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Viewpoint

Optimising motor adaptation in childhood obesity

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Introduction

Childhood obesity is a major public health concern. According to the World Health Organization, more than 22 million children worldwide are classified as overweight (WHO, 2009). In Australia, the most recent data available show that 4.5% of boys and 5.5% of girls ages 2–18 years old are obese (Magarey & Daniels, 2001). Cutoffs for body mass index, weight in kilograms divided by height in metres squared, ≥ 30 kg/m^2 for obesity are universally accepted for adults. International cutoffs for obesity designed for children (Cole, Bellizzi, Flegal & Dietz, 2000) use age, gender and body mass index to define obesity (e.g. the cutoff for a 2-year-old boy is 20.09 kg/m^2, whereas the cutoff for a 17½-year-old girl is 29.84 kg/m^2).

Current research on the role of occupational therapy in addressing childhood obesity has focussed on weight loss, weight gain prevention, or increases in physical activity by restructuring environments and routines (Ziviani, Desha, Poulsen & Whiteford, 2010). However, weight loss is not immediate. Examining how to maintain children's safety during weight loss is important. Obesity affects children's ability to maintain safety (Bazelmans *et al.*, 2004) while performing their occupations. Impairments in motor adaptation, altering actions to cope with continuously changing environments, result in increased safety risks for children who are obese. They also influence occupational performance, 'the ability to perceive, desire, recall, plan and carry out roles, routines, tasks, and subtasks for the purpose of self-maintenance, productivity, leisure and rest in response to demands of the internal and/or external environment' (Chapparo & Ranka, 1997, p. 58). Although improving motor adaptation can potentially be important for any client receiving occupational therapy services, it is not currently represented in the literature as a factor to consider in occupational therapy intervention for childhood obesity.

The purpose of this article was to describe how impairments in motor adaptation impact occupational performance for children who are obese and to use constructs from the Occupational Performance Model (Australia) as guidelines for improving motor adaptation with occupational therapy intervention for children who are obese. The Occupational Performance Model (Australia) uses constructs that conceptualise occupation. Viewpoints in this article on how motor adaptation is affected by childhood obesity are based on an electronic search of key databases (Pubmed, Google scholar, PsycINFO, ISI Web of Knowledge and Medline) conducted using three main search terms (i.e. motor adaptation and childhood obesity, adaptive movement patterns and childhood obesity, childhood obesity and adaptation). The role of occupational therapy with children who are obese should include addressing how to minimise injuries by improving motor adaptation in the context of children's occupational performance.

Occupational performance roles

The Occupational Performance Model (Australia) defines occupational performance roles as 'patterns of occupational behaviour composed of configurations of self-maintenance, productivity, leisure, and rest occupations' that are 'determined by individual person-environment-performance relationships' and 'established through need and/or choice and modified with age, ability, experience, circumstances, and time' (Chapparo & Ranka, 1997, p. 58). Roles that children participate in include those of students, playmates and extracurricular activity participants. An aspect of each of these roles involves engaging in activities that require modifying movements to adapt to environmental changes. As students, children spend time at school involved in movement such as during gym class. As playmates, children engage in structured and unstructured movement with their peers. As extracurricular activity participants, children participate in formal activities involving movement such as playing on a soccer

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team. Each role has demands for performance. Impairments in motor adaptation affect occupational performance roles for children who are obese.

Occupational performance roles have three dimensions defined as doing (carrying out routines), knowing (understanding external expectations of performance), and being (feeling satisfied with role performance). Obesity can influence children's ability to know how to perform roles and to learn how to meet external expectations of performance. Children who are obese have limited opportunities to improve motor skill and to amass motor experience. Overall, they spend more time engaging in sedentary activities (Andersen, Crespo, Bartlett, Cheskin & Pratt, 1998). Trouble acquiring appropriate levels of motor skill and experience impair adaptation to occupational demands (Slining, Adair, Goldman, Borja & Bentley, 2010). Increased levels of motor skill and experience may improve doing and knowing in the context of roles. Obesity also affects children's levels of satisfaction or being when performing roles. Children who are obese experience a sense of loneliness due to frequent participation in sedentary activities alone (Meriaux, Berg & Hellstrom, 2010).

