

BMJ Open Is screening for motor skill deficits in Tyrolean preschool children warranted and feasible? A protocol for a two-stage cross-sectional study

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ABSTRACT

Introduction Children with developmental coordination disorder (DCD) show deviations in motor development and motor skills in early childhood where the learning and execution of coordinated motor skills are below the level expected for their age. Early detection of DCD is critical to provide an opportunity for intervention and support, yet many cases remain undetected until school age. The study described aims to determine the warranty, feasibility and validity of a mobility screening in Tyrolean kindergartens and evaluate its potential benefit to enhance the motor development prospects of affected children.

Methods and analysis This research employs a two-stage cross-sectional approach with 6 months of follow-up assessments. The initial stage involves a playful mobility screening for all participating kindergarten children, followed by individual assessments for those displaying conspicuous motor skills. Motor skills will be evaluated using MobiScreen 4–6 and the Movement Assessment Battery for Children-2. Prior to the screening, informed consent is obtained from kindergarten bodies and authorities, parents and the children themselves. Parents are provided with information sheets and questionnaires to assess their attitudes and their child's eligibility. The study described aims to form a representative sample of kindergarten children, aged 4–6, in Tyrol. To target approximately 20–40 children with DCD for follow-up, the goal is to include 650 children, assuming an incidence of 3%–6%. For the follow-up, matching control groups will be formed and information about how identified motor deficits were addressed, including therapies or sports, will be gathered. Quantitative data will mainly be analysed descriptively, while feedback from kindergarten teachers regarding the practical implementation will be analysed using qualitative content analyses, according to Mayring. **Ethics and dissemination** The study has been approved by the Research Committee for Scientific Ethical Questions (RCSEQ 3369/24). Findings will be disseminated through contributions, peer-reviewed journals, and conferences.

INTRODUCTION

Children with developmental coordination disorder (DCD) show deviations in motor development and motor skills in early childhood where the learning and execution of

STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This study enhances awareness regarding the importance of motor development in children in kindergartens and among parents.
- ⇒ In addition to quantitative data collection, reflective discussions with kindergarten management will be conducted and qualitatively analysed, providing insights into the perspectives of kindergartens in case of later implementation desires.
- ⇒ The follow-up examination offers an opportunity to investigate how parents cope with the identification of developmental coordination disorder (DCD) and how it evolves over a period of 6 months with different approaches.
- ⇒ There is a risk of selection bias, as children who are more or less interested in physical activity may be more or less likely to participate.
- ⇒ Assessing parental support for the screening may not directly translate to its practical feasibility in kindergarten settings. The willingness of parents to participate does not ensure the overall programme's feasibility.

coordinated motor skills are below the level expected for their age.^{1–3} To diagnose DCD (International Classification of Diseases, 10th revision: F 82), the child must score at least 1.5 SD below the expected level based on its age on a standardised test of fine and gross motor coordination. In addition, the impairment must interfere with schooling or everyday activities and the disorder cannot be attributed to any other diagnosable (neurological) disorder.⁴ In clinical practice, diagnosis is often achieved interprofessionally in collaboration with physiotherapists, although it must be medically determined by a physician. The precise aetiology of DCD remains largely elusive, though there is empirical support for atypical brain structure and function in affected children. An association with reduced physical activity was identified.^{5 6}

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A lack of motor control and insufficient movement experience in everyday life promote the child's insecurity in movement, increase the risk of injury⁷ and result in higher levels of anxiety.⁸ In contrast, good motor skills are considered important for future levels of physical activity,⁹ self-sufficiency¹⁰ and the social, cognitive and psychological development of children.^{10–12} Thus, the quality of motor skills is closely related to the quality of social-communicative skills and the ability of children to react situationally to their environment.^{13 14} Restricted exploration possibilities due to motor deficits greatly increase the risk of global developmental impairments in children.¹⁵

According to a guideline on the definition, diagnosis and treatment of DCD, prevalence reaches 5%–6% of all schoolchildren, with boys being affected more often than girls.¹⁶ 80%–90% of DCD-diagnosed children have difficulties learning at school and significantly higher incidences of behavioural or social development problems compared with the general population.^{10 17 18} International studies revealed that many preschool children are not sufficiently physically active and that only 50% of preschool children are demonstrating sufficient competence in a broad range of skills, such as coordination, balance, strength and endurance.^{19–21} Studies show that especially sports and/or play-related group-based training, both task-oriented and goal-oriented, shows significant improvements in motor skills, motor coordination and performance, as well as balance, in children with DCD.^{22 23} Interventions in smaller groups with activities chosen by the children themselves seem to be an effective factor in decreasing their level of anxiety.²³

