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PILOT STUDY ON THE DEVELOPMENT OF HAND-EYE COORDINATION IN THEORETICAL HIGH SCHOOL STUDENTS

Alexandru Andrei GHERMAN[1], Albert OSTAFE[2*], Leon GOMBOŞ[3]

ABSTRACT. ***Introduction***: the study addressed the development of hand-eye coordination in high school students with a theoretical profile, recognizing its importance in both sport and cognitive performance. ***Objective***: the aim of the research was to examine the effects of a structured five-week training program on reaction time, coordination, and fine motor skills among adolescents. ***Material and methods***: three students, aged 15–16 years (two males and one female), participated in the study. All had prior experience with school handball training. the program was implemented over five weeks, with three sessions per week, each lasting 60–75 minutes. Ten exercises were included, such as ruler drop, reaction to cups with auditory cues, tennis ball drop at different levels, wall toss, and finger tapping. difficulty, repetitions, and tempo were progressively adjusted based on individual performance. ***Results***: preliminary findings indicated improvements in reaction time, bilateral coordination, and fine motor dexterity, with estimated progress of 10–15%. The greatest gains were observed in exercises emphasizing rhythm and accuracy. individual differences were noted, and the role of varying pauses, auditory cues, and exercise sequencing appeared to influence outcomes. improvements became evident after two weeks and were confirmed in the intermediary evaluation. ***Discussion***: the results were consistent with existing literature supporting the role of progressive coordination training in enhancing perceptual-motor abilities. The small sample size limited generalization but highlighted practical tendencies for future validation. ***Conclusions***: structured coordination training improved hand-eye coordination in adolescents. Future research with larger samples is recommended to establish broader applicability, especially for goalkeepers in theoretical high schools who have limited access to specialized programs.

Keywords: hand-eye coordination, high school students, training program, reaction time, motor skills, handball.

[1] Sports Game Department, Babeş-Bolyai University, Cluj-Napoca, Romania
[2] Physical Education and Sports Teacher at "Regina Maria Highschool", Dorohoi, Romania
[3] Sports Game Department, Babeş-Bolyai University, Cluj-Napoca, Romania
[*] Corresponding author: ostafealbertuel@gmail.com

INTRODUCTION

Even at the school sports level, we need to take into consideration developing psychomotor abilities such as eye-hand coordination, as modern athletic performance requires an interdisciplinary approach, in which psychomotor control plays a key role (Predoiu, 2015). Hand-eye coordination, a specific feature of the physical fitness, is effectively developed through competitive sports that engage the upper limbs. (Kaluga et al., 2020). This capability is fundamentally biometric and is closely related to other very important components of physical fitness such as speed, strenght or endurance (Kasmad et.al., 2020). It is an important component of the overall physical base, bearing in mind that physical conditioning serves as a vital supporting factor for basic technical execution in sports (Candra, 2020). It plays a crucial role in acquiring sports skills. (Stricker, 2002, as cited in Yadav, 2019). Also, eye-hand coordination is not only a sport aspect; it is a fundamental skills, very important for accurately executing everyday tasks that involve reaching, grasping or manipulating objects (Niechwiej-Szwedo, 2021).The primary rationale for this pilot study is to develop an accessible training program that can be utilized by the most physical education teachers, irrespective or heavy financial or time constraints. The proposed methods, materials, and tests are intentionally easy to acquire and implement, ensuring broad availability for an PE instructor. Handball players needs specific training to efficiently perform during the intermittent and demanded phases of the match (Gabrys et. al, 2020).

For a goalkeeper, speed and agility are paramount, and the quality of their movements is critically determined by underlying factors such as visual processing, reaction time, and perception (Eler & Eler, 2020). Furthermore, spatial anticipation plays a vital role, defined as the ability to predict the time and location where an object, such as a ball in team sports, will appear (Krawczyck et al., 2017). Therefore, an effective program must integrate exercises that specifically target both the speed of movement and the cognitive components of visual-motor processing. Hand-eye coordination represents a complex process involving the integration of ocular and manual motor systems. The execution of precise, timely, and skillful actions – such as reaching for or grasping small objects – relies on accurate visual information about surrounding environment and the simultaneous control of eye and hand movements (Rizzo et al., 2020).

