AUCTORES
Globalize your Research

Clinical Research and Clinical Trials

Theofilidis Antonis *

Open Access

Review Article

Developmental Motor Coordination Disorder Gross and fine motor skills of preschool, school-age and adolescent children

Theofilidis Antonis[1*], Katsarou Dimitra[2]

1 Aristotle University of Thessaloniki, 2 Aegean University

2 Department of Psychology Aristotle University of Thessaloniki 54006, Thessaloniki, Greece

***Corresponding Author:** Theofilidis Antonis, Department of Psychology Aristotle University of Thessaloniki 54006, Thessaloniki, Greece.

Received date: May 12, 2025; Accepted date: May 23, 2025; Published date: June 23, 2025

Citation: Theofilidis Antonis, (2025), Developmental Motor Coordination Disorder Gross and fine motor skills of preschool, school-age and adolescent children, *Clinical Research and Clinical Trials*, 12(5); **DOI:10.31579/2693-4779/270**

Abstract:

As described in the latest edition of the Diagnostic and Statistical Manual of Mental Disorders (DSM-5) of the American Psychiatric Association, the child with Developmental Motor Coordination Disorder (DMCD), has motor coordination below that expected for his or her chronological age, may be described as "clumsy," and may have a delay in early motor milestones such as walking and crawling. Children with DMCD experience a range of difficulties in posture, movement, and coordination without the presence of neurological, cognitive, or musculoskeletal causes. In the previous DSM edition (DSM-IV-TR), developmental coordination disorder was included under the broad category of "learning disorders," whereas in DSM-5 it is a subscale, categorized as a movement disorder within of the broader category of "neurodevelopmental disorders."

The main objective of this study is to present the basic elements of DMCD.

Keywords: coordination disorder; fine motor skills; preschool; school-age; adolescent children

Introduction

Movements have been divided into those due to subconscious reflexes and those related to intentional action. Reflex movements are automatic involuntary responses to various types of external stimuli. They appear from the womb and persist during the first year. They are divided into survival reflexes and positional reflexes, and are equally important for adults as for infants. As the central nervous system (CNS) matures, reflex movements subside, as voluntary movement emerges. Voluntary movement is the result of signals transmitted through a communication channel that connects the inner world in our minds with the physical world around us. Intention can be viewed as the desire for change in the environment, which is included in the signals from the brain, from the nervous system to the muscles, and creates displacements and forces in the environment.

Voluntary movements are the result of cognitive processes that lead to the performance of an action/activity. These processes are not clearly defined or understood, which makes it difficult to develop specific, rigorous models to describe how they work (90). The development of a skill (e.g., gross and fine motor skills) depends on the maturation of the nervous system, with the result that a child, for example, cannot walk if his nervous system is not yet mature for this function. Each of these skills is characterized by various stages of development, which are called milestones and are the same in all children. However, significant differences in the rate of development can be observed of different abilities from one child to another. For example, a child must learn to sit before walking, but the age at which they will sit and walk varies considerably. The different abilities develop in parallel. In typically developing children, one ability may be a few months behind others, but it is rare for all abilities to be delayed.

Motor skill is a learned, goal-directed activity that is achieved through muscular contributions to action and involves a wide range of human behaviors. Motor skills cover a range of behaviors that are primarily achieved through the coordination of limbs and body parts caused by the participation of muscles. Motor skills contribute to the achievement of a specific task with the aim of environmental adaptation. Although each skillful behavior involves combinations of cognitive, perceptual, and motor processes, with varying degrees of importance, motor skills refer to muscular performance, which is decisive for the achievement of the goal. Motor skills can be learned and are not the result of the activity of reflexive or inherited natural abilities. They range from simple actions that are easily learned to complex ones that require long periods of practice.

In 1952, Guthrie gave a definition of motor skills in terms of the characteristics that distinguish performers of different levels of skill. Guthrie's position was that all motor skills consist of the ability to produce some end result with maximum certainty and minimum expenditure of energy or energy and time. Specifically, it emphasizes the qualitative aspect of motor skills, i.e. the ability of different individuals to perform the same skill with different quality of performance. In Guthrie's definition, there are three characteristics that distinguish non-skilled from skilled performers: 1. Maximum certainty of goal achievement, 2. Minimum energy expenditure, and 3. Minimum movement time (40).