Occupational performance areas

For children who are obese, impairments in motor adaptation can be considered relative to their occupations for productivity/school and leisure/play occupations. Occupations can be graded according to subtasks (portions of tasks), tasks (sequences of subtasks), and routines (sequences of tasks) (Chapparo & Ranka, 1997). At school, students participate in activities that require motor adaptation. Obesity impacts the ability to structure and time movements according to task demands without compromising safety (Bazelmans *et al.*, 2004; McGraw, McClenaghan, Williams, Dickerson & Ward, 2000). Tasks become more complex when movements must be coordinated with implements used for routines such as balls used in soccer games. Children frequently engage in motor activities requiring adaptation as part of leisure activities alone or in groups. An example includes dodging other players on a field to score a goal on a soccer team.

Occupational performance components

Underlying biomechanical and cognitive components affected by obesity can impede obese children's ability to perform routines and tasks. Children's ability to perform these routines and tasks involves an assumption that they have the necessary physical and cognitive resources.

Biomechanical

Childhood obesity leads to biomechanical and musculoskeletal impairments. Most of the research about these impairments relates to walking, which is an everyday activity used to perform roles. Compared to their non-obese counterparts, children who are obese demonstrate movement impairments. They walk more slowly, take more steps per minute, keep both feet on the ground for longer periods of time (Hills & Parker, 1992), and are less stable (McGraw *et al.*, 2000). These impairments threaten children's ability to recover from a loss of balance to prevent falls. Obesity affects musculoskeletal structure. Although more weight is usually linked to increased bone development, obese children have lower bone mass and bone surface area when their weight is corrected for based on their maturational age. Obese children's decreased activity levels contribute to decreases in bone mass and strength (Goulding *et al.*, 1998). Decreased bone strength and having a high degree of force during a fall put obese children at risk for fractures (Goulding *et al.*).

Cognitive

Cognitive processes are needed to plan adaptive movements to fulfill roles during productivity and leisure. Obesity is correlated with poor cognitive functioning (Miller *et al.*, 2009). Several reasons may underlie the correlation between obesity and children's cognitive functioning. First, impaired metabolic processing may affect brain structures responsible for planning and organisation. For example, typical cognitive functioning, especially in the cerebellum, helps in planning movements. Recent imaging studies suggest that childhood obesity may be related to reduced cerebellar functioning (Miller *et al.*, 2009). Second, a lack of physical activity may decrease oxygen flow to the brain and impair spatial abilities needed to plan movements. Studies have linked childhood obesity and decreased physical activity to decreased cognitive functioning (Li, Dai, Jackson & Zhang, 2008). The correlation between obesity and cognition may affect planning adaptive motor movements.

Core elements of occupational performance

The body is a core element that affects motor adaptation needed to perform roles in order to be productive and to participate in leisure (Chapparo & Ranka, 1997). The body element refers to the body's intrinsic physical elements such as tissue or muscle integrity and acknowledges that this influences occupational performance. Physical pathologies linked with obesity are body elements that affect occupational performance for children who are obese. Obesity affects the body and influences occupational performance.

External environment

As motor adaptation involves tailoring movements to meet environmental demands, the physical environment

largely affects adaptive movements. Childhood obesity is associated with increased risks of injury (Bazelmans *et al*., 2004). To maintain safety, children must alter movements to cope with changing physical environments. Obesity in childhood causes impairments in the occupational performance components needed to adapt to the physical environment. These impairments can subsequently lead to injuries such as falls while fulfilling occupational performance roles.

