BJMHR
British Journal of Medical and Health Research
Journal home page: www.bjmhr.com

Exploring the Link between Postterm Birth and Developmental Coordination Disorder: A Comprehensive Review on Developmental Coordination Disorder

Manish Prasad Gupta[1]*, Hua Jing[1], Dhiraj Gupta[2]
1.Department of Pediatrics, Shanghai First Maternity and Infant Hospital, Tongji University School of Medicine 2699 Gaoke Road, Shanghai, China
2.Department of Radiation Oncology, All India Institute of Medical Sciences, 249203 Virbhadra Road, Rishikesh, Uttarakhand, India

ABSTRACT

A postterm birth is one that occurs after completed 42 weeks of pregnancy, is linked to higher rates of newborn morbidity and mortality. Despite the fact that babies delivered one or two weeks early have lifetime effects, there is scant evidence that babies born after their due date have lasting detrimental effects. The infant's risk of infection, delayed stillbirth, and difficulties during delivery increases if crossed their due date. Hence, if more hazards were associated with extending the pregnancy than with intervening, procedures might be utilized to accelerate delivery. The majority of the research currently available on postterm consequences focused on short-term observations, even though long-term effects might be far more significant. The incidence of DCD which ranges from 5% to 6%, is sufficient to designate it as one of the most common disorders among school-age children. Previous research indicated significant risk of DCD in infants born preterm. Whether infants born at varying gestational ages including postterm birth are more likely to experience developmental coordination disorder DCD than children born at full term is yet uncertain. Therefore, the purpose of this review study is to present a summary of the data connecting postterm birth to DCD. Using specific keywords, a comprehensive systematic search of internet databases (PubMed, Google Scholar) revealed up very few research on the topic of postterm births which demand for further postterm cohorts throughout adolescence in order to completely identify the long-term health concern and provide remedies designed to lessen the negative impacts of post-term births.

Keywords - Child development, Child motor impairment, Developmental Coordination Disorder (DCD), Gestational age, Postterm birth

*Corresponding Author Email: maneesgupta5@gmail.com
Received 26 February 2024, Accepted 17 March 2024

Please cite this article as: Gupta MP *et al*., Exploring the Link between Postterm Birth and Developmental Coordination Disorder: A Comprehensive Review on Developmental Coordination Disorder. British Journal of Medical and Health Research 2024.

INTRODUCTION

Background and Definition

It's critical for perinatal and postnatal health that labour commence on time. The effects of perinatal events can last a lifetime for the child and their family, and babies who are still unborn after their due date seem to be among the high-risk category. Neonatal mortality and morbidity are linked to both preterm and postterm deliveries (1-3). Postterm birth is defined as the pregnancy that have completed 42 weeks of gestation. The frequency of post-term birth is impacted by local management practices for labour induction and elective caesarean deliveries. Despite an overall rise in labour inductions occurring prior to or at 42 weeks of gestation (1), postterm deliveries still occur periodically (up to 5–10%), even within developed nations (3, 4). Although the long-term effects are unknown, post-term delivery raised the risk of newborn encephalopathy and mortality within the first year of life (5, 6). Without evident advantages to the child, babies that stay in utero over their due date are more vulnerable to infection, delayed stillbirth, and consequences as shoulder dystocia and neonatal hypoxia (7, 8). Despite the fact that studies have shown that preterm birth has major developmental consequences (9, 10), there is limited recognition of any long-term effects of post-term delivery (11, 12). Contrary to premature birth, interventions can be utilized to deliver the baby if there are greater risks to mother and child associated with extending the pregnancy than with giving birth (13). Like the effect of preterm delivery, the effects of post-term outcomes may be far bigger in the course of time (14), however a large portion of the information currently available is centred on short-term surveys.

Developmental coordination disorder (DCD), impairment of a motor skills is one of the prevalent disorders among school aged children (5 to 11 years) with the prevalence estimated to be 5-6% globally (15), with an even higher prevalence of 8.3% in China (16, 17). Struggle with motor coordination in children with DCD makes it difficult for them to accomplish academic goals or participate in daily activities (18). The labels developmental dyspraxia, minimal brain malfunction, perceptual-motor dysfunction, physical awkwardness, and, very often, the clumsy kid syndrome has all been used to characterize these children in the past (19, 20). These kids were referred to be DCD as a group in 1994 during an international consensus conference that took place in London, Ontario (21). The Diagnostic and Statistical Manual of Mental Disorders (DSM) (22) and the 10th revision of the International Classification of Diseases (ICD-10) (23) has been one of the most extensively used classification systems, provides the diagnostic criteria for motor functioning issues in children and adolescents. The four DCD diagnostic criteria are described in the DSM-5 are illustrated in the table 1.

Developmental impairments can range from extremely specific restrictions to a broad impairment of motor abilities. Among the motor symptoms of DCD are difficulties performing coordinated movements as well as fine and gross motor abnormalities, which cause clumsiness, slowness, and incorrect motor performances (24). DCD sufferers may consequently have abnormalities in sensorimotor coordination, motor learning (acquiring newer movements, adaptation to change, motor planning, etc.) and postural control (poor static and dynamic balance, immature distal control, and hypertonia or hypotonia, etc.) (24). Despite the possibility of early-life noticeable abnormalities in motor development, DCD is typically not identified in children less than five years old (25). Inspired by the idea that early life and perinatal environments can have a significant impact on long-term health, a new preventative paradigm has surfaced in recent years (26). A broad understanding of the effect of perinatal factors, especially the gestational age at birth on motor impairment will aid in directing intervention efforts and creating successful population-based initiatives and strategies to treat this illness. For this reason, the purpose of this review study is to explore the association of post-term born children with children's motor impairment emphasizing DCD. Using keywords like "child", "children", "motor development", "motor impairment", "developmental coordination disorder", "gestational weeks", "gestational age at birth", "postmaturity", 'postterm" a search was conducted on online databases (PubMed and the Google Scholar) to find articles to review for this study.