Motor behavior refers to the nature and causes of human movement. The term denotes the physiological (motor) and psychological (behavioral) aspects of movement. The term motor behavior, as an umbrella, encompasses the cognitive and theoretical approaches of the sciences of motor development, motor learning, and motor control. Such movements and motor skills include the movement of the body in space (locomotion), posture and balance, and manipulation (gestures, kicking a ball). Movements can be slow, deliberate, and intense with concentration. Movements can be automatic that may require little or no thought. Goal-directed movements, whether small or large, combine behavioral and physiological elements. The physiological component, motor control, primarily concerns the systems that perform movements, mainly the motor and sensory neurophysiological systems and the musculoskeletal systems. The behavioral component, motor learning, emphasizes the role of the mind in the acquisition (learning) of movement planning, initiation, and modification and how cognitive processing and behavioral states regulate the quality of movement. In fact, the control and behavioral components work in concert with each other as neurophysiological systems provide the living structures for behavioral functions (38).

Motor development concerns physical, cognitive, physiological, motor, psychological changes during development and refers to the process, that is, the techniques of performing movements, but also to the final result of the execution, which is the performance of the movement. Motor development is related to but not identical to age. The difference from motor learning is that it concerns the acquisition and maintenance of skills that depend on practice and not on maturation or biological development. Thus, two individuals of the same age-development theoretically have the same ability to perform-learn. However, this also depends on the previous experiences of each. Also, two individuals with the same amount and quality of practice but of different ages do not have the same performance ability, because they have a different level of development. The most important points of motor development are that motor development is continuous, systematic and delimited through stages. Motor development is related to and independent of age, studies the process (mechanisms) of change and studies the outcome of performance.

Motor learning is the process of acquiring an ability to produce skilled actions. It occurs as a direct result of practice and not due to maturation or physical changes. Motor learning cannot be observed directly and leads to relatively permanent changes in the ability to perform a skilled behavior. Learning is defined as a relatively permanent change in the ability to perform a motor skill as a result of practice or experience. Performance, the action of performing the motor skill, is a permanent or non-permanent change and should not be confused with the concept of learning. The first characteristic of motor learning is that a process is required to cause a change in the ability of the individual to perform the skill. A process is defined as the set of events or occurrences that result in a change in the situation. The second characteristic is that motor learning must occur as a direct result of practice. The change due to maturation is a change in motor development. For example, the beginning of walking is motor development, not motor learning, as it is a motor skill common to all humans. In contrast, learning a sport requires practice and is due to motor learning. Motor learning cannot be observed directly.It can be considered as a possibility based on long-term changes in performance (34).

Motor control examines motor behavior from the perspective of the systems that control movement. Specifically, it studies human movement in terms of its neurological, physiological, and behavioral dimensions, the nervous systems involved, the coordination and control of the limbs or body, the involvement of joints, muscles, and neurons, and the movement control processes assessed by reaction time. Motor control studies how the neuromuscular system functions to produce coordinated movement during the learning of a new skill and during the improvement of an already acquired skill. It also studies the synchronization of perception with movement, the degrees of freedom – constraints, the sequence, and the timing of motor behaviors (35).

Gross and fine motor skills of preschool, school-age and adolescent children

The terms gross and fine motor skills are used to describe types of movement. Gross movements are controlled by large muscles or large muscle groups. These muscles are integral to producing a range of movements, such as walking, running, and jumping. Fine movements are controlled by small muscles or muscle groups. Many hand movements are considered fine movements because the small muscles of the fingers and wrist are critical to producing finger movements. Therefore, activities such as drawing and writing are considered fine movements. Although there is a distinction between gross and fine movements, few are controlled exclusively by either small muscles or large muscle groups. For example, writing is considered a fine motor movement, but as with most fine movements there is a gross motor component.

In addition, the large muscles of the shoulder, which are necessary for the correct positioning of the hand, are required before the finer movements carried out by small muscles can be effective. A combination of large and small muscle groups is also responsible for the production of gross movements. For example, throwing an object is considered a gross movement, as while it originates from the shoulder and legs, it requires adjustments in the fingers and wrist for reasons of precision (31).