Hand-eye coordination is fundamentally dependent on proprioceptive control. This control mechanism is essential not only for the optimization of sports performance and daily life activities but also for rehabilitation in medical conditions. In this context, studies show that proprioceptive deficiencies, which can manifest from early ages have direct effects on movement regulation (Szabo et al., 2021).

MATERIAL AND METHODS

Participants

The participant group consisted of a small, non-random convenience sample of three high school students (N=3; two males, one female) recruited from Regina Maria Highschool in Dorohoi, Romania. Participants ranged in age from 15 to 17 years. A key inclusion criterion was the absence of prior formalized training or competitive experience in performance sports or registered handball clubs, ensuring that the observed improvements could be predominantly attributed to the intervention program. The values from the next table are presented in cm, except the weight.

Table 1. Subjects measurements

Subject	Height	Waist	Weight	Bust	Length of arms	Length of lower limbs	Wingspan	Arm circ.
S1	175 cm	72 cm	65 kg	83 cm	80 cm	103 cm	184 cm	25 cm
S2	182 cm	91 cm	84.0 kg	97 cm	76 cm	94 cm	180 cm	30 cm
S3	177 cm	73 cm	62.7 kg	86 cm	79 cm	95 cm	178 cm	29 cm

The study was conducted with 3 students from Regina Maria Highschool Dorohoi. Their age is between 15 and 17. Two subjects are male and one female. Is important to mention that none of them had prior experience in performance sports or handball clubs. All of them were healthy, had a normal or corrected-to-normal vision and provided voluntary consent to participate. Also, because they are minors, written consent was also obtained from their parents.

The working hypothesis of the study stated that a progressive hand-eye coordination training program would produce a general improvement in motor performance ranging between 10-15%, reflected in enhanced reaction time, bilateral coordination, and fine motor execution speed.

The research questions are:

1. To what extent can a progressive hand-eye coordination program improve visuomotor reaction time in highschool students?
2. What is the impact of differentiated coordination exercises on bilateral control and precision of execution?

The experimental study took place at the Regina Maria Highschool in Dorohoi, Botoșani County, Romania. The intervention was structured over a four-week period, which included three evaluation stages. The initial testing was conducted on September 8, 2025, followed by the intermediate evaluations on September 23, 2025, and the final evaluation on October 6, 2025. The training program consisted of three sessions per week. Each training session lasted between 45 and 60 minutes and was designed to be highly concentrated. A key component of the protocol was the inclusion of all six primary exercises in every training session. This approach ensured continuous, balanced exposure to all perceptual motor demands, with the difficulty, repetitions, and tempo being progressively adjusted over time to maintain a high intensity and optimize individual progress.

A total of six exercises were used in this study for the development of hand-eye coordination. The exercises were related to the evaluation test, plus they needed to be adjusted to the participants' skill levels. They were simple in design and were progressively modified, following the principle of decreasing volume while increasing intensity over time.

First exercise – Ruler Drop

The training protocol applied a progressive overload model. Initial, the process starts with an acclimation of the participant with an initial drop height of 10 cm. Volume was systematically increased from two to three sets of 10 drops. The final phase intensified with sets of 10 drops from 5 cm, ensuring a high-intensity preparation for the measurements.

Second exercise – Two Tennis Ball Drop

The Two-Tennis Ball Drop Test assessed choice reaction time, requiring the participant to catch one of two randomly released tennis balls before hit the ground. The protocol applied three progressively difficult levels based on the drop height: Level I (shoulder height), Level II (intermediate height), and Level III (hip height). Training volume was progressively increased at each level, gradually introducing higher difficulty levels.

Third exercise – Alternate Hand Wall Toss

The exercise required participants to stand two meters in front of a wall and repeatedly throw a tennis ball with one hand while catching it with the other for 30 seconds. The wall was divided imaginatively into three zones (low, medium, and high) to help participants identify optimal target areas. Starting point was from one set of three repetitions focused on technique and rhythm, then progressed to two and finally three sets.

