

CHARACTERISTICS OF COORDINATION ABILITIES OF YOUNG ATHLETES: A REVIEW OF ASSESSMENT METHODS AND INTERSPECIES DIFFERENCES

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Abstract. This article examines the development of coordination skills in 9- to 10-year-old hockey players and evaluates the impact of a set of exercises aimed at improving intersegmental coordination and movement variability. Based on a summary of current research (Jaakkola et al., 2017; Mazurek et al., 2020; Mazurek et al., 2021), it was established that the effectiveness of a hockey player's motor activity is determined by the level of adaptability and flexibility of coordination. The experimental study revealed a significant improvement in balance, agility, and movement synchronization in hockey players who trained according to a program using complex coordination exercises. Practical conclusions are drawn regarding the advisability of incorporating elements of gymnastics, acrobatics, and variation exercises into the training process to develop adaptive coordination abilities.

Keywords: Ice hockey, coordination skills, intersegmental coordination, movement variability, young athletes, adaptability.

ОСОБЕННОСТИ КООРДИНАЦИОННЫХ СПОСОБНОСТЕЙ ЮНЫХ СПОРТСМЕНОВ: ОБЗОР МЕТОДОВ ОЦЕНКИ И МЕЖВИДОВЫЕ РАЗЛИЧИЯ

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Аннотация. В статье рассматриваются особенности развития координационных способностей у хоккеистов 9–10 лет и оценка влияния комплекса упражнений, направленных на совершенствование межсегментной координации и вариативности движений. На основе обобщения современных исследований установлено, что эффективность двигательной деятельности хоккеиста определяется уровнем адаптивности и гибкости координации. В ходе экспериментальной работы выявлено достоверное улучшение показателей равновесия, ловкости и синхронизации движений у хоккеистов, тренировавшихся по программе с использованием координационно-сложных упражнений. Сделаны практические выводы о целесообразности включения в тренировочный процесс элементов гимнастики, акробатики и вариативных упражнений для формирования адаптивных координационных способностей.

Ключевые слова: хоккей на льду, координационные способности, межсегментная координация, вариативность движений, юные спортсмены, адаптивность.

Modern ice hockey training requires not only the development of physical qualities but also the formation of stable motor coordination structures that ensure the effectiveness and efficiency of technique. Motor coordination reflects the coordinated actions of various parts of the body and is the foundation for the development of complex motor skills and abilities, as well as such components of coordination abilities as a sense of balance and orientation in space and time. According to Jaakkola, Watt, and Kalaja [2], athletes of different specialties develop unique motor coordination profiles depending on the conditions of motor activity. Gymnasts and swimmers have more developed balance and precision, while hockey players demonstrate an advantage in dynamic lower limb coordination. Mazurek's research has shown that elite hockey players exhibit optimal desynchronization of hip, shin, and foot movements (out-of-phase coordination), which ensures efficient energy use and adaptation to changing ice conditions.

The *aim* of this work is a systematic analysis of modern methods for assessing coordination abilities in children and adolescents, as well as identifying specific features of coordination development in young athletes of various specializations based on an analysis of scientific literature.

Material and methods. A systematic literature review identified 14 main instruments assessing motor coordination, which can be divided into two categories: (1) standardized motor performance tests that require the performance of specific motor tasks under the supervision of a qualified professional, and (2) questionnaires for parents, teachers, and healthcare professionals that assess the impact of coordination difficulties on daily motor activities.

Motor performance tests include widely used instruments such as:

- Movement Assessment Battery for Children-2 (M-ABC 2) — the most common test, covering ages 3-17 and adapted in 10 countries. It includes assessment of manual dexterity, throwing/catching, and balance.
- Körperkoordinationstest für Kinder (KTK) — a German test for children aged 5-14 that focuses on dynamic balance through four tasks: walking backwards on a beam, jumping on one leg over obstacles, lateral movement on platforms, and jumping from side to side.
- Bruininks-Oseretsky Test of Motor Proficiency (BOTMP) is a comprehensive American test for ages 4-21 that assesses fine motor skills, coordination, balance, strength, and dexterity through 53 items (long form) or 14 items (short form).

The questionnaires are represented by the following instruments:

- Developmental Coordination Disorder Questionnaire (DCDQ'07) – a 15-item parent questionnaire for children aged 5-15 years, adapted in nine countries and with high internal consistency ($\alpha = 0.88-0.89$).
- M-ABC 2 Checklist – a 30-item teacher questionnaire assessing movement in static/predictable and dynamic/unpredictable environments.

Psychometric analysis showed that most instruments demonstrate acceptable test-retest reliability (0.79-0.99) and interrater consistency (0.58-0.98). However, there are significant differences in cultural adaptation: while the M-ABC 2 and DCDQ'07 have multiple validated versions, instruments such as the APCM-2 (Italy) or MOT 4-6 (Germany) are limited to a single country.