Preschool (36-60 months) - Gross Mobility

By the age of three, children have improved significantly in balance and do not need to look at their steps as they walk. They are able to descend stairs with alternating feet. Bayley (1935) found that 50% of three-year-old children could walk three meters on a thin line without falling and had the ability to balance on one foot for 3-4 seconds. The ability to bounce on the spot or not has not yet been fully achieved but partially and changes during preschool age. A three-year-old child can jump on one foot without

rhythm and precision. Accordingly, throwing a ball by a three-year-old child is done with the palm facing down, turning the body but without the ability to transfer its weight. At this age, the child can achieve a throw at a distance of about two meters. The three-year-old child catches the ball with straight arms, without bending the elbows. At 4 years, children acquire the ability to walk in a circular line, while at 4-5 years they can achieve a movement that combines bouncing and walking (galloping). The child's ability to jump with both feet develops more in preschool age. The four-year-old child can jump on one foot while limping up to 4-6 steps. Regarding throwing and catching a ball, the four-year-old child can achieve weight transfer during the first and arm extension, but with stiff elbows, during the second. At five years, the child can balance on one leg for 3-5 seconds. In running activities, he acquires coordination and speed as well as smooth reciprocal movement of the arms, as a result of which he can run fast (3.5 meters per second). He can limp 8-10 steps. When catching a ball, the child has his arms at his sides and can make the necessary movements to catch it. A five-year-old child can catch a large ball that bounces off the floor at a distance of 4.5 meters 75 percent of the time (33).

Fine Motor Skills

A three-year-old child can build a tower with 10 blocks, is able to copy a cross and a circle, while a four or five-year-old child can copy a square and a triangle. The use of scissors is tested by the preschooler, but not with precision until the first school year. The drawings of preschoolers begin to make sense. In preschool, they can build complex structures with cubes and blocks and they can throw small objects into containers (such as a piggy

bank) with good speed. Fine movements at this age become more evident in drawing and writing.

Between the ages of four and six, the child develops a dynamic tripod pencil grip, where he uses the thumb, index and middle finger to grasp the pencil or marker with the ring and little fingers to provide additional stability. The writing instrument is held in the position most adults use.

This way of grasping with the fingers allows for highly coordinated writing movements.

The four-year-old child makes recognizable drawings, while the five-year-old child now makes drawings with well-formed lines and an enriched design and is able to copy recognizable letters.

An additional skill that the child demonstrates at five years of age is the slow-speed finger-thumb contrast, where the child now has the ability to grasp each finger with the thumb.

School age (6 years – 10 years)

Rough movement

Children at the age of six acquire physical strength and agility. They have the ability to run, jump over obstacles with good balance, and kick a ball six meters away. Similarly, in upper limb skills, they can catch and throw a ball with accuracy, as well as ride a bicycle, possibly without training wheels. Children at the age of seven can limp and walk on a thin line with their arms outstretched for balance. They ride a bicycle without training wheels or roller skate. They can jump over obstacles with skill. They have increased endurance, which is evident in activities such as swimming, roller skating, gymnastics, and martial arts. They can control their speed when running and maneuver to avoid obstacles. They throw and catch a ball with one hand with skill. Children aged 8-9 have increased physical strength and coordination, as well as fast reaction time. They ride a bike with ease and can jump freely. They enjoy active, energetic games and sports and enjoy participating in competitive sports. Children aged 10-11 differ in physical maturation, as girls experience puberty earlier. Their body proportions are similar to those of adults.

Fine motor

Six-year-old children dress themselves, tie their shoelaces, their writing is clear, copying all the letters, and their dexterous movements have improved.

Seven-year-old children are able to build a tall and straight tower with small blocks. They are more proficient in their handwriting skills, where the letters are clear and the uppercase and lowercase letters are the right size.

They are able to draw human figures with a head, body, hands, fingers, and clothing, and they are able to use a large needle to sew with thread.

8-9-year-old children have more control over their small muscle groups and write and draw with greater dexterity. The human figures in their drawings consist of details in the clothing and facial features. They color in a more natural way, adding depth with shadows, three-dimensional shapes, and begin to connect letters.

Children aged 10-11 do more detailed work, such as sewing and woodworking. They have an established style of writing, usually with joined letters (36).