Fourth exercise – Modified Multiple Choice Reaction Time Drill

The exercise is adapted from the cone test, was conducted indoors due to unfavorable weather. Participants performed reaction speed tasks in response to auditory cues, by touching one or more cones placed on a desk. The exercise had three levels of difficulty, with higher levels included synchronized arm-leg movements to stimulate goalkeeper reactions. Directional commands ("left," "center," "right") and cues ("Stop" or "Move") were used to test reaction time and coordination.

Fifth exercise – Red Light, Green Light reaction drill:

The exercise was based on the classical "Red Light, Green Light" reaction test and was used throughout the program primarily for consolidation purposes. The task remains identical to the evaluation test: subjects had to react as quickly as possible to the visual stimuli (green light) displayed on the smartphone screen, following a red signal. The exercise was repeated systematically during the training sessions, maintaining the same structure, to improve reaction consistency and reduce variability in response time. Regular repetition also aimed to strengthen concentration and to stabilize visual-motor coordination.

Sixth exercise – Tap Test Simulation

The sixth exercise consisted of repeated simulations of the Tap Test, designed to enhance fine motor control and hand movement frequency. During the activity, the subject was seated on a chair with a desk in front. The arm was positioned on the table, extend from the elbow joint, with the hand placed above the smartphone screen. Each repetition lasted 10 seconds, during which the participant tapped the screen as quickly as possible.

First test – Ruler drop test

The ruler-drop test is a standardized test, applicable both in sports performance evaluation and in medical rehabilitation, particularly for concussion assessment and recovery monitoring (Del Rossi et. al, 2014).

Purpose: Determination of the reaction visual-motric time. Materials: 30 cm wood ruler, classroom. Procedure: The test was held like this: the subject stood upright at a distance of approximately half a meter from the examiner. The examiner held the 30cm ruler vertically, with the 0 cm mark aligned with the subject's fingers. The ruler was released randomly, without any other signals. The subject's task was to catch the ruler as quickly as possible after release, and to be as close as possible to the lowest point of the ruler.

Second test – Two Tennis Ball Drop Test

This test is a practical method to asses hand-eye coordination and reaction time using random stimuli. Similar protocols using reaction ball have been shown to significantly improve hand-eye coordination and speed response in athletes (Lenik et al., 2017).

Purpose: To evaluate reaction time and hand-eye coordination under random stimuli. Materials: Two tennis balls, classroom. Procedure: The examiner stood in front of the participant at a distance of approximately 1.5 meters, holding one tennis ball in each hand. The balls were positioned at shoulder lever of the examinator. The subject stood relaxed, with arms by their sides. Without any signal, the examiner released one of the tennis balls, and the participant had to catch it before it touched the floor. The tennis balls were released randomly.

It was counted the number of tennis balls caught, touched or missed. Also, we counted the hand from which the ball was released (left or right). Each participant performed 10 repetitions at shoulder height.

Third test: Multiple Choice Reaction Time Test

Purpose: To assess reaction time in situations with multiple motor response options, typical in oppositions sports. Materials: 3-4 cones, digital stopwatch, smartphone (for recording), flat area (40x20m field). Procedure: The subject stood at the starting line in a reaction stance with slightly bent knees. One, two or three cones were placed 5 meters ahead, depending on the level of the test level. The examiner randomly announced a direction (left, center or right), and the subject had to move as quickly as possible to touch the indicated cone. Timing stopped when the subject touched the cone. Each level included six trials, and the final score was the average of the recorder times.

Fourth test – Alternate Hand Wall Toss Test

The Alternate Hand Wall Toss Test is considered a valid, and reliable measure of dynamic hand-eye coordination. Its validity was demonstrated in a large-scale study on Korean children (n = 2753), where researchers confirmed the capacity of the test to distinguish coordination levels based on adequate wall distance (Cho et al., 2020)

Purpose: To evaluate bilateral coordination and manual reaction speed**.** Materials: Tennis ball, smooth wall, stopwatch**.** Procedure: The subject stood 2 meters from the wall. The task was to throw the ball with one hand and catch it with the other continuously for 30 seconds. Each participant performed two sets of 30 seconds. If the ball dropped, the participant continued the exercise, but the number of errors and successful throws was recorder.