Comorbidity associated with DCD

There is a strong correlation between DCD and other developmental abnormalities, primarily Attention Deficit Hyperactive Disorder (ADHD) (27, 28), given that new research points towards a genetic connection between these two conditions (29, 30). Additionally, Gillberg et al. discussed the deficits in attention, motor and perception (DAMP models) that shows a 40% overlap between DCD and ADHD (31). Performance of Children with DCD were lower than their peers in school and frequently experience learning problems, particularly dyslexia, even though they are average intelligent and/or above average (19, 32). Additionally, impairments in social and emotional behaviour, anxiety, and depression, as well as impairments in speech, communication, and language, including articulatory speech abnormalities, have been linked to DCD comorbidity (15, 19). A study finding risk of motor impairment in Autism Spectrum Disorder (ASD) concluded that most children with ASD have a risk for motor impairment or DCD, and that risk lasts throughout adolescence (33). Furthermore, they typically do poorly in sports and stay away of athletics and other physically demanding pursuits (34). As a result, individuals are more susceptible to health issues like overweight/obesity, and cardiovascular problems (35-38).

Children and adults who experience these symptoms encounter significant impact on their daily lives, as these consequences typically have reduced health-related quality of life, autonomy, physical and psychological well-being, and other aspects of their daily lives (39-41). The comorbidity associated with DCD was illustrated in figure 1.

Prevalence of DCD

Despite the fact that the prevalence rates of DCD are well-documented in several nations, the range varies greatly depending on the nation. Low prevalence of probable DCD is seen in some nation such as 8% in Canada (42), 4.9% in Sweden (43), 1.8% in southwest England (44), whereas higher prevalence was reported among other nations such as >25% in Spain (45), 19.9% in Brazil (46), 15-19% in Greece (42). The variances in definition, range of age, and finding technique of the case are among the reasons that could be responsible for the discrepancies in the motor impairment (47). Globally the prevalence of DCD estimated to be 5-6% (15), with an even higher prevalence of 8.3% in China (16, 17).

Assessment of DCD

The process of assessment helps to ensure that each kid receives customized, research-based care that can lead to better physical, social, and mental health outcomes. A physician, pediatrician, and psychologist (in certain countries) permitted to review the particular DSM-5 criteria will usually diagnose DCD (48). A diverse team of healthcare professionals should preferably conduct a thorough evaluation before making a diagnosis (48, 49). A diagnosis of DCD can be made for pre-schoolers (ages 3 to 5) based on the results of at least two longitudinal assessments if they exhibit significant motor impairments (despite having had plenty of opportunities for learning and after other potential causes of motor delay have been ruled out) (48). The evaluation ought to comprise comprehensive health and developmental history, clinical assessment, motor evaluations, questionnaires and a conversation about the kid's motor abilities and how they affect their everyday life, education, leisure, and engagement with the child and important adults (48, 49). The International Clinical Practice Guidelines for DCD are an update (published in 2019) to the DCD guideline that the European Academy of Childhood Disability (EACD) released in 2012 in which suggestion were made regarding the definition, assessment, diagnosis, and intervention for DCD (25, 48). Despite suggestions for evaluating the results of DCD, there is debate about the most appropriate tools to utilize (50). Depending on their psychometric characteristics, the suggested outcome tools for identifying issues were the Movement assessment battery children-2 (MABC-2), Developmental Coordination Disorder Questionnaire revised (DCDQ–R), Little DCDQ (LDCDQ), Bruininks-Oseretsky Test of Motor Proficiency-2 (BOT-2) for motor disability and Systematische Opsporing Schrijf problemen-2-NL (SOS-2-NL), Handwriting Screening Questionnaire and Detailed Assessment of Speed and Handwriting

for the identification of writing issues. Although the most popular tool for assessing the effectiveness of rehabilitation for individuals with DCD is the MABC-2 test, the Developmental Coordination Disorder daily (DCD daily) and the Canadian Occupational Performance Measure (COPM) seem to be very responsive and an important element (51, 52). Setting targets for rehabilitation was said to be much easier with the help of COPM (25). The guideline's authors indicated that it is crucial to measure treatment outcomes across all domains of the International Classification of Functioning, Children and Youth version (ICF-CY) and that appropriate tools have to be employed (25, 48, 53). The suggested tools for assessment of DCD are illustrated in figure 2. Suggested outcome measures based on their psychometric qualities to identify issues on school going children are displayed in table 2.

Aetiology and Risk factors of DCD

The aetiology of DCD is still unknown, and there is no one element that causes it. Nonetheless, progress has been achieved as a result of several investigations examining potential causes of DCD. It was proven that events before, during and after the delivery plays crucial role for development of DCD. As noted by Cermak et al., prenatal, perinatal, and postnatal events impact early brain development and are believed to be significant contributors to DCD (54). Nevertheless, Peters et al. analyzed neuroimaging research in children with DCD and discovered that while there is a dearth of information on neuroimaging in DCD, but the neuropathophysiology of DCD is thought to include several different brain regions (55). With respect to perinatal factors, majority of the research showed association with the Prematurity and Low birth weight (16, 44, 56, 57). Various others factors were also reported to be associated with DCD such as newborn pathological jaundice and intrauterine fetal distress (16, 58), Intrauterine Growth Retardation (IUGR) as well as delayed walking (59), being a male (57), families from lower socioeconomic background (44), chronic lung disease, threatened abortion, advanced maternal age (16). Various prenatal, perinatal and postnatal factors associated with DCD is illustrated in figure 3.

