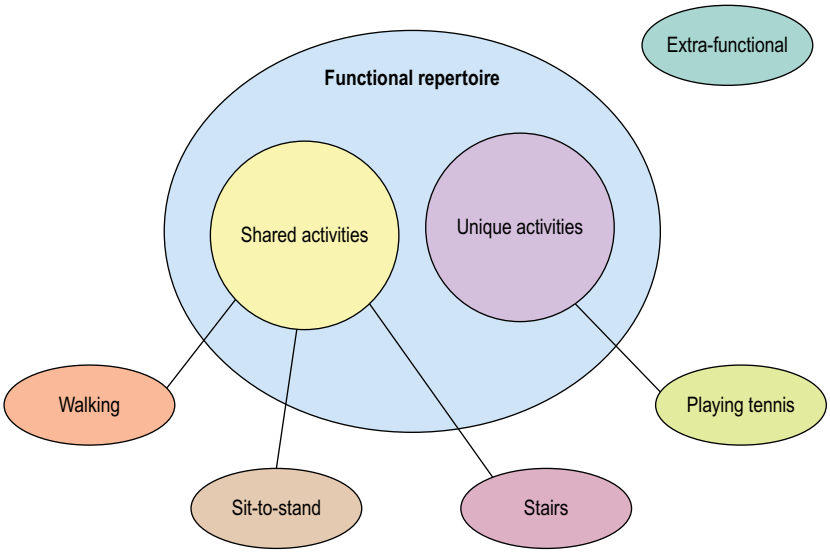

FIGURE 2.5
A person's functional repertoire represents their total movement experiences – activities which they are familiar with. It contains a range of shared and unique activities. Activities outside the individual's movement experience are extra-functional. In functional rehabilitation the remedial exercises are constructed from the person's movement repertoire.

their stage of recovery. They can be in the form of graded challenges, such as using tennis to rehabilitate a tennis player or a progressive workout with weights for the gym enthusiast. This personal repertoire is the basis for individualizing exercise prescription. Why invent something new? Use what the person has already knows and is used to.

CONSTRUCTING A FUNCTIONAL EXERCISE MANAGEMENT PROGRAM

How do we construct an exercise plan within a functional approach? Do we need to know specific exercises for certain areas of the body or particular pathologies? How do upper limb exercises differ from lower limb or trunk exercise? From where do we source the remedial exercise?

These questions can be resolved by looking at the regional functionality of an area such as the lower limbs (Fig. 2.6A–C). Within the shared repertoire, the lower extremity is used in activities such as getting up from sitting, standing, walking, climbing stairs, and so on. Hence, regardless of the underlying condition or pathology, the knee has to flex, extend, and rotate in all leg activities, in the context of what the person does with their leg within their environment: sit to stand, walk, climb stairs, and so on. Now, imagine two patients, each presenting with a different knee condition: say, post-operative cruciate and meniscus repair. Would the management differ between the two conditions? In both conditions the physiological movement ranges of the knee have to recover (flexion, extension, and rotation), but also the knee has to participate in all the functional weight-bearing activities. Hence, the exercise prescription for the two conditions would be exactly the same. This principle applies to any knee condition, regardless of the underlying pathology. A person who has had

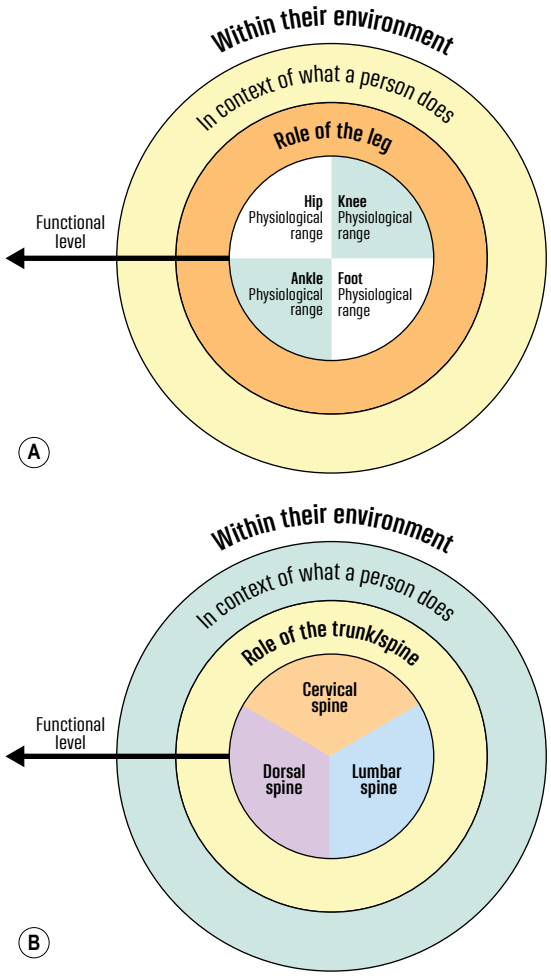

FIGURE 2.6
Context principle in constructing a functional exercise rehabilitation. (A) For the lower limb. (B) For the spine/trunk. (A and B, After Lederman E. Neuromuscular rehabilitation in manual and physical therapy. Edinburgh: Churchill Livingstone; 2010.)