These findings clearly indicate that there is a need for children with DCD to be identified as early as possible to facilitate motor skill development and reduce the risk of further developmental delays in other areas. Although DCD can be diagnosed earlier,¹⁶ the majority of children remain undetected and, therefore, untreated until they attend school.²⁴ A way to approach this problem could be to introduce mobility screening into kindergartens. Due to the time-consuming nature of the process, guidelines do not recommend performing motor tests in kindergartens.^{16 25} In contrast to motor tests, screenings can be carried out much more quickly and are appropriate as an initial assessment of a child's motor skills, distinguishing children into motorically conspicuous and inconspicuous. Subsequently, it is recommended to further examine conspicuous children by conducting a more comprehensive motor test.¹⁶ Implementing a standardised and validated motoric screening in kindergarten could contribute to the early identification of motor deficits and hence help to initiate further steps to promote the motor development of affected children.

The Austrian federal province of Tyrol, where the study described will be conducted, is known for having a population with a propensity for physical activity. This might lead to the assumption that children are less likely to show motor deficits. However, previous research in this region

has yielded similar results to international studies.²⁶ A study conducted in 2011 assessed the motor skills of 100 preschool children in three Tyrolean kindergartens, focusing on velocity strength, strength endurance, balance, coordination and agility. Standard measurement procedures were used, including the stand-reach test, the one-leg stand test and the standing long jump test. Deficient results were observed in all areas, with the most notable findings in the stand-reach test, where 20% of boys and 30% of girls achieved insufficient results.²⁶

Consequently, the following research questions arise:

- Is a screening for motor skill deficits in Tyrolean preschool children warranted?
- Is the conduct of a screening for motor skill deficits in Tyrolean kindergartens feasible?
- Does the screening for motor skill deficits in Tyrolean preschool children yield valid results?

METHODS AND ANALYSIS

Study design

This research protocol describes a two-stage cross-sectional study with follow-up assessments, accompanied by qualitative surveying of stakeholder feedback. Stage 1 is a playful mobility screening in which all children will participate. In stage 2, a separate individual assessment and further investigation of motoric skills will be offered and conducted with those children who appeared conspicuous in stage 1 (see figure 1). For the follow-up study, all DCD children will be reassessed for a period of 6 months after their initial testing. As controls, two equally sized, matched control groups will be reassessed (see figure 1).

Invitations to participate in the study will be sent out in April 2024. The stage 1 screenings will be carried out directly in the participating kindergartens in September 2024, while the individual assessments of the conspicuous children will take place 2 weeks later (October 2024), independently of the kindergarten. The follow-up study will be conducted 6 months later, also independently of the kindergartens, in May 2025.

To address our first research question, warranty will be investigated by determining the prevalence of DCD in the age cohort of 4–6 in Tyrol and by evaluating whether existing procedures, such as teacher or parent observations, already identify children with motor deficits.

For our second research question, feasibility will be assessed through structured questionnaires for parents to capture attitudes towards the implementation of a standardised mobility screening and to determine prerequisites for such a screening from their perspective. Furthermore, feedback from kindergarten teachers is solicited regarding the practical implementation.

In our third research question, validity is to be understood in terms of the consistency of the results. While the reliability of the used tests has already been investigated, this study aims to determine whether the test results persist over time as children undergo natural developmental changes and how the results vary when parent-selected interventions are implemented.