Adolescence (11 years-18 years)

According to the definition of the World Health Organization, adolescence is the age of 11-19 years, while the American Academy of Pediatrics sets the upper age limit at 21 years. Differences in motor skills between the sexes become apparent in adolescence, where adolescent boys outperform adolescent girls in most activities. Puberty begins naturally for girls between 8 and 14 years of age and for boys between 9 and 14.5 years of age. The process of pubertal changes lasts a total of 4 to 7 years. Girls grow about 23.5 cm in height and 20 kg in weight, and boys grow about 26.4 cm in height and 18 kg in weight during this time. The growth spurt begins with the growth of the limbs and neck, followed by the growth of the hips, chest, shoulders, and trunk. Head circumference also increases during pubertal growth. Temporary clumsiness may develop due to the rapid skeletal changes.

Developmental motor coordination disorder

Developmental motor coordination disorder and overweight/obesity are of increasing importance in the study of human development, mainly because both conditions are associated with a range of comorbidities. The term developmental motor disorder is used to describe the motor difficulties experienced by children that are not due to a neurological condition affecting movement (e.g. cerebral palsy, muscular dystrophy, degenerative disorder). These motor difficulties concern gross and fine motor skills and the onset of symptoms is observed early in the developmental period. It is a disorder that affects 6% of the general population, and is considered one of the most common problems in school-age children worldwide.

Colier referred to DMCD as congenital clumsiness. In 1966, a child psychiatrist and psychologist described it as childhood dyspraxia, using constructional apraxia in adults as a reference and defined it as a disorder of physical integration (46). Dyspraxia has been defined as an impairment of action and the inability to use voluntary motor skills effectively in all aspects of life, from play to structured skilled activities. Among the medical and scientific communities, dyspraxia is generally considered to mean a disorder or difficulty in organizing, planning, and executing movement that is developmental rather than acquired in origin. Most individuals with dyspraxia exhibit a combination of ideation or planning dyspraxia and ideomotor or executive dyspraxia. Ideation or planning dyspraxia affects planning and coordination, and ideomotor or executive dyspraxia affects the flow and speed of motor skills (47)The act includes:

1. Ideation, which is the ability to mentally plan a motor goal and think about how to reach the goal.

2. Motor planning, which is the ability to intentionally plan and sequence the motor actions needed to reach the goal.

3. Motor coordination, which allows the individual to achieve movements with precision.

4. Feedback, which involves the recognition of a successful attempt at a goal and the appropriate further action (correction).

Clinical features and Cognitive subcategories DMCD

A significant body of literature describes the cognitive limitations of children with ADHD, revealing a profile of cognitive dysfunction that can be attributed to a damage to the information processing system (visual-perceptual, attention, planning or working memory, and learning deficits). According to the results of the study by Asonitou and colleagues (45), with the aim of identifying the cognitive subtypes of preschool children with ADHD, six subtypes emerged, with two (YT2, YT3) of them being children without ADHD. The above types are: YT1 = children at risk (who face significant difficulties with the ability to bounce, minor difficulties in manual dexterity and simultaneous coding), YT2 = children who belong to the average (all cognitive - motor abilities are close to the average), YT3 = without cognitive - motor problems (all scores above the average), YT4 = difficulties in manual dexterity, planning and simultaneous coding difficulties, YT5 = difficulties in manual dexterity, dynamic balance and planning difficulties, YT6 = generalized dysfunction in the cognitive and motor domain (all scores significantly below the average). Furthermore,

Marie Farmer, Bernard Echenne, M'hamed Bentourkia(44) found that ASD occurred in 3.17 boys for every one girl, all children with ASD were characterized as slow, 47% were left-handed or ambidextrous, 36% and 26% had orofacial and verbal dyspraxia, respectively, 83% were found to be anxious, and 84% of the children were described as clumsy.

Factors responsible for the development of DMCD

There is no single factor that causes DMCD, and its etiology is unknown. Various causes of DMCD have been investigated at different levels of analysis, and a wide range of approaches attempt to identify the source of the difficulties experienced by children with DMCD was originally considered a form of "minimal cerebral dysfunction" (MCD), a term used to describe a set of symptoms reflecting deficits in learning, attention, and motor coordination. DMCD was later replaced by the "minimal neurological dysfunction" complex, which reflects a distinct form of acquired perinatal dysfunction, which is probably associated with a structural brain deficit (53). Premature birth and low birth weight have also been associated with DMCD. Conditions associated with prematurity are considered important predisposing factors. Gubbay, in 1985, suggested that children with DMCD have a history of perinatal abnormalities, especially those with severe motor problems, and Johnston, Short, and Crawford described a higher incidence of perinatal complications (especially jaundice), low birth weight, and a higher incidence of prematurity in a sample of children with poor coordination (32). A recent study (54) found that DMCD is a common problem in 8- to 9-year-old children with extremely low birth weight (-800 g). Specifically, of the 73 children with extremely low birth weight, (51%) were diagnosed with DMCD likely (43%) to have learning difficulties than children with low birth weight who did not have DMCD.