acute sprain, osteoarthritis, knee replacement, or meniscal repair still has to be able to flex, extend, and rotate the knee, stand up, walk, and so on. But what about ankle rehabilitation: would it be different to the above knee management? From a functional perspective, all the lower limb joints participate in the activities of daily living. The ankle has to dorsiflex and plantar-flex within the context of what the person does with their leg within their environment: e.g., stand up, walk, play football, and so on. Hence, all lower limb joints and conditions can be managed by applying this functional regional repertoire – no need for complex or exhaustive exercise regimes.

This regional principle can be applied for managing various upper limb conditions. Within the shared functional repertoire, the upper limb is used typically for reaching, grasping, and retrieving, carrying and manipulating objects, and so on. From a functional perspective, the shoulder, elbow, wrist, and hands are all involved in this repertoire. This means that in all upper limb conditions the exercise prescription will be similar, regardless of the anatomical location, joints, tissues involved, or even the nature of the underlying pathology: e.g., a person with frozen shoulder, or subacromial decompression, or post-shoulder dislocation surgery, still has to recover daily tasks that require reaching and retrieving movements.

What about the spine – or, more correctly, the trunk? Would the prescribed exercise change if two patients presented with conditions in different locations: say, dorsal and lumbar spine? The answer to this clinical conundrum can be explored with another question: is there any human activity in which the trunk is left out? The whole of the trunk is involved in all human activities, from walking, lifting, bending, twisting, reaching, and using stairs to playing tennis, and so on. It difficult to imagine an activity in which the trunk is not under some form of mechanical loading or in complete muscle silence (even lying down we use our trunk muscles for breathing). This means that all activities within a person's functional repertoire can be used to challenge the spine/trunk – no need for back-specific exercise. Hence, the dorsal and lumbar spine can be rehabilitated using the same daily activities. But what about a person who presents with lumbar spine discectomy and another who has had abdominal or heart surgery? Would the management of the anterior and posterior aspects of the torso be the same or different? Since the trunk, as a whole, participates in all human movements, all these activities can be part of the remedial care. This means that all functional activities can be used to manage recovery from any condition or pathology afflicting any part of the torso.

Exercise prescription for neck conditions can follow the same principles described above. Although the neck is involved in all functional tasks, it is also has the unique job of supporting the head in movements associated with tracking the senses: sight, taste, and hearing. This function can be utilized to challenge neck movements. For example, neck rotation can be challenged by simply following the gaze to the right and left while sitting or standing, or walking with the head slightly turned to the affected side. There is no physiological difference between giving a patient a neck rotation exercise or a functional task such as turning the head when parking the car.

From the above examples it can be seen that the body may be divided into four major functional regions: lower limbs, upper limbs, torso/trunk, and head and neck (Fig. 2.7). Each of these regions has a unique role within any given task. This, somewhat artificial, division