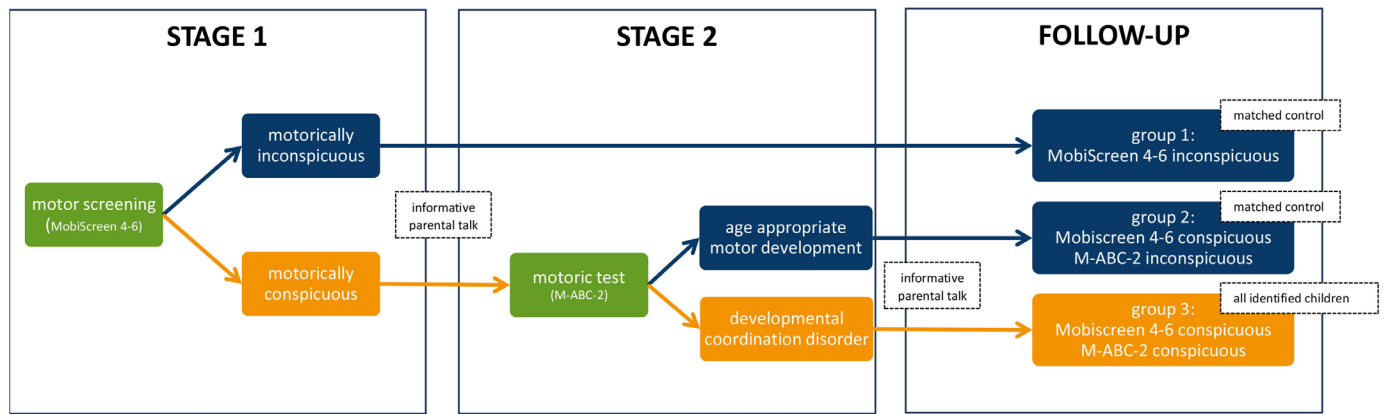


Figure 1 Study design for the two-staged cross-sectional study and the 6-month follow-up, own figure.

Patient and public involvement

Prior to the conception of the study described, extensive discussions were held with relevant stakeholders, including kindergartens, parents/guardians and a representative from the Tyrolean Regional Government for Health, Care, Education, Science and Research.

Procedure

The screening will be conducted in participating kindergartens throughout Tyrol by teams consisting of a member of the project's research team (a physiotherapist) and a student assistant. The project leader will seek written informed consent from kindergartens and parents. The respective screening teams will obtain verbal consent from the children on the day of the screenings. Prior to the screenings, the legal guardians of the children will be given an information sheet about the objectives and procedure of the screening, as well as a short questionnaire related to their attitudes towards the implementation of a standardised motor screening. The parents will further be asked about their children's disabilities or other motor impairments to assess their eligibility according to the defined inclusion criteria.

The feasibility of this study design, the applicability of the assessments MobiScreen 4–6 and Movement Assessment Battery of Children-2 (M-ABC-2) and the compliance of relevant stakeholders were already tested in a pilot study conducted with one kindergarten in March and April 2023 (ethics vote: RCSEQ 3126/22). A rural kindergarten was recruited, and 39 children aged 4–6 years were screened. As recommended, the screening was conducted in a child-friendly manner in the form of an adventure story, which the children visibly enjoyed. All children whose parents had given their consent participated. There were no incidents or near-misses, and the schedule was kept. Those children with conspicuous results in the screening were examined further in a second step with a motor test. The parents were informed about the results and options for further possible procedures were explained.

Participants

In 2023, approximately 23 100 children between the ages of 4 and 6 were registered in Tyrol, of which approximately 22 700 children were enrolled in 484 kindergartens.²⁷ We will strive to achieve a representative sample of kindergarten-aged children in Tyrol and will therefore invite all Tyrolian kindergartens to participate in this study. Among those volunteering, we will select representative numbers from rural and urban areas.

Children are eligible for the study if they meet the following inclusion criteria:

- ▶ Age 4–6.
- ▶ Sufficient German language skills to understand the verbal instructions for the mobility screening.
- ▶ Physical and cognitive eligibility in order to safely participate in the mobility screening (see questions 3 and 4 of the parent questionnaire in the 'Data collection' section).
- ▶ Parental consent.
- ▶ Completed parental questionnaire.

Reported DCD incidence rates range from 5% to 6%^{16 18}; however, in the aforementioned pilot study, 6 children out of 39 were classified as conspicuous and differential testing by the M-ABC-2 confirmed (only) one child with DCD, who scored more than 1.5 SD below the level that would be expected based on its age. This can be taken as an indication that the incidence rate in Tyrol might be lower than 5%. Therefore, an incidence rate of 3%–6% for sample size considerations was assumed. We aim for 20–40 cases of children with DCD for the planned follow-up study, indicating that a minimum sample size of 650 children between the ages of 4 and 6 needs to be screened.