EFFECTS OF POSTTERM BIRTH ON RISK OF DCD

One important factor in predicting DCD and motor development is gestational age (56), However, the connection between motor development in infants born full term (37 weeks) or later and gestational age in weeks has received less attention. It has also been discovered that the number of fullterm gestational weeks correlates with the neuromotor and motor development of 9 to 15 weeks old newborns (60) and 12-month-old infants (61). Most of the research conducted previously has reported preterm birth as the significant risk factors for development of DCD (16, 44, 56, 57). Suboptimal brain development is a major risk factor for preterm newborns (62), and the risk of DCD rises with lower gestational age (59, 63). However, some post-term babies also experience fetal development limitation, which is most

likely brought on due to poor function of the placenta that is not able to supply enough nourishment (64, 65) and raised the incidence of newborn encephalopathy and mortality in the 1st year of life (5, 6), but there is uncertainty about the long-term effects.

Recent research (1, 66-69) has shown a negative correlation between a child's short- and long-term health outcomes with postterm delivery (>41 weeks). According to a meta-analysis (70), compared to full-term birth, postterm birth is linked to significantly worse outcomes on cognitive tests. Additionally, compared to full-term babies, post-term babies had higher rates of emotional and behavioural issues at 18 and 36 months of age (69). Furthermore, it has been discovered that postterm children have a higher chance of developing autism spectrum condition and its symptoms (66, 71), as well as attention deficit/hyperactivity disorder (72). In contrast to full-term babies, post-term babies were also noted to have met the major developmental milestones in their early life (73). Developmental milestone impairment may have resulted from complex postterm delivery circumstances such as shoulder dystocia, cephalopelvic disproportion, and extended labour (2), all of which raise the chance of perinatal oxygen deficiency. As earlier research has stated that DCD is linked to lack of oxygen during the process of labor (16). Furthermore, a postterm placenta may provide a foetus bigger than average with fewer nutrients and oxygen (1), this may be connected to abnormal motor development. Despite some debate regarding the variability of motor performance in the literature (74), in contrast to atypical motor development, which is characterized by restrictions on variation and variability, typical motor development is marked by variation and the emergence of adaptive variability (75). As a result, in post term delivery, as children get older, it might become evident how children with typical and atypical development differ in their motor function. Identifying children early who are at susceptible to having DCD later in life may provide a substantial opportunity for early intervention (76). Assessment of the impacts on children delivered after the full-term period (41 weeks and later) has, however, received relatively less attention. Moreover, the limited amount of research that has been conducted on the development of infants delivered after full term has yielded inconsistent results (77, 78).

After searching for the association of post term birth with DCD, only few studies (three) on post term born children have been found with mixed results regarding their association with DCD, with two studies reported non-significant correlation (56, 59) and one study reported positive association (79). J.L Zhu et al. (2012) conducted research for finding correlation of gestational age at birth with the risk of DCD, calculating DCDQ’07 among children who was the part of Danish National Birth Cohort. In this study, researcher designated children as possible DCD if their DCDQ score was 46 or below and concluded that the possibility of DCD was negatively correlated with gestational age at birth with a one week decrease in

gestational age was linked to a 19% [95% CI 14%, 25%] rise in the probability of DCD. In the same study, children born postterm did not show a statistically significant higher risk of DCD (56). Similarly, non-significant association of postterm birth with DCD was reported by Rikke faebo larsen et al. (2013). They conducted population-based study in children from same Danish National Birth Cohort, finding determinants of DCD in 7 years old children. Using the validated Developmental Coordination Disorder Questionnaire revised 7 (DCDQ'07), the study's result was assessed and concluded that as gestational age decreases, the risk of DCD rises (59). In contrast to above two findings, Hua et al. (2021) found different results. They carried out retrospective cohort study in mainland China and studied 3–5 years old children from 2403 public kindergartens in 551 Chinese cities assessing children's motor function using MABC-2. Using retrospectively collected data to explore the correlation of Gestational age at birth with suspected DCD, they found that compared to full term, postterm, early term and every stage of preterm at birth were linked to suspected DCD (79). A novel finding discovered by the study of Hua et al. (79) involving 152 433 children (may be a large national representative sample among current research), aged 3 to 5 is the increased risk of DCD linked to postterm delivery, which was not observed in the approximately 23,000–33,000 children in the Danish community at age seven (56, 59). These contradictory results might be attributed to variations in the sample size, age at follow-up, DCD assessment, and/or confounder control, which were comparable in both cohorts but could have different contextual factors in the two nations (80). An overview of the studies conducted on postterm births and their correlation with motor disability are displayed in table 3.