Fifth test – Red Light Green Light Test (University of Washington)

The Red Light Green Light Test is a valid method to asses simple visual reaction time using a mobile device. Prior research shows that smartphones can accurately measure reaction times in response to visual stimuli, fact that provides validity and the possibility of reproductibile results (Burke et al., 2017). Purpose: To determine visual reaction time to light stimuli. Materials: Smartphone with internet connection. Procedure: The subject sat on chair with the forearm resting on a table and with the hand above the smartphone. The app simulated a traffic light, staring with red light. The subject had to press the screen as quickly as possible when the green light appeared. Each participant completed five repetitions, and the average reaction time was calculated.

Sixth test – Tap test

This test is validated for assessing fine motor speed and neuromuscular integrity. Although this aspect was traditionally administered by specialized devices, recent research confirms that the use of a smartphone application demonstrates acceptable reliability and known groups validity (Bohannon & Wang, 2021).

Purpose: To evaluate motor reaction speed and finger tapping frequency. Materials: Smartphone with internet connection. Procedure: The subject sat on a chair with the forearm resting on a table and the hand above the touch screen. After starting the app, the participant triggered the timing by pressing a button. The participant had 10 seconds to perform as many progressive raps on the screen as possible. The number of taps was automatically recorded by the app.

RESULTS

Ruler Drop Test – Results and Interpretations

According to the testing protocol, each participant performed three trial attempts before every evaluation phase, with a 15-second pause between the familiarization and the actual testing series. The mean value for each stage was calculated based on six valid attempts, in order to minimize the effect of random error and enhance measurement reliability.

Subject 1 started with a mean value of 13.16 cm, registering two peak values of 17 cm during the initial testing. During the intermediate stage, the results became more stable, ranging between 5 and 12cm, indicating a visible improvement in consistency and reaction control. At the final evaluation, the average results remained within the 11-12 cm range, suggesting that the subject maintained the achieved progress and developed a steady visuomotor response pattern. Compared to the three initial values above 13 cm, the subject demonstrated a clear evolution toward faster and more controller reactions. Subject 2 showed the most significant improvement. Starting from maximum initial values around 16 cm, the participant progressed to the point where no value exceeded 9 cm at the final testing, achieving a best score of 5 cm. Subject 3 also displayed measurable improvement. While the initial test included three values above 12 cm, the final evaluation presented stable scores between 9 and 10 cm, indicating enhanced attention and timing accuracy.

Overall, all three participants exhibited progress between the initial and final measurements. The greatest changes were recorder between the first and second stages, where adaptation and concentration mechanism appeared to consolidate. The final results confirm that the progressive coordination program contributed to faster visuomotor reaction times and a reduction in performance variability, especially for Subjects 1 and 2.

Table 2. Results of the first test

SUBJECT	INTIAL	INTERMEDIATE	FINAL
Subject 1	13.16 cm	11.6 cm	12.1 cm
Subject 2	12.16 cm	14.1 cm	7.6 cm
Subject 3	10.3 cm	11.8 cm	9.16 cm

Second test – Two Tennis Ball Drop Test

The performances in this test showed significant progress compared to the initial evaluation. However, the main difficulty was not related to the number of dropped balls, but rather the number of tennis balls touched without being caught.

Starting from the intermediate stage, both Subject 1 and Subject 3 began to convert their touches into successful catches – each improving by two balls on average. Their progress continued during the final testing, where Subject 1 added two more caught ball, and Subject 3 added one additional successful catch. The total number of errors (missed balls) decreased progressively – from four in the initial test, to three in the intermediate, and finally zero in the last stage. The reduction demonstrates a clear improvement in control, anticipation, and catching precision.