Suggestions for occupational therapy intervention

Table 1 summarises how motor adaptation for children who are obese can be viewed in relation to constructs in the Occupational Performance Model (Australia). These constructs highlight areas that can be used to set appropriate goals, to create interventions, and to measure outcomes. Occupational therapy intervention should include the understanding that these constructs occur in relation to space (positive or negative aspects of physical space or children's view of motor adaptation experiences) and time (children's past experiences of motor adaptation and times of day when experiences occurred) (Chapparo & Ranka, 1997).

The Occupational Performance Model (Australia) can be used to help occupational therapists improve safety for children who are obese by improving motor adaptation. Preparation for occupational therapy intervention using this model could involve determining the level of intervention required to improve motor adaptation at the subtask, task, and routine level and selecting the appropriate level of intervention based on identified areas and components of need. The nature of intervention could involve working to refine motor adaptation routines, working on tasks and subtasks of motor adaptation that require massed practice, and working on component skills identified as major contributing factors to impairments in motor adaptation. The focus of occupational therapy intervention should be to use roles and occupations meaningful to children who are obese as a context for improving motor adaptation.

Occupational therapists are well suited to helping children who are obese adapt movements to meet occupational performance demands. Several factors make motor engagement in occupational therapy intervention unique from approaches used by other allied health professionals (e.g. physiotherapists) and from other activity programs (e.g. community activity programs). First, the suggested intervention approaches for motor adaptation involve shaping children's movements during meaningful activities based on children's occupational performance roles. Instead of practicing exercises in de-contextualized situations, occupational therapy intervention would structure and grade children's motor engagement embedded in meaningful occupations. Work on components or tasks in motor adaptation should be done with an awareness of how occupational therapy can optimise children's performance of their occupational roles. Second, the recommended approaches differ from those used in community activity programs. Community activity programs have achieved impressive success in

TABLE 1: *Use of Occupational Performance Model (Australia) to improve motor adaptation in childhood obesity*

Occupational performance constructs related to motor adaptation
Occupational performance roles
• Student
• Playmate
• Extracurricular activity participant
Occupational performance areas
• Productivity/School
Examples of routines
– Playing a soccer game in gym class
Examples of tasks and subtasks
– Speed or timing of movements
– Accurately executing movements
– Coordinating movements with objects (e.g. soccer ball)
• Leisure/Play
Examples of routines
– Participating in organised classes (e.g. ballet)
Examples of tasks and subtasks
– Speed or timing of movements
– Accurately copying movements based on verbal directions
Components of occupational performance
• Biomechanical
Examples of biomechanical components
– Balance
– Muscle strength
– Bone strength
• Cognitive
Examples of cognitive components
– Problem solving
– Planning
– Judgement
Core elements of occupational performance
• Body
Examples of body element
– Effects of biomechanical impairments
External environment
• Physical
Examples of physical environment
– The size of the gymnasium used for a soccer game in gym class
– The presence of mirrors on the walls in a ballet studio

decreasing obesity in young children (de Silva-Sanigorski *et al*., 2010), but do not address how children who are obese can minimise injury risks while they are losing weight. The current proposed focus for occupational therapy intervention is to engage children who are obese in meaningful physical activities to improve their ability to adapt movements and improve safety. Therefore, the current recommendations do not contradict those of community activity programs, but could be used in combination with them.

Summary and future directions

Not all aspects of the Occupational Performance Model (Australia) were addressed due to the absence of research establishing links between motor adaptation in childhood obesity and each of the model's constructs. Future research is needed to understand how motor adaptation impairments for children who are obese affect social, cultural, and sensory environments, self-maintenance and rest, sensory-motor, intrapersonal and interpersonal components, as well as mind and spirit elements. Addressing these points can enhance client-centred and occupation-based interventions to improve motor adaptation in children who are obese.

This article provided suggestions for how occupational therapy intervention can improve motor adaptation for children who are obese. The article outlines how the Occupational Performance Model (Australia) can be used to determine the scope required for adequate assessment of occupations involving motor adaptation, how motor adaptation can be analysed relative to differing levels of occupational performance, and offers suggestions for the preparation and nature of occupational therapy intervention.

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