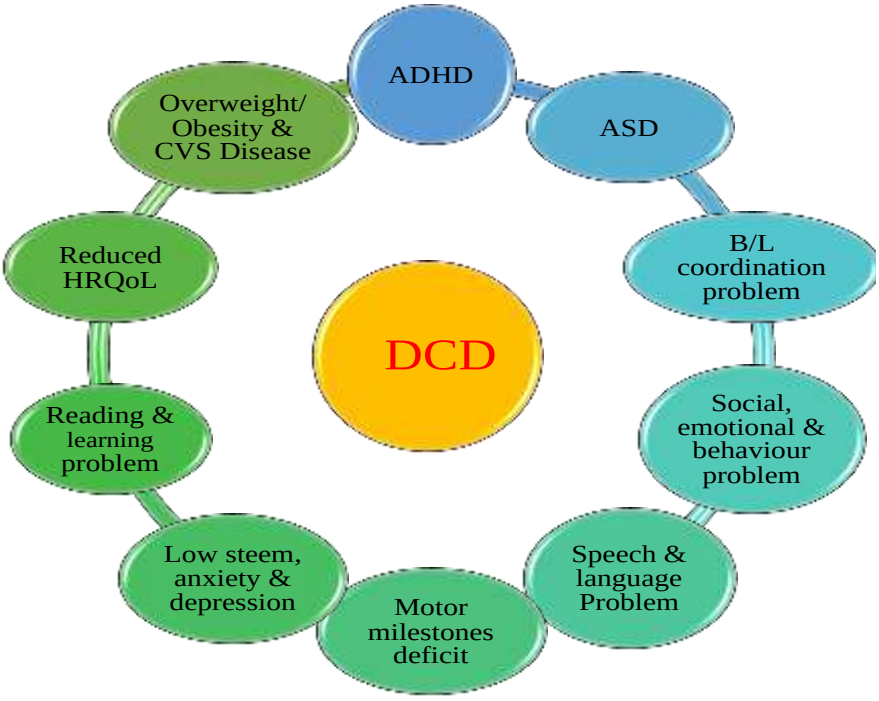

Figure 1: Comorbidity associated with DCD

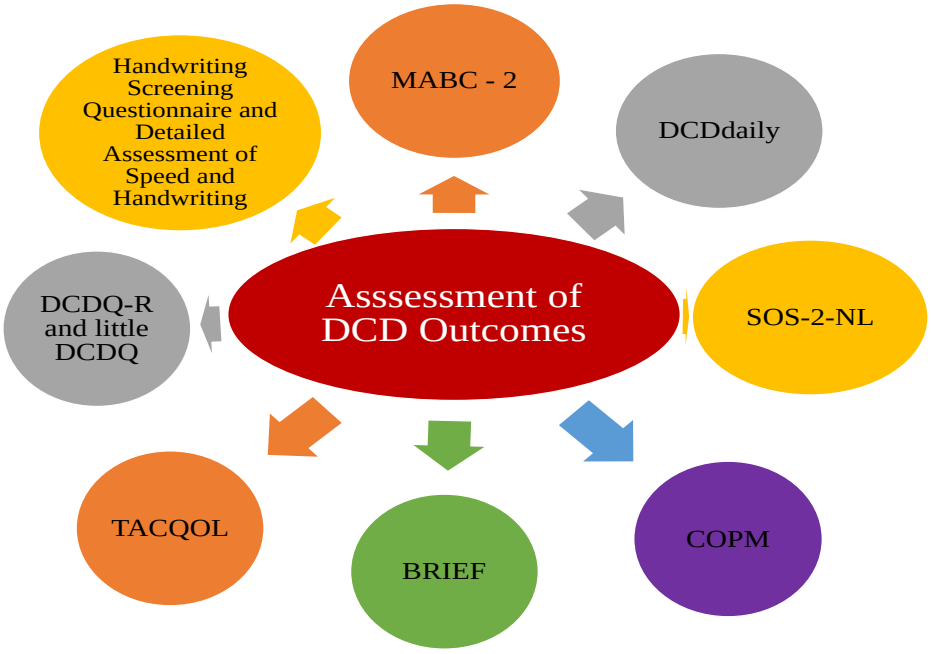

Figure 2: Assessment tools for DCD

Note – BRIEF - Behaviour rating inventory of executive functioning; TACQOL - TNO-AZL questionnaire for children's health-related quality of life