The main reasons for these improvements include: working through progressive difficulty levels, where the other two training levels were more challenging than the one used in testing, improvements of catching technique, with a more relaxed hand and adjusted finger positioning to reduce strong contact and prevent ball deflection, inclusion of the wrist relaxation drills, which helped increase fluidity and reaction efficiency during the catching movement

These technical adjustments, combined with repeated exposure to variable stimuli, likely contributed to a learning effect, reflected in better timing, anticipation, and decision-making speed.

Legend of the table: C – catched tennis balls, T – touched, M – missed

Table 3. Results of the second test

SUBJECT	INITIAL	INTERMEDIATE	FINAL
Subject 1	C – 3, T – 4, M – 2	C – 7, T – 2, M – 1	C – 9, T – 1, M – 0
Subject 2	C – 2, T – 5, M – 2	C – 1, T – 7, M – 1	C – 9, T – 1, M – 0
Subject 3	C – 7, T – 3, M – 0	C – 8, T – 1, M – 1	C – 9, T – 1, M – 0

Third test: Multiple Choice Reaction Time Test

The Multiple Choice Reaction Time Test did not show significant changes in reaction times over the course of the study. However, improvements were observed in technique and efficiency. Notably, subjects demonstrated better movements trajectories and were increasingly able to avoid the tendency to move in the opposite direction of the announced target. These refinements are particulary relevant for decision-making in handball goalkeepers, as they enhance the ability to react accurately and efficiently during gameplay. An important aspect of the test was the inclusion of difficulty-based levels. The differences between the first two levels, however, are minimal. The values in the table are in seconds.

Table 4. Results of the third test

SUBJECT	INITIAL	FINAL
Subject 1	I – 1.99, II – 1.92, III – 1.95	I – 1.77, II – 2.17, III –2.77
Subject 2	I – 1.81, II – 1.90, III – 1.92	I – 1.84, II – 2.09, III – 2.00
Subject 3	I – 1.64, II – 1.77, III – 1.69	I – 1.65, II – 1.87, III – 1.76

Fourth test – Alternate Hand Wall Toss Test

Significant improvements were observed from the first assessment, particularly in the intermediate evaluation. Subject 1 demonstrated the most notable progress, reducing errors from 9 in the initial 2 series of 30 seconds to only 4 in the final assessment, and even achieving 0 errors during the intermediate evaluation.

All three subjects showed substantial gains in tennis ball-catching performance. Subject 1 improved from 10 catches in the initial evaluation to 24 in the final assessment, with the intermediate evaluation reaching 26 catches, close to the final maximum of 25. Subject 2 also progressed, achieving 29 catches in the final assessment compared to 23 initially and 25 in the intermediate evaluation. Subject 3 developed greater stability, increasing from a maximum of 21 catches in the first evaluation to 27 in the final one.

Key factors contributing to these improvements included focusing on imaginary target zones to ensure direction, control and stability during throws, and performing movement on the tennis balls of the feet, which promotes continuous motion – a critical skill for handball goalkeepers. In the table, the values in parentheses represent: the first value - the number of balls caught, the second value - the number of errors (or mistakes).

Table 5. Results of the fourth test

SUBJECT	INITIAL	INTERMEDIATE	FINAL
Subject 1	I (8-5)/2 (10-4)/A (10-5)	I (26-0)/2 (26-0)/A (26-0)	I (23-2)/2 (25/2)/A (24-2)
Subject 2	I (19-1)/2 (23-0)/A (10-5)	I (26-0)/2 (26-0)/A (26-0)	I (29-0)/2 (25/3)/A (27-2)
Subject 3	I (21-0)/2 (18-1)/A (19,5-1)	I (20-0)/2 (21-0)/A (20.5 – 0)	I (27-0)/2(22-3)/A (25-2)

Fifth test – Red Light Green Light Test (University of Washington)

The Red Light Green Light test showed minimal differences in scores compared to other assessments. However, the key improvements was observed in participants' decision-making and technique. Subjects became increasingly able to quickly choose between two colors and respond as accurately as possible.