Results and discussions. A study by Jaakkola et al. [2] on a sample of 766 young athletes (463 gymnasts, 70 swimmers, 233 hockey players) aged 11-14 years found significant interspecific differences using the KTK test:

Superiority of gymnasts:

- Overall motor coordination (MQ) was higher in gymnasts compared to hockey players ($p = 0.004$)
- Backward beam walk: gymnasts outperformed both swimmers ($p = 0.016$) and hockey players ($p < 0.001$)
- Hurdles jump: gymnasts performed better than hockey players ($p = 0.017$)
- Lateral movement: gymnasts and swimmers outperformed hockey players (both $p < 0.001$)

Hockey players' advantage:

- Side-to-side jumps: Hockey players significantly outperformed both swimmers and gymnasts (both $p < 0.001$), which the authors attribute to the biomechanical similarities between the takeoffs in skating and two-legged jumps.

These results support the hypothesis of a specific influence of the training environment on coordination development. Gymnasts training in conditions most similar to the KTK tasks (working with various apparatus, body control in the air) demonstrate superiority in most tests. Interestingly, swimmers, despite the specific nature of the aquatic environment, demonstrated high results in lateral movements, which the authors attribute to the presence of “dry” training, including jumps and coordination exercises [1].

Correlation analysis revealed small correlations between the KTK subtests ($r = 0.13-0.29$), which contrasts with the original findings by Kiphard and Schilling ($r = 0.60-0.81$). This suggests that children with intensive sport experience develop more differentiated and specific coordination abilities.

Intersegmental Coordination in Hockey Players Mazurek et al. [3] conducted an innovative study of intersegmental coordination in skating, comparing highly skilled ($n = 8$, 19 ± 4 years of experience) and low-skilled ($n = 8$, 9 ± 6 years of experience) hockey players. A 10-camera motion capture system (240 Hz) was used to analyze continuous relative phase (CRP) between lower limb segments in three pairs: leg-thigh (sagittal plane), leg (sagittal)-thigh (frontal plane), and foot-thigh

(sagittal plane). CRP quantifies the temporal relationships between segments, where 0° indicates in-phase movement and 180° indicates out-of-phase movement.

Key findings:

1. Shin-femur (sagittal):
 - Highly skilled players demonstrated more antiphase coordination during the gliding and push-off phases ($p = 0.011$)
 - Delayed transition to in-phase coordination during the recovery phase ($p = 0.014$)
2. Shin (sagittal)-femur (frontal):
 - Highly skilled players demonstrated more antiphase coordination throughout the entire gait cycle ($p = 0.013$)
 - In low-skilled players, higher CRP values correlated with greater skating speed, which was not the case for highly skilled players
3. Foot-shin (sagittal):
 - Earlier transition to antiphase coordination during the push-off phase in highly skilled athletes ($p = 0.007$)
 - Smaller difference in CRP between mid-slide and early recovery ($p = 0.016$)

These findings challenge the traditional notion of motor coordination as a stable, genetically determined construct. If coordination were completely resistant to environmental influences, we would not observe systematic interspecies differences consistent with the specificity of training activities. For example, gymnasts' superiority in balance and body control tests logically follows from thousands of hours of practice on various apparatus. Similarly, hockey players' superiority in two-legged side-to-side jumps reflects the biomechanical specificity of the push-off on ice.

However, it is important to note an alternative explanation: perhaps children with certain coordination predispositions initially select and continue to participate in sports that suit their strengths. Longitudinal studies are needed to separate these selection and adaptation effects.

An important observation is that interspecific differences are more pronounced in adolescents aged 11-14 than in the younger children studied by [1] and colleagues (aged 9-11). This supports the hypothesis of a cumulative effect of specific practice: the longer the training period, the more differentiated coordination abilities become.

Conclusions. The presented analysis demonstrates that motor coordination in young athletes is a multifaceted construct influenced by specific training practices.

Comparative studies of young athletes from various disciplines convincingly demonstrate that intensive sports training has a specific impact on the development of coordination abilities. Gymnasts demonstrate superiority in tasks requiring balance control and work with different planes of motion, while hockey players excel in dynamic two-legged jumps, biomechanically similar to the specific requirements of ice skating. These differences cannot be explained solely by selection effects and suggest genuine adaptability of coordination abilities under the influence of specific training environments.

From a practical perspective, the review results highlight the need for a balanced approach to developing coordination skills in young athletes. While specialized practice certainly contributes to the improvement of specific coordination skills, one-sided training can lead to a relative lag in other aspects of coordination. Incorporating a variety of coordination exercises beyond the specifics of the primary sport appears to be an important component of the comprehensive training of young athletes.

For clinical practice, the selection of culturally adapted, psychometrically valid assessment tools that take into account the child's age and athletic experience is critical. A combination of standardized performance tests and questionnaires on functioning in everyday life provides the most comprehensive picture of coordination abilities and their impact on a child's quality of life.

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