Data collection

Baseline characterisation of the participants will include sociodemographic information and kindergarten attendance, and self-reported participation in mother-child-pass examinations (a recommended medical assessment schedule for expecting mothers and their children up to the age of 5). It will be documented whether the children

attend an urban or rural kindergarten and whether the kindergarten has a specific pedagogical focus.

To assess parents' attitudes towards the implementation of standardised mobility screening and to review the inclusion and exclusion criteria for participation, a parent questionnaire will be carried out. In this questionnaire, the following parameters will be collected:

1. Name, age and gender of the child.
2. Previous attendance of the kindergarten in months.
3. Question about sufficient language skills to understand the tasks.
4. Question about known illnesses or impairments.
5. Assessment of the importance of specific preventive examinations in the kindergarten setting.
6. Question about attitudes towards the introduction of standardised mobility screening in kindergarten.
7. Question about previous use of mother-child-pass examinations.
8. Question about perceived conspicuities in movement behaviour.
9. Question about the preferred course of action in cases of conspicuous outcomes.

There are several standardised and validated procedures to evaluate the motor skills of children at different ages, with the MobiScreen 4–6, and the M-ABC-2 being specific for detecting DCD. The children's motor skills will first be evaluated by conducting a screening (MobiScreen 4–6). The MobiScreen 4–6 is a time-efficient mobility screening tool to determine whether there are conspicuities in the motor skills development of children at the age of 4–6 and whether further examination is necessary.²⁸ To take the variable motor development in this age group into account, the MobiScreen 4–6 distinguishes three different time limits regarding the cut-off values (age of 4: 39 s, age of 5: 29 s and age of 6: 26 s) for completing a parcours of five different stations, including a slalom, overcoming and negotiating an obstacle, and manoeuvring a ball once with the feet and once with the hands. Criterion validity was tested using the motoric assessments M-ABC-2, *Leistungsinventar zur objektiven Überprüfung der Motorik von 3- bis 6-Jährigen* (LoMo 3–6) and the *Karlsruher Motorik-Screening für Kindergartenkinder* (KMS 3–6). The evaluation objectivity is given as very good, with $r=0.92$ (criterion total score) and $r=0.96$ (criterion total time). With a test–retest interval of 2 weeks, the stability is given as very good with $r=0.93$. Regarding diagnostic validity, the MobiScreen 4–6 has a very high sensitivity of 0.80–1.00 and a high specificity with values between 0.82 and 0.90. As required, the discriminatory power is in a high range, and norm values for 653 children from Germany are available. The given implementation time is about 20 children per hour. Another 2–3 min per child is needed for the evaluation.²⁹

In a second step, motorically conspicuous children shall be further tested using the M-ABC-2. It is the most commonly used motoric assessment in the field of DCD and is divided into eight subtests, which can be assigned to the following three dimensions: 'Manual dexterity',

'Aiming and Catching' and 'Balance'.³⁰ The test can be carried out for an age range of 3–16 years. It is organised across three age bands (3–6, 7–10 and 11–16), with individual tasks and scores for each age group.³¹

Dependent variables and analyses

For the first aim of this study—the determination whether DCD screening in kindergartens in Tyrol is warranted—the primary outcome variables will be (1) the prevalence of DCD as determined through MobiScreen 4–6 followed by M-ABC-2 assessments in a sample representative for the federal province of Tyrol and (2) within the group of DCD children, the percentage of those who have not yet been identified through either other screening procedures or through teacher or parent observations will be determined. Thereto, parents' questionnaires will include questions assessing whether their child has ever been diagnosed or suspected of having a motor conspicuity. These variables will be collected and descriptively evaluated using the statistical programme *jamovi*.³²

For the second objective—assessment of the feasibility of DCD screenings in Tyrolian kindergartens—we will analyse the following outcome variables: (1) parents' attitudes towards the implementation of a standardised screening protocol, assessed through questionnaires; (2) the percentage of children who participated in the screenings compared with the total number of children enrolled in the participating kindergartens; (3) documented qualitative observation data concerning children's compliance during the screening and (4) qualitative data from interviews with kindergarten teachers to obtain their feedback. The willingness of parents to have their child participate in a motor screening can be determined based on the consent forms for participation in this study. To determine the compliance of the children, the number of consent forms will be compared with the actual number of participating children (excluding illness, etc). The study provides documentation of both the number and reasons (such as fear or lack of motivation) for children who, despite having been provided consent by their parents, do not participate in the screening on the test day. The number of consent forms for a differentiated examination of conspicuous children through the motoric assessment M-ABC-2 will determine the parent's compliance for further clarification. This data will be analysed and presented descriptively. The collected qualitative data will be analysed using qualitative content analysis, according to Mayring.³³