Zwicker (51) and Bo and Lee(52) reviewed the behavioral evidence for the neural correlates of ASD, exploring the dominant hypotheses and their relationships to motor skill production and learning in children with DMCD, leading to the identification of three major brain bases of DMCD: the cerebellum, the basal ganglia, and the parietal lobes. Given the cerebellum's role in motor coordination and posture and control, it is not surprising that it may be implicated in the neuropathology of DMCD. Mild neurological signs suggest cerebellar involvement, as children with DMCD do not perform well on traditional tests of cerebellar function, such as finger-to-nose touch and rapid alternating hand movements. For now, DMCD is one of the disorders that can be characterized as a deficit in brain function that can be triggered by various causes.

Comorbidity

Evidence suggests that ADHD is a unique and distinct neurodevelopmental disorder that often coexists with one or more other neurodevelopmental and neurobehavioral disorders, such as attention deficit hyperactivity disorder. Their co-occurrence with ADHD has been documented by several studies, with 50% of children with ADHD also diagnosed with ADHD (7, 74, 69). In addition, dyslexia and specific language disorder are common disorders in children with ADHD(69), with language disorder having been shown to be co-morbid in up to 70% of children with language problems. Furthermore, there is frequent co-morbidity between ADHD and reading and writing disorders(75). The findings of the research by Deborah Dewey, Bonnie J. Kaplan, Susan G. Crawford, Brenda N. Wilson(48) showed that all children with movement problems are at risk for attention, learning, and psychosocial adjustment problems.

Furthermore, ADHD has been associated with difficulty in reading, spelling and social communication (73). Kadesjo and Gillberg(74) in their study found that half of the children with ADHD had significant attention problems and that ADHD was associated with reading comprehension problems at age 10. Similarly, the study by Lucia Margari and colleagues (71) showed comorbidity with specific learning disabilities in 17.8% of a sample of 448 children aged 7-16. Recently, the coexistence of mood and anxiety disorders with ADHD has emerged in the literature (15,72). The coexistence of internalizing problems is often presented in the literature as a result of ADHD, rather than as disorders that share a common underlying pathology. There is strong evidence that ADHD is associated with many emotional, social, and specific learning disabilities.

In some children, however, it cannot be determined whether the behavioral problems are coexisting disorders or are the consequences of long-term negative experiences with clumsiness in everyday life. Kaplan and colleagues (76) question the term 'comorbidity' as there is a large overlap between ASD, learning disorders and ADHD. They prefer the term 'atypical brain development'.

Symptoms

Depending on the age of the child, different difficulties are observed. For example, at a younger age, difficulty may be observed in walking, while at an older age, difficulty in playing ball games.

A more general difficulty is observed in learning new motor skills, in developing coordination and in feedback. For example, if they hold the fork incorrectly, they will not be able to automate it and will hold it incorrectly again the next time.

They also have difficulty in succession / sequencing. Therefore, planning the movements needed to carry out an activity can be extremely difficult for them.

Difficulties in motor planning can make it quite difficult to learn the steps in self-care activities, such as brushing teeth, getting dressed, etc. Difficulty in balance can make it quite difficult for the child to sit still at the table and eat properly, e.g. prepare a bowl of cereal and milk.

Some symptoms during preschool age:

Difficulty using tools clumsiness incorrect posture when sitting difficulty playing ball games difficulty using scissors difficulty using a marker collision with other people or objects as an accident difficulty in self-care easy interruption

Some symptoms during school age: difficulty using cutlery slow speed in writing faint writing or not enough pressure on the pencil difficulty in self-care difficulty in planning or organizing letters

Diagnosis

ASD is usually recognized when a child's parents, caregivers, or teachers express concern about clumsiness and delays in gross and fine motor skills (65). Although parents are the ones who report overall gross motor development to the pediatrician, the pediatrician should use his or her own observations to detect possible ASD. Pediatricians often encounter children with motor delays in their clinical practice. The starting point should be a detailed medical history. This allows for mapping of behavior patterns and the impact of motor difficulties on daily functioning. During this event, it is important to gather information from more than one setting, where possible (e.g., home and school).

