



Usefulness of Core Stability Exercise for Postural Control in Children with a Developmental Coordination Disorder

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Abstract

Purpose of the review: Developmental coordination disorder (DCD) is a condition that interferes with daily life due to impaired motor coordination. The school-age motor function problems were associated with the quality of life at school. Motor coordination is a function that is based on postural control. Therefore, evaluating and improving postural control is crucial to enhance motor coordination in children with DCD. This review aims to propose a support method that is focused on maintaining and improving postural control in children with DCD.

Recent findings: Balance, strength, video games, taekwondo, and tai chi training help improve balance abilities in children with DCD. Conversely, anticipatory postural adjustments (APAs) contribute to postural readiness, which is required for exhibiting the power to move and appropriately respond to perturbation. Children with DCD demonstrated poor APAs compared with typical developing children. Additionally, the abnormality in trunk muscle activation for APAs has been observed in children with DCD. Moreover, body functions generally grow from proximal trunk movement to distal site movement in terms of motor development. Thus, proper trunk muscle activation is crucial for postural control in children with DCD. Some studies have revealed that core stability exercise improved motor proficiency (including coordination or balance items, etc.), and a core stability group program enhanced balance ability in children with DCD. However, only a few studies report on the associations between core stability exercise and postural control.

Summary: Core stability exercise may be effective for postural control in children with DCD, but we should clarify the effect of core stability exercise on the postural control, which is associated with APAs, including trunk activities in children with DCD in future studies due to insufficient research.

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Introduction

Developmental coordination disorder (DCD) is a condition that interferes with daily life caused by impaired motor coordination despite the absence of obvious paralysis or muscular disease according to the Ministry of Health, Labor and Welfare in Japan [1]. Coordinated movements that children with DCD have difficulty with have three main types: 1) exercise that uses the whole body, 2) exercise using hands and fingers, and 3) exercise to match eye movement with hand movement [2]. School-age motor function problems were associated with the quality of life at school [3], and children with DCD are more likely to exhibit depressive tendencies [4]. Thus, having motor function problems may be a crucial issue for children with DCD. This study aims to propose a support method that is focused on maintaining and improving postural control in children with DCD.

Recent findings

The predominant symptoms in children with DCD include clumsiness and delay in motor milestones (e.g., walking and crawling), related to poor balance and coordination [5, 6]. Reportedly, DCD is associated with disturbances in the internal model of the cerebellum [7]. Motor coordination is a function that is based on postural control [7]. The incidence rate of DCD in children aged 5–11 years old is 5%–6%. A high percentage (50%–70%) of these children still demonstrate symptoms in adolescence, and the children with attention-deficit hyperactivity disorder or learning disorder complicates DCD in 30%–50% and 50% of cases, respectively [2, 7]. Therefore, evaluating and improving postural control is particularly important to enhance motor coordination in children with DCD.

The intervention for postural control in children with DCD

Table 1 shows the summary of intervention effectiveness for postural control in children with DCD. A task-specific balance training (functional-movement training) improved the balance performance in children with DCD [8]. Additionally, the balance training circuit, including a trampoline station program, exhibited a positive effect on the balance performance [9]. Moreover, strength training improved static balance and muscle strength, but not dynamic balance [10]. Therefore, balance and strength training improved the balance abilities associated with postural control in children with DCD. Moreover, the children with balance problems (probable DCD) who had undergone Wii fit games demonstrated a change in balance after intervention [11]. Smits-Engelsman et al. reported that Wii fit games improved the abilities of balance items [12]. Thus, the intervention using video games could exhibit positive effects on balance abilities. Fong SS et al. revealed that taekwondo training improved standing balance [13, 14]. Additionally, tai chi training reduced the risk of falls in children with DCD [15]. Therefore, balance, strength, video games,