For the third objective—validity assessment—all DCD children will be reassessed 6 months after their initial testing. As controls, two equally sized groups of children will be reassessed who (1) were identified as conspicuous in the MobiScreen 4–6 screenings but were not confirmed as DCD children in the M-ABC-2 assessments and (2) children who were not found conspicuous in the first screening. We aim to determine whether the test results persist over time as children undergo natural developmental changes, and how the results change

when parent-selected interventions are implemented. Therefore, parents will be asked whether further examinations have taken place, if therapy has been pursued, or if explicit efforts have been made, for instance, to enhance the child's motor skills through a specific sport or other developmental opportunities. This information will be evaluated descriptively, and by using qualitative content analysis, according to Mayring.³³

DISCUSSION

The implementation of a standardised mobility screening for kindergarten children is a matter of political deliberation. This study attempts to provide data for this decision-making process. We anticipate the following potential outcomes.

Scenario A: The study reveals a significant number of previously undetected motor deficits in children, supported by confirmatory follow-up testing, which warrants the adoption of standardised screenings. This would call for raising parental awareness, advocating early interventions and prompting policy reforms.

Scenario B: The study uncovers a notable number of previously undetected motor deficits in children, but follow-up testing fails to validate these findings. This may necessitate further research.

Scenario C: The study fails to reveal significantly more children with motor deficits compared with established methods. This suggests the effectiveness of current practices, such as parental or pedagogical observations. In such an instance, resources and research focus can be directed towards other facets of child development that may warrant attention.

Depending on the resulting scenario, the feasibility assessments conducted in this study can offer guidance for future implementations and policy adjustments or aid in shaping future research endeavours. Furthermore, the implementation of a standardised mobility screening for kindergarten-aged children in Tyrol, as proposed in this protocol, presents various potential risks and challenges. Below, some key risks are highlighted and presented with strategies to address them:

1. Low participation rate: Parents may express reservations about their children participating in mobility screening due to privacy concerns or worries about labelling. To mitigate this, the motor test of children with conspicuous results within the screening and the subsequent 6-month follow-up will be carried out individually and independently of the kindergarten. Furthermore, the research team should engage in extensive communication and educational efforts with parents and guardians, emphasising the study's importance, benefits and child privacy protection.
2. Data collection errors: Errors in data collection during screening or follow-up could compromise the study's validity. To minimise this risk, the research team should provide thorough training to investigators and ensure strict adherence to standardised procedures.

3. Selection bias: The potential for selection bias exists if certain characteristics make children more (eg, highly active children with well-developed motor skills) or less (eg, children with less interest in physical activity) likely to participate. This bias could affect the validity of the results. Thus, the research team should aim for a diverse and representative sample, actively collaborating with municipalities and parents to encourage participation.

ETHICS AND DISSEMINATION

Ethical issues

The clinical protocol and written informed consent forms for kindergartens and legal guardians received approval from the Research Committee for Scientific Ethical Questions (RCSEQ 3369/24), adhering to ethical principles outlined in the Declaration of Helsinki,³⁴ and ensuring compliance with all relevant local legal and regulatory obligations.

The main ethical issues are the protection of data privacy and the inclusion of underage participants with the consent of their parents or legal guardians. All potential participants will receive comprehensive information about the study's objectives and methodologies. Written consent must be given by the kindergarten and the guardians, while the participating children will be verbally asked for their consent on the day of the screening. Data security is a priority, and the research team must establish and enforce stringent confidentiality and privacy measures. Only authorised staff handle sealed envelopes with parental consent forms. After digitisation and password protection by the project manager, access is restricted to them, while analogue forms are securely disposed of, and test results are digitally recorded and password-protected for analysis by designated staff.

Contact addresses will be provided for further questions or in case of withdrawal.

Dissemination plan

The scientific results will be disseminated via articles submitted to peer-reviewed scientific journals and via presentations at scientific conferences. In addition, the data will be presented to the Tyrolean government.

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Competing interests None declared.

Patient and public involvement Patients and/or the public were involved in the design, or conduct, or reporting, or dissemination plans of this research. Refer to the Methods section for further details.

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