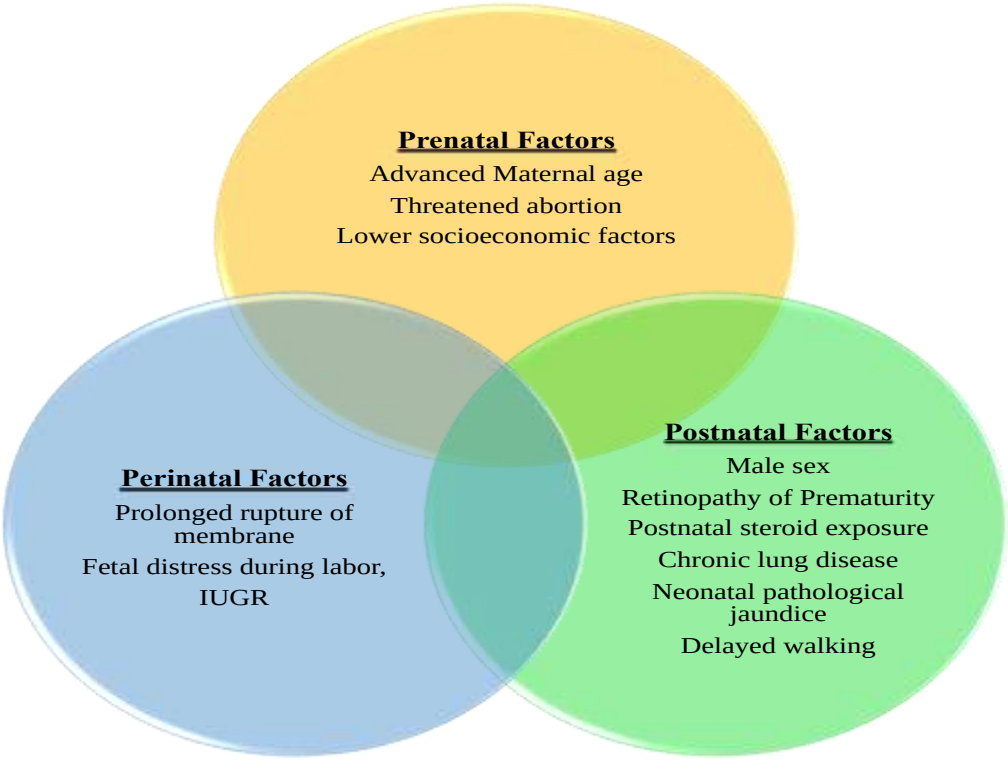

Figure 3: Determinants of DCD

Table 1: Outcome measurements to identify issues in school going children

Category	Issues
A	The individual's performance in daily tasks requiring motor coordination is significantly below average considering their age and assessed IQ. Manifested as walking, crawling, sitting), dropping things, "clumsiness," poor performance in sports, or poor handwriting
B	The disruption in Criterion A substantially hinders the ability to succeed academically or carry out daily tasks.
C	The problem does not fit the criteria for a pervasive developmental disorder and is not caused by a general medical illness (such as cerebral palsy or muscular dystrophy);
D	If mental retardation is present, the motor difficulties are in excess of those usually associated with it.

Table 2: Assessment tools for outcome measurement of DCD

Assessment tools	Outcome Measurement	Remarks
MABC-2	Motor skills	Age - 3-16 years Assessment: - Manual dexterity, Ball skills and balance
BOT - 2	Motor Skills	Age range: 4 to 21 years Assessment: - B/L co-ordination, Balance, Upper limb speed, and dexterity, Running ability, agility and Visual motor control
DCDQ'07	Activities of daily living	Age range: 5 to 15 years Assessment: - General coordination, Fine motor skills & handwriting, and Control during movement
(MABC-2 Checklist)	Activities of daily living	Age range: 5 to 12 years Assessment: - Movement in dynamic & static environment, Nonmotor factors
DCDdaily	Daily Task performance	Age - 5–8 years old Assessment: - Self care (feeding, dressing), School (writing, crafts, colouring, cutting) and play (hopping)
SOS-2-NL	Writing problems	School aged children (Grade 1^{st} to 6^{th}) Assessment: - Writing Speed and Quality
COPM	Daily life and Rehabilitation goal setting	Assessment: - self-management, productive activities and leisure activities.
BRIEF	Executive Dysfunction	Assessment: - 1. BRI: Inhibit (Inhibitory control and Impulsivity), Shift (ability to shift from ongoing situation/activity/problem) and Emotional control 2. MI: - Initiate (begin a task), Working memory (hold information to complete task), plan/organize and monitor.

TACQOL	Health-Related Quality of Life (HRQoL)	Age - 6-15 years Assessment: - Functions of body, motor, daily routine, cognitive, social, positive and negative emotions.

Table 3: Association of Postterm birth with DCD

Author	Population characteristics	Assessment Factors	Result	Remarks
J.L.zhu et al. (2012)	22898 singletons birth between February 2007 and march 2009 (child with GA between 25 to 44 weeks with median GA of 40 weeks). Child with GA of 40 weeks serve as control group. (7 years follow up data from Danish National Birth Cohort)	Total score from the developmental coordination disorder questionnaire (DCDQ'07)	Children born postterm did not show a statistically significant higher risk of DCD.	Negative association
Rikke faebo larsen et al. (2013)	33 354 women and their children (child with GA between 23 to >/=42 weeks) Term gestation (37+0–41+6) serve as control group. (7 year follow up data from Danish National Birth Cohort)	Total DCD score using the validated developmental coordination disorder questionnaire (DCDQ'07).	As gestational age decreases, the risk of DCD rises. Postterm did not show statistically significant risk of DCD.	Negative association
Hua et al. (2021	152 433 children aged 3 to 5 years (mean [SD] age, 4.5 [0.8] years). Sample consists of child with GA of <32 weeks to > 41 weeks. Full term born children (39-40 weeks' gestation) serve as control group. Data from Chinese National Cohort of Motor Development	Outcome assessment using the little developmental coordination disorder questionnaire (LDCDQ), completed by their parents.	Suspected DCD was linked to every phase of preterm birth, postterm birth, and early term birth	Positive association

CONCLUSION

Early identification of developmental disorders in newborns is crucial as it facilitates early intervention possibilities, since delayed motor milestone onsets throughout infancy may indicate a disruption in both physical and neurological growth. This review study has found mixed result with comparatively less evidence of association of postterm birth with DCD. However, evidence of displaying other morbidity like sleep disorders, delayed social development, reading difficulties, neurologic handicaps, cerebral palsy, ASD, ADHD were evident with post term born children. Thus, we hypothesise that identifying these contributing characteristics might make it easier to identify high-risk pregnant women and develop specific approaches to reduce the number of postterm deliveries. The outcomes of this review study could help doctors to decide the best timing to deliver a full-term pregnancy. Even if the absolute hazards of post-term birth were fewer than those of preterm birth, post-term neonates still need to be closely monitored, which can be accomplished by long-term follow-up evaluations. We observed minimal evidence of a link between DCD and postterm born children, thus more study of postterm cohorts in adulthood is needed to completely ascertain the long-term health concerns associated with prolonged gestation.