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Study (years)	Age (years, experimental group)	Intervention	Outcomes
Fong SS et al ⁸ (2016)	7.9 (average)	A task-specific balance training	Balance performance (+)
Giagazoglou P et al ⁹ (2015)	8.8 (average)	Balance training circuit including a trampoline station program	Motor coordination (+) Balance performance (+)
Kordi H et al ¹⁰ (2016)	8.0 (average)	Strength training	Static balance (+) Dynamic balance (-)
Jelsma LD et al ¹¹ (2014)	5-11 (range)	Wii fit game	Balance (+)
Smits-Engelsman BC et al ¹² (2015)	7.9 (average)	Wii fit game	The abilities in balance items (+)
Fong SS et al ¹³ (2012)	7.6 (average)	Taekwondo training	Standing balance (+)
Fong SS et al ¹⁴ (2013)	7.6 (average)	Taekwondo training	Standing balance (+) Reactive balance control (-)
Fong SSM ¹⁵ (2022)	9.9 (average) 9.8 (average)	Tai chi training Muscle power training	The risk of fall (+) The risk of fall (+)

Table 1: The summary of interventions effective for postural control in children with DCD
(+); improvement (-); no change
DCD; Developmental coordination disorder

taekwondo, and tai chi training could improve balance abilities among children with DCD.

Anticipatory postural adjustments (APAs)

Disturbance in the process of coordinating one’s imagined motion prediction with one’s body movements to execute one’s intended motion caused DCD [2]. Motor coordination is a function that is based on postural control [7]. APAs contribute to postural readiness, which is required for demonstrating the power to move and appropriately respond to perturbation [16, 17, 18]. APAs made prior to voluntary limb movements serve to maintain postural stability by supplementing for destabilizing forces related to limb movements [19]. The children with DCD demonstrated poor APAs compared with typical developing children [20]. Additionally, the abnormality in trunk muscle activation for APAs has been observed in children with DCD [18, 21]. Trunk stability is the foundation of postural control [7]. Therefore, improving trunk muscle activity for APAs may be important for changing the postural control in children with DCD.

The principles of motor development

Regarding motor development, orderliness exists, including 1) from involuntary to voluntary, 2) from gross motor to fine motor, and 3) from proximal trunk movement to distal site movement [22]. The feedforward activation of transversus abdominis is associated with arm movement [23]. Additionally, the trunk muscles, such as transversus abdominis, quadratus lumborum, and lumbar multifidus, demonstrated feedforward activation for shoulder movements [24]. Moreover, lumbar multifidus and erector spinae are associated with feedforward activation leg landing [25]. In particular, proper limb movement may require proper trunk activity. Therefore, proper trunk muscle activation is important for postural control in children with DCD, even from the perspective of the principle of motor development.

The effect of core stability exercise on postural control in children with DCD

The participants with stroke were targeted, but core stability exercise improved the abilities of APAs [26]. Additionally, core stability exercise could have positive effects on postural control and

motor coordination in children with DCD. Some previous studies have revealed the association of core stability exercise with postural control or motor coordination in children with DCD. Au et al. (2014) reported core stability exercise as effective, similar to task-oriented training (e.g., standing, walking, hopping), for improving motor proficiency (including coordination or balance items, etc.) with Bruininks–Oseretsky Test of Motor Proficiency Second Edition (BOT-2) Short Form in children with DCD [27]. Additionally, a core stability group program improved balance ability in three children with DCD [28]. Moreover, a core stability program improved the balance ability in adolescents with DCD (average 12.9 ± 8.3 years) [29]. The combined core stability and coordination exercise improved motor coordination and balance in children with DCD [30]. However, only a few studies reported on the associations between core stability exercise and postural control; thus, more knowledge is required in future studies.

Summary

Few studies have investigated the effects of postural control on core stability exercise in children with DCD. Conversely, some reports have demonstrated that the core stability exercise improved postural control in children with DCD. DCD is related to disturbances in the internal model of the cerebellum [7, 31]. APAs contribute to postural readiness, which is required for demonstrating the power to move and appropriately respond to perturbation [16, 17, 18]. Children with DCD exhibited poor APAs compared with typical developing children, and the abnormality in trunk muscle activation for APAs has been observed in children with DCD [18, 20, 21]. The school-age motor function problems were associated with the quality of life at school [3], and children with DCD may demonstrate depressive tendencies [4]. Therefore, we should determine the effect of core stability exercise on the postural control, which is associated with APAs, including trunk activities, in children with DCD in future studies.

Competing Interests

The author declares that there is no competing interests regarding the publication of this article.

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