Questions for parents when a child is referred for possible ASD

· Was your child born prematurely? If so, how early?

· How much did your child weigh at birth?

· At what age did your child first walk independently?

· Would you (or anyone else) describe your child as "clumsy"?

· Does your child have difficulty with activities of daily living, such as getting dressed (including buttoning shirts and tying shoelaces), brushing teeth, and using a knife and fork when eating?

· At what age did your child learn to ride a bicycle (without training wheels)?

Does your child have difficulty with fine motor activities, such as writing, copying, or cutting with scissors? Does he/she switch hands while writing?

· Does your child have difficulty with gross motor activities, such as throwing or catching a ball, in competitive team sports at school or in the community, or in participating in physical education classes?

· Has anyone else in your family been diagnosed with a developmental coordination disorder, attention deficit/hyperactivity disorder, or specific learning disabilities?

Harris, S. R., Mickelson, E. C., & Zwicker, J. G. (2015).

Diagnosis and management of developmental coordination disorder. Canadian Medical Association Journal

Early diagnosis of children with Developmental Coordination Disorder can lead to the appropriate design of intervention programs, so that secondary problems, which may arise from the disorder, can be avoided. Appropriately weighted motor tests are used to assess the disorder. The most widely used test for the assessment of Developmental Coordination Disorder is the «Movement Assessment Battery for Children-2» (MABC-2, Henderson, Sugden & Barnett, 2007), which is the updated form of the motor test «Movement Assessment Battery for Children» (MABC, Henderson & Sugden, 1992), which has undergone modifications and improvements. The content of the "MABC-2" (Henderson, Sugden & Barnett, 2007) is consistent with the older test as studies of the reliability of the previous version can confirm the reliability of the updated version. The «Movement Assessment Battery for Children-2» is designed in such a way that it can be used by a wide range of professionals (physicians, physiotherapists, occupational therapists, psychologists, physical education teachers, etc.) (62)

Conclusions

Developmental Coordination Disorder concerns difficulties identified in the development of motor skills and coordination and significantly affects the child's performance, especially in the areas of self-care and academic performance.

DMCD is now the current term often used to describe the image of children with difficulty in motor coordination. Previously, it was known as dysfunction in the perception of movement or as clumsiness.

It is an "umbrella" term that includes developmental dyspraxia, which is a specific type of DMCD. with more specific difficulties in motor programming.

It is not a specific learning disorder, such as dyslexia or dyscalculia. It is considered a neurodevelopmental disorder, such as ADHD, and can affect a child's school performance, as well as his performance in physical education. In general, children with DMCD have difficulty in several areas related to the learning process, such as writing, copying from the board, and organizing their things.