REFERENCES

1. Caughey AB, Snegovskikh VV, Norwitz ER. Postterm pregnancy: how can we improve outcomes? Obstet Gynecol Surv. 2008;63(11):715-24.
2. Norwitz ER, Snegovskikh VV, Caughey AB. Prolonged pregnancy: when should we intervene? Clin Obstet Gynecol. 2007;50(2):547-57.
3. Shea KM, Wilcox AJ, Little RE. Postterm delivery: a challenge for epidemiologic research. Epidemiology. 1998;9(2):199-204.
4. Zeitlin J, Blondel B, Alexander S, Bréart G. Variation in rates of postterm birth in Europe: reality or artefact? Bjog. 2007;114(9):1097-103.
5. Savitz DA, Terry JW, Jr., Dole N, Thorp JM, Jr., Siega-Riz AM, Herring AH. Comparison of pregnancy dating by last menstrual period, ultrasound scanning, and their combination. Am J Obstet Gynecol. 2002;187(6):1660-6.
6. Mogren I, Stenlund H, Högberg U. Recurrence of prolonged pregnancy. Int J Epidemiol. 1999;28(2):253-7.
7. Daskalakis GJ, Mesogitis SA, Papantoniou NE, Moulopoulos GG, Papapanagiotou AA, Antsaklis AJ. Misoprostol for second trimester pregnancy termination in women with prior caesarean section. Bjog. 2005;112(1):97-9.

8. Odd DE, Yau C, Winter C, Draycott T, Rasmussen F. Associations between birth at, or after, 41 weeks gestation and perinatal encephalopathy: a cohort study. BMJ Paediatr Open. 2018;2(1):e000010.
9. Chiossi G, Lai Y, Landon MB, Spong CY, Rouse DJ, Varner MW, et al. Timing of delivery and adverse outcomes in term singleton repeat cesarean deliveries. Obstet Gynecol. 2013;121(3):561-9.
10. Costeloe KL, Hennessy EM, Haider S, Stacey F, Marlow N, Draper ES. Short term outcomes after extreme preterm birth in England: comparison of two birth cohorts in 1995 and 2006 (the EPICure studies). Bmj. 2012;345:e7976.
11. Moster D, Wilcox AJ, Vollset SE, Markestad T, Lie RT. Cerebral palsy among term and postterm births. Jama. 2010;304(9):976-82.
12. Linder N, Hiersch L, Fridman E, Klinger G, Lubin D, Kouadio F, Melamed N. Post-term pregnancy is an independent risk factor for neonatal morbidity even in low-risk singleton pregnancies. Arch Dis Child Fetal Neonatal Ed. 2017;102(4):F286-f90.
13. Molina G, Weiser TG, Lipsitz SR, Esquivel MM, Uribe-Leitz T, Azad T, et al. Relationship Between Cesarean Delivery Rate and Maternal and Neonatal Mortality. Jama. 2015;314(21):2263-70.
14. Wolke D, Samara M, Bracewell M, Marlow N. Specific language difficulties and school achievement in children born at 25 weeks of gestation or less. J Pediatr. 2008;152(2):256-62.
15. Kirby A, Sugden DA. Children with developmental coordination disorders. J R Soc Med. 2007;100(4):182-6.
16. Hua J, Gu G, Jiang P, Zhang L, Zhu L, Meng W. The prenatal, perinatal and neonatal risk factors for children's developmental coordination disorder: a population study in mainland China. Res Dev Disabil. 2014;35(3):619-25.
17. Hua J, Jin H, Gu G, Liu M, Zhang L, Wu Z. The influence of Chinese one-child family status on developmental coordination disorder status. Res Dev Disabil. 2014;35(11):3089-95.
18. Polatajko HJ, Cantin N. Developmental coordination disorder (dyspraxia): an overview of the state of the art. Semin Pediatr Neurol. 2005;12(4):250-8.
19. Zwicker JG, Missiuna C, Harris SR, Boyd LA. Developmental coordination disorder: a review and update. Eur J Paediatr Neurol. 2012;16(6):573-81.
20. Mandich A, Polatajko HJ. Developmental coordination disorder: mechanisms, measurement and management. Hum Mov Sci. 2003;22(4-5):407-11.

21. Polatajko HJ, Fox M, Missiuna C. An International Consensus on Children with Developmental Coordination Disorder. Canadian Journal of Occupational Therapy. 1995;62:3 - 6.
22. D-TF APA. Diagnostic and statistical manual of mental disorders: DSM-5™ (5th ed.). 2013.
23. The ICD-10 Classification of Mental and Behavioural Disorders: Clinical descriptions and diagnostic guidelines 1992 [Available from: https://www.who.int/publications/i/item/9241544228).
24. Biotteau M, Danna J, Baudou É, Puyjarinet F, Velay JL, Albaret JM, Chaix Y. Developmental coordination disorder and dysgraphia: signs and symptoms, diagnosis, and rehabilitation. Neuropsychiatr Dis Treat. 2019;15:1873-85.
25. Blank R, Barnett AL, Cairney J, Green D, Kirby A, Polatajko H, et al. International clinical practice recommendations on the definition, diagnosis, assessment, intervention, and psychosocial aspects of developmental coordination disorder. Dev Med Child Neurol. 2019;61(3):242-85.
26. Oken E, Gillman MW. Fetal origins of obesity. Obes Res. 2003;11(4):496-506.
27. Kadesjö B, Gillberg C. The comorbidity of ADHD in the general population of Swedish school-age children. J Child Psychol Psychiatry. 2001;42(4):487-92.
28. Watemberg N, Waiserberg N, Zuk L, Lerman-Sagie T. Developmental coordination disorder in children with attention-deficit-hyperactivity disorder and physical therapy intervention. Dev Med Child Neurol. 2007;49(12):920-5.
29. Fliers E, Vermeulen S, Rijsdijk F, Altink M, Buschgens C, Rommelse N, et al. ADHD and poor motor performance from a family genetic perspective. J Am Acad Child Adolesc Psychiatry. 2009;48(1):25-34.
30. Martin NC, Piek JP, Hay D. DCD and ADHD: a genetic study of their shared aetiology. Hum Mov Sci. 2006;25(1):110-24.
31. Gillberg C. Deficits in attention, motor control, and perception: a brief review. Arch Dis Child. 2003;88(10):904-10.
32. Iversen S, Berg K, Ellertsen B, Tønnessen FE. Motor coordination difficulties in a municipality group and in a clinical sample of poor readers. Dyslexia. 2005;11(3):217-31.
33. Bhat AN. Is Motor Impairment in Autism Spectrum Disorder Distinct From Developmental Coordination Disorder? A Report From the SPARK Study. Phys Ther. 2020;100(4):633-44.