Table 6. Results of the fifth test

SUBJECT	INITIAL	FINAL
Subject 1	0.4402	0.436
Subject 2	0.4718	0.577
Subject 3	0.4	0.439

Sixth test – Tap test

All three subjects showed improvement from the initial to final assessment, indicating overall gains in hand-eye coordination and execution speed. The marked increase between the intermediate and final evaluations for Subjects 2 and 3 suggests that the prior exercises focused on coordination and catching had a cumulative effect, preparing the subjects to perform the test more efficiently. The results from the table show the number of taps.

Table 7. Results of the sixth test.

SUBJECT	INITIAL	INTERMEDIATE	FINAL
Subject 1	73	74	76
Subject 2	71	77	97
Subject 3	68	68	87

DISCUSSION

As noted by Baloga & Șandor (2019, p. 73), "the most important asset for a basketball player is the coordination of the body and mind, defined as the minimum effort made in order to obtain the easiest and almost perfect shot to the basket." This statement encapsulates the essence of hand–eye coordination as a fine-tuned process of perceptual regulation and motor precision. Building on this concept, educational programs that cultivate rhythmic control, stable postural alignment, and visual focus can effectively translate high-performance motor control principles into physical education contexts.

Negru (2023, p. 50) emphasized that "balance is defined as quick postural adaptation against changes in the centre of gravity at the time of activity." This finding underscores the biomechanical foundation of dynamic balance as a prerequisite for efficient coordination. Although no direct correlation was found between strength and balance measures, the study revealed improvements in successive balance trials, suggesting that repeated exposure and attentional calibration enhance stability through practice.

Balla & Hanțiu (2017, p. 114) found that "the degree of trunk asymmetry was lower in subjects who live in rural areas compared to those from urban environments," linking habitual physical activity with postural alignment and proprioceptive equilibrium. Such evidence indicates that natural movement variety and frequent engagement in physical activity contexts reduce asymmetrical load patterns, which in turn support eye–hand coordination and motor balance among youth populations.

Prodea & Pătrașcu (2011, p. 33) reported that "the need to continuously improve the motoric learning led up to an increased attention towards the mental algorithms that influence learning." Inaccurate verbal or visual cues were shown to disrupt the encoding of motor responses, highlighting the pedagogical importance of precise and consistent communication during coordination-based instruction. This reinforces the role of clear feedback and reinforcement in optimizing motor learning efficiency.

These findings suggest that coordination development among students is multifactorial shaped by perceptual acuity, balance control, proprioceptive feedback, and communication accuracy. As demonstrated by Baloga & Șandor (2019), Negru (2023), Balla & Hanțiu (2017), and Prodea & Pătrașcu (2011), structured yet adaptable practice environments that emphasize both cognitive engagement and physical stability yield sustainable improvements in reaction time and hand–eye synchronization.

LIMITS

This pilot study has several limitations, primarily due to the small sample size (N=3, understandable given the highly niche focus on theoretical high school students). A key constraint is the reduced five-week intervention period, which limits the observation of long-term skill retention. Nevertheless, the structured program demonstrated numerous positive trends and can serve as an effective foundation for future research with the perspective of observing sustained improvements over a longer period.

CONCLUSIONS

The working hypothesis, anticipating a 10-15% general improvement, is confirmed and significantly surpassed by most of the results of the five-week intervention. The structured training effectively enhanced perceptual motor skills, particularly in complex tasks. For example, bilateral dynamic coordination (Wall Toss Test) improved by 50,50%, with not many changes concerning the mistakes, bearing in mind the fact that in the intermediate evaluation all of the subjects had 0 mistakes. The reduction of errors in the Two Tennis Ball Drop demonstrated a 100% elimination of missed tennis balls and a 125% increase in successfully caught tennis balls.

Regarding first research question, we can affirm that both the Ruler Drop Test and Two Tennis Ball Drop Test indicated consistent improvement in visuomotor reaction, especially after the intermediate evaluation phase. The adaptation of neuromotor pathways, combined with visual anticipation drills, contributed to faster and more stable reactions. Anticipation skills were particularly developed through the strategies adopted by the subjects during the Alternate Hand Wall Toss Test.