References

1. Bart, O., Daniel, L., Dan, O., & Bar-Haim, Y. (2013). Influence of methylphenidate on motor performance and attention in children with developmental coordination disorder and attention deficit hyperactive disorder. Research in Developmental Disabilities, 34(6), 1922-1927.
2. 90. Schwartz, A. B. (2016). Movement: How the Brain Communicateswith the World. Cell, 164(6), 1122-1135.
3. 48. Dewey, D., Kaplan, B. J., Crawford, S. G., & Wilson, B. N. (2002). Developmental coordination disorder: Associated problems in attention, learning,and psychosocial adjustment. Human Movement Science, 21(5–6), 905–918.
4. 40. William H. Edwards (2010). Motor Learning and Control: From Theory to Practice. Cengage Learning.
5. 38. Jeffrey C. Ives (2013) Motor Behavior: Connecting Mind and Body for Optimal Performance Lippincott Williams & Wilkins.
6. 34. Pamela S. Haibach, Greg Reid, Douglas H. Collier. Motor Learning and Development 2nd Edition With Web Resource. Human Kinetics.
7. 35 Morven Ball (2002) Developmental Coordination Disorder: Hints and Tips for the Activities of Daily Living. Jessica Kingsley Publishers.
8. 31. V. Gregory Payne, Larry D. Isaacs (2017). Human Motor Development: A Lifespan Approach. Routledge
9. 33. Wendy L. Votroubek, Julie Townsend (1997). Pediatric Home Care. Jones & Bartlett Learning.
10. 36. Carolyn Meggitt (2006) Child Development: An Illustrated Guide. Heinemann.
11. 46. Vaivre-Douret, L., Lalanne, C., Ingster-Moati, I., Boddaert, N.,Cabrol, D., Dufier, J. L., … Falissard, B. (2011). Subtypes of developmental coordination disorder: Research on their nature and etiology. Developmental Neuropsychology, 36(5), 614-643.
12. 47. Gibbs, J., Appleton, J., & Appleton, R. (2007). Dyspraxia or developmental coordination disorder? Unravelling the enigma. Archives of Disease in Childhood, 92(6), 534-539.
13. 53. Zwicker, J. G., Missiuna, C., Harris, S. R., & Boyd, L. A. (2012). Developmental coordination disorder: A review and update. European Journal of Paediatric Neurology, 16(6), 573-581.
14. 54. Zwicker, J. G., Missiuna, C., Harris, S. R., & Boyd, L. A. (2012). Developmental coordination disorder: A review and update. European Journal of Paediatric Neurology, 16(6), 573-581.
15. 32. Sharon A. Cermak, Dawne Larkin (2002) Developmental coordination Disorder. Cengage Learning.
16. 51. Zwicker, J. G., Missiuna, C., & Boyd, L. A. (2009). Neural correlates of developmental coordination disorder: A review of hypotheses. Journal of Child Neurology, 24(10), 1273-1281.
17. 52. (Bo, J., & Lee, C. M. (2013). Motor skill learning in children with Developmental Coordination Disorder. Research in Developmental Disabilities, 34(6), 2047-2055.
18. 75. Tseng, M. H., Howe, T. H., Chuang, I. C., & Hsieh, C. L. (2007). Cooccurrence of problems in activity level, attention, psychosocial adjustment, reading and writing in children with developmental coordination disorder. International Journal of Rehabilitation Research, 30(4), 327-332.
19. 69. Blank R, Smits-Engelsman B, Polatajko H, et al. European Academy for Childhood Disability. European Academy for Childhood Disability (EACD): recommendations on the definition, diagnosis and intervention of developmental coordination disorder (long version). Dev Med Child Neurol 2012;54:54-93.
20. 74. Kadesjö, B., & Gillberg, C. (1999). Developmental coordination disorder in Swedish 7-year-old children. Journal of the American Academy of Child and Adolescent Psychiatry, 38(7), 820-828.
21. 15. Missiuna, C., Cairney, J., Pollock, N., Campbell, W., Russell, D. J., Macdonald, K., Cousins, M. (2014). Psychological distress in children with developmental coordination disorder and attention-deficit hyperactivity disorder. Research in Developmental Disabilities, 35(5), 1198–1207.
22. 72. Lingam, R., Jongmans, M. J., Ellis, M., Hunt, L. P., Golding, J., & Emond, A. (2012). Mental Health Difficulties in Children

With Developmental Coordination Disorder. Pediatrics, 129(4), 882–891.

23. Margari, L., Buttiglione, M., Craig, F., Cristella, A., de Giambattista, C., Matera, E., … Simone, M. (2013). Neuropsychopathological comorbidities in learning disorders. BMC Neurology, 13, 1-6.
24. 73. Lingam, R., Golding, J., Jongmans, M. J., Hunt, L. P., Ellis, M., & Emond, A. (2010). The Association Between Developmental Coordination Disorder and Other Developmental Traits. Pediatrics, 126(5), 1109-1118.
25. 65. Psy-, A., Harris, M., & Assosiation, A. P. (2016). Αναπτυξιακή Διαταραχή Συντονισμού Κίνησης, 48-51.
26. 76. Kaplan, B. J., Dewey, D. M., Crawford, S. G., & Wilson, B. N. (2001). The term comorbidity is of questionable value in reference to developmental disorders: Data and theory. Journal of Learning Disabilities, 34(6),555-565.
27. 62. Harris, S. R., Mickelson, E. C., & Zwicker, J. G. (2015). Diagnosis and management of developmental coordination disorder. Canadian Medical Association Journal, 187(9), 659-665.

DOI:10.31579/2693-4779/270