34. Magalhães LC, Cardoso AA, Missiuna C. Activities and participation in children with developmental coordination disorder: a systematic review. Res Dev Disabil. 2011;32(4):1309-16.
35. Cairney J, Kwan MY, Hay JA, Faught BE. Developmental Coordination Disorder, gender, and body weight: examining the impact of participation in active play. Res Dev Disabil. 2012;33(5):1566-73.
36. Cantell M, Crawford SG, Tish Doyle-Baker PK. Physical fitness and health indices in children, adolescents and adults with high or low motor competence. Hum Mov Sci. 2008;27(2):344-62.
37. Faught BE, Hay JA, Cairney J, Flouris A. Increased risk for coronary vascular disease in children with developmental coordination disorder. J Adolesc Health. 2005;37(5):376-80.
38. Wagner MO, Kastner J, Petermann F, Jekauc D, Worth A, Bös K. The impact of obesity on developmental coordination disorder in adolescence. Res Dev Disabil. 2011;32(5):1970-6.
39. Caçola P, Killian M. Health-related quality of life in children with Developmental Coordination Disorder: Association between the PedsQL and KIDSCREEN instruments and comparison with their normative samples. Res Dev Disabil. 2018;75:32-9.
40. Karras HC, Morin DN, Gill K, Izadi-Najafabadi S, Zwicker JG. Health-related quality of life of children with Developmental Coordination Disorder. Res Dev Disabil. 2019;84:85-95.
41. Zwicker JG, Harris SR, Klassen AF. Quality of life domains affected in children with developmental coordination disorder: a systematic review. Child Care Health Dev. 2013;39(4):562-80.
42. Tsiotra GD, Flouris AD, Koutedakis Y, Faught BE, Nevill AM, Lane AM, Skenteris N. A comparison of developmental coordination disorder prevalence rates in Canadian and Greek children. J Adolesc Health. 2006;39(1):125-7.
43. Kadesjö B, Gillberg C. Developmental coordination disorder in Swedish 7-year-old children. J Am Acad Child Adolesc Psychiatry. 1999;38(7):820-8.
44. Lingam R, Hunt L, Golding J, Jongmans M, Emond A. Prevalence of developmental coordination disorder using the DSM-IV at 7 years of age: a UK population-based study. Pediatrics. 2009;123(4):e693-700.
45. Ávila EMG, & Pérez, L. M. R. Problems of motive coordination and percentage of body fat in school students. Fit Perform J. 2008:7, 239-44. .
46. Valentini NC, Coutinho, M. T. C., Pansera, S. M., Santos, V. A. P., Vieira, J. L. L., Ramalho, M. H., & Oliveira, M. A. . Prevalência de déficits motores e desordem

coordenativa desenvolvimental em crianças da região Sul do Brasil [Prevalence of motor deficits and developmental coordination disorders in children from South Brazil]. Rev Paul Pediatr,. 2012:30, 377-84.

47. Durkin M. The epidemiology of developmental disabilities in low-income countries. Ment Retard Dev Disabil Res Rev. 2002;8(3):206-11.
48. Blank R, Smits-Engelsman B, Polatajko H, Wilson P. 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(1):54-93.
49. Chung A CA. Clinical Review: Developmental Coordination Disorder (Occupational Therapy). CINAHL Information Systems, Rehabilitation Reference Center,. 2016.
50. van der Linde BW, van Netten JJ, Otten E, Postema K, Geuze RH, Schoemaker MM. A systematic review of instruments for assessment of capacity in activities of daily living in children with developmental co-ordination disorder. Child Care Health Dev. 2015;41(1):23-34.
51. van der Veer G, Kamphorst E, Minnaert A, Cantell M, Kakebeeke TH, Houwen S. Assessing Motor Performance in Preschool Children: The Zurich Neuromotor Assessment-2 and the Movement Assessment Battery for Children-2. Percept Mot Skills. 2021;128(5):2014-32.
52. Heus I, Weezenberg D, Severijnen S, Vlieland T, van der Holst M. Measuring treatment outcome in children with developmental coordination disorder; responsiveness of six outcome measures. Disability and Rehabilitation. 2020;44:1-12.
53. WHO. ICF Domains 2016 [cited 2024 7 march]. Available from: http://www.who.int/classifications/icf/en/.
54. Cermak SA GS, Larkin D. What is developmental coordination disorder? In Cermak SA, Larkin D, editors, Developmental Coordination Disorder. Albany, NY: Delmar. 2001;1.
55. Peters LH, Maathuis CG, Hadders-Algra M. Neural correlates of developmental coordination disorder. Dev Med Child Neurol. 2013;55 Suppl 4:59-64.
56. Zhu JL, Olsen J, Olesen AW. Risk for developmental coordination disorder correlates with gestational age at birth. Paediatr Perinat Epidemiol. 2012;26(6):572-7.
57. Zwicker JG, Yoon SW, Mackay M, Petrie-Thomas J, Rogers M, Synnes AR. Perinatal and neonatal predictors of developmental coordination disorder in very low birthweight children. Arch Dis Child. 2013;98(2):118-22.