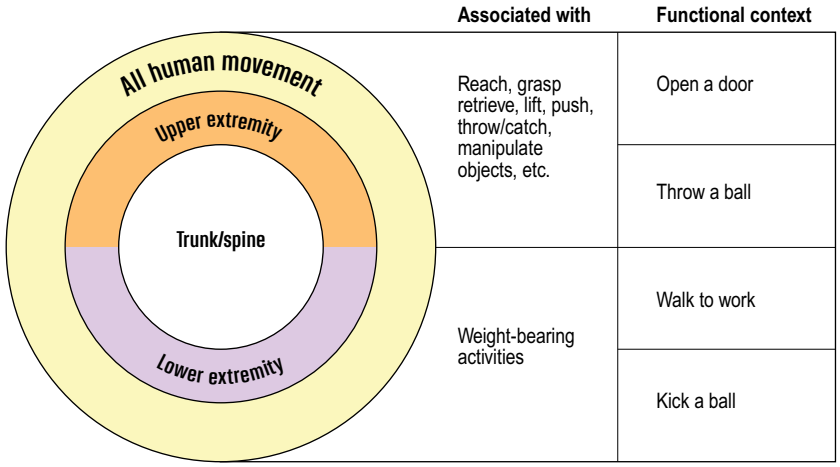

FIGURE 2.7
The whole body plays a role in the functional repertoire. However, there are functional regions that are associated with the ability to perform specific tasks: lower limbs, upper limbs, torso/trunk, and head and neck. Each of these regions has a unique role within the context of any given task. Exercise prescription is constructed from these functional roles. However, in functional rehabilitation the aim is to enable the patient to recover their capacity to perform the affected task(s), so in most exercise prescription all the regions play a part in the task: for example, a simple side-reaching exercise for the arm can be used to rehabilitate the arm, trunk, and legs.

provides a convenient clinical tool; it dramatically simplifies the planning of an exercise prescription program. The therapist is no longer required to construct a specific rehabilitation for every pathology in any of these four regions. Prescription is given according to the role that each of these regions plays within the affected tasks, as described in the above examples.

EXTRA-FUNCTIONAL MANAGEMENT

Traditional forms of exercise prescription are mostly based on strength and conditioning principles. They are often very different from the individual's functional repertoire or goals of recovery. It is not unusual for a patient recovering from leg surgery or injury to be given exercises such as seated leg bench-presses or extension exercise using resistance bands. These exercises bear no resemblance to functional human activities and are likely to be outside the individual's movement experiences. In a functional approach the term "*extra-functional*" refers to movements and activities which are unfamiliar to the individual and outside their functional repertoire.

To make a point by way of exaggeration: imagine prescribing an extra-functional exercise such as soccer to a tennis player recovering from a leg injury. This management would seem misplaced and ineffective. Similarly, it would be considered unsuitable to prescribe tennis for a runner with leg injuries or to prescribe rock climbing for a tennis player with shoulder injuries. Yet, paradoxically,

it is common to see an extra-functional exercise prescription which bears no resemblance to the activities the individual aims to recover (termed *goal activity*). For example, patients with low back conditions are commonly prescribed extra-functional exercise such as core stability training on the floor or exercise ball, complex stretching, strength training with gym equipment or resistance bands, and so on. All these activities bear no resemblance to the functional repertoire of most individuals. Traditional rehabilitation literature and training practices are dominated by extra-functional management. It seems that the more outlandish the exercise is and the further it is from recognizable functional activities, the more therapeutic value is placed on it. But how useful are these extra-functional approaches for rehabilitating the functional repertoire, activities such as getting out of a chair, standing, walking, and so on? How close does the remedial exercise need to be, in order to benefit the goal activity the person aims to recover?

For close on a century, research has been exploring how similar the training and the goal activity have to be. The message so far from the sciences is very clear: there are greater benefits when the prescribed exercise closely resembles the goal activity. Even minor dissimilarities between the two can reduce the carry-over (transfer) of training gains to the goal activity. This phenomenon was observed in skill acquisition, and human and sports performance, as well as movement rehabilitation (see Chapter 7).[12] For example, in stroke rehabilitation, recent guidelines recommended that interventions should favor task-specific training.[13] Importantly, it was noted that improvements are mostly within the functions and activities a person has been trained in; essentially, we only learn or improve what we have practiced (we are unlikely to learn or improve something we have not practiced). A similar ineffective carry-over of training gains was reported in a recent review of functional rehabilitation in the elderly.[14] It was found that the commonly prescribed resistance exercises (extra-functional) have a limited contribution to activities of daily living, whereas a functional rehabilitation was shown to be more beneficial.

There are occasions when transfer of training gains is seen between dissimilar activities; however, they tend to be rare and unpredictable.[12] Hence, a functional approach removes this uncertainty and simplifies the selection of prescribed exercises. Essentially, if the training is in the form of the goal activity, it tends to minimize the reliance on transfer. It also dramatically simplifies the management!

Benefits of functional versus extra-functional management

There are several important benefits in a functional exercise management in comparison to an extra-functional one. A functional approach uses the individual's own movement resources and therefore does not require additional learning and ongoing instruction. On the other hand, extra-functional exercises are unfamiliar to the individual. The individual has to learn a new set of activities at a time when they are least able to – often, when they are experiencing pain and loss of movement capacity. Learning requires set-aside time, intense mental focus, and physical effort. Extra-functional approaches create an unfavorable situation in which the individual is highly dependent on others for instructions and guidance, at least during the training period. We have to keep in mind that 40–80% of medical instructions are forgotten immediately after the session, and 50% remembered incorrectly; the more we pile on the information, the less is remembered.[15,16] Considering all these factors,