Concerning the second research question, observable improvements were noted in attention control and motor response stability. Repetition and task variation enhanced selective attention and visual regulation, resulting in more consistent performance and reduced variability across trials. In the Tap

Test, participants demonstrated greater focus and rhythm, maintaining a constant tapping frequency throughout the 10 seconds interval, with fewer pauses or missed taps.

AUTHOR CONTRIBUTIONS

Alexandru Andrei GHERMAN, Albert OSTAFE, and Leon Gomboș contributed equally to the design and implementation of the research, to the analysis of the results, and to the writing of the manuscript. All authors had equal rights and responsibilities in the preparation of this work. All authors have read and agreed to the published version of the manuscript.

CONFLICT OF INTEREST

The authors declare that they have no conflict of interest related to this research.

REFERENCES

Balla, B. J., & Hanțiu, I. (2017). Trunk asymmetry at children: Risk factors. *Timișoara Physical Education and Rehabilitation Journal*, 10(19), 114–120. https://doi.org/10.1515/tperj-2017-0027

Baloga, I., & Vizi, S. (2019). Factors influencing basketball shooting. *Studia UBB Educatio Artis Gymnasticae*, *64*(3), 71–76. https://doi.org/10.24193/subbeag.64(3).23

Bohannon, R. W., & Wang, I. (2021). Measurement of finger tapping performance using a smartphone application: a pilot study. *Journal of Physical Therapy Science*, 33(8), 618–620. DOI:10.1589/jpts.33.618

Burke, D., Linder, S., Hirsch, J., Dey, T., Kana, D., Ringenbach, S., Schindler, D., & Alberts, J. (2017). Characterizing Information Processing With a Mobile Device: Measurement of Simple and Choice Reaction Time. *Assessment, 24*(7), 885–895. DOI:10.1177/1073191116633752

Candra, O. (2020). The Contribution of Eye-Hand Coordination to Basketball Lay Up Shoot Skills. *In 1st Progress in Social Science, Humanities and Education Research Symposium* (PSSHERS 2019). https://doi.org/10.2991/assehr.k.200824.192

Cho, J., Yun, K., & Kim, Y. (2020). The Validity of Alternative Hand Wall Toss Tests in Korean Children. *Journal of Men's Health*, *16*(1), 166–171. DOI:10.15586/jomh.v16i1.166

Del Rossi, G., Malaguti, A., & Del Rossi, S. (2014). Practice effects associated with repeated assessment of a clinical test of reaction time. *Journal of Athletic Training*, *49*(3), 356–359. DOI:10.4085/1062-6059-49.2.04

Eler, S., & Eler, N. (2020) The Relationship Between Hearing Level and Speed and Speed of Linear Direction Change of Handball Players with Heating Impairments. *The Journal of Eurasia SportSciences & Medicine*, *2*(2), 202. http://dergipark.gov.tr/jessm

Gabrys, T., Stanula, A., Gupta, S., Szmatlan-Gabrys, U., Benešová, D., Wicha, Ł., & Baron, J. (2020). A Comparative Study on the Performance Profile of Under-17 and Under-19 Handball Players Trained in the Sports School System. *International Journal of Environmental Research and Public Health*, *17*(21), 7979. DOI:10.3390/ijerph17217979

Kaluga, E., Straburzyinska-Lupa, A. & Elzbieta, R. (2020) Hand-eye coordination, movement reaction time and hand tactile sensitivity depending on the practiced sports discipline. *The Journal of Sports Medicine and Physical Fitness*, *60*(1). DOI: 10.23736/S0022-4707.19.09726-3

Kasmad, M. R., Badaru, B., & Rosmanita, N. (2020). The Effect of Hand-Eye Coordination, Wrist Flexibility, and Self-Confidence on Serve Ability in Badminton on Senior High Schools Students. In *1st Progress in Social Science, Humanities and Education Research Symposium* (PSSHERS 2019) (pp. 64-68). Atlantis Press. https://doi.org/10.2991/assehr.k.201027.051

Krawczyk, P., Bodasinski, S