58. Hua J, Meng W, Wu Z, Zhang L, Gu G, Zhu L. [Prenatal and perinatal risk factors for developmental coordination disorder in children]. Zhonghua Liu Xing Bing Xue Za Zhi. 2014;35(3):250-4.
59. Faebo Larsen R, Hvas Mortensen L, Martinussen T, Nybo Andersen AM. Determinants of developmental coordination disorder in 7-year-old children: a study of children in the Danish National Birth Cohort. Dev Med Child Neurol. 2013;55(11):1016-22.
60. van Batenburg-Eddes T, de Groot L, Arends L, de Vries A, Moll HA, Steegers EA, et al. Does gestational duration within the normal range predict infant neuromotor development? Early Hum Dev. 2008;84(10):659-65.
61. Rose O, Blanco E, Martinez SM, Sim EK, Castillo M, Lozoff B, et al. Developmental scores at 1 year with increasing gestational age, 37-41 weeks. Pediatrics. 2013;131(5):e1475-81.
62. Ranger M, Grunau RE. Early repetitive pain in preterm infants in relation to the developing brain. Pain Manag. 2014;4(1):57-67.
63. Du W, Ke L, Wang Y, Hua J, Duan W, Barnett AL. The prenatal, postnatal, neonatal, and family environmental risk factors for Developmental Coordination Disorder: A study with a national representative sample. Res Dev Disabil. 2020;104:103699.
64. Mannino F. Neonatal complications of postterm gestation. J Reprod Med. 1988;33(3):271-6.
65. Vorherr H. Placental insufficiency in relation to postterm pregnancy and fetal postmaturity. Evaluation of fetoplacental function; management of the postterm gravida. Am J Obstet Gynecol. 1975;123(1):67-103.
66. Persson M, Opdahl S, Risnes K, Gross R, Kajantie E, Reichenberg A, et al. Gestational age and the risk of autism spectrum disorder in Sweden, Finland, and Norway: A cohort study. PLoS Med. 2020;17(9):e1003207.
67. Lahti M, Eriksson JG, Heinonen K, Kajantie E, Lahti J, Wahlbeck K, et al. Late preterm birth, post-term birth, and abnormal fetal growth as risk factors for severe mental disorders from early to late adulthood. Psychol Med. 2015;45(5):985-99.
68. Odd D, Glover Williams A, Winter C, Draycott T. Associations between early term and late/post term infants and development of epilepsy: A cohort study. PLoS One. 2018;13(12):e0210181.
69. El Marroun H, Zeegers M, Steegers EA, van der Ende J, Schenk JJ, Hofman A, et al. Post-term birth and the risk of behavioural and emotional problems in early childhood. Int J Epidemiol. 2012;41(3):773-81.

70. Glover Williams A, Odd D. Investigating the association between post-term birth and long term cognitive, developmental and educational impacts: a systematic review and Meta-analysis. J Matern Fetal Neonatal Med. 2020;33(7):1253-65.
71. Movsas TZ, Paneth N. The effect of gestational age on symptom severity in children with autism spectrum disorder. J Autism Dev Disord. 2012;42(11):2431-9.
72. Ask H, Gustavson K, Ystrom E, Havdahl KA, Tesli M, Askeland RB, Reichborn-Kjennerud T. Association of Gestational Age at Birth With Symptoms of Attention-Deficit/Hyperactivity Disorder in Children. JAMA Pediatr. 2018;172(8):749-56.
73. Olesen AW OJ, Zhu JL. Developmental milestones in children born post-term in the Danish National Birth Cohort: a main research article. B J O G. 2015:122(10):1331-9.
74. Wade MG, Kazeck M. Developmental coordination disorder and its cause: The road less travelled. Hum Mov Sci. 2018;57:489-500.
75. Hadders-Algra M. Variation and variability: key words in human motor development. Phys Ther. 2010;90(12):1823-37.
76. Zwicker JG, Lee EJ. Early intervention for children with/at risk of developmental coordination disorder: a scoping review. Dev Med Child Neurol. 2021;63(6):659-67.
77. Figlio DN, Guryan J, Karbownik K, Roth J. Long-term Cognitive and Health Outcomes of School-Aged Children Who Were Born Late-Term vs Full-Term. JAMA Pediatr. 2016;170(8):758-64.
78. Smithers LG, Searle AK, Chittleborough CR, Scheil W, Brinkman SA, Lynch JW. A whole-of-population study of term and post-term gestational age at birth and children's development. Bjog. 2015;122(10):1303-11.
79. Hua J, Barnett AL, Williams GJ, Dai X, Sun Y, Li H, et al. Association of Gestational Age at Birth With Subsequent Suspected Developmental Coordination Disorder in Early Childhood in China. JAMA Netw Open. 2021;4(12):e2137581.
80. Zwicker JG. Association of Gestational Age and Developmental Coordination Disorder. JAMA Network Open. 2021;4(12):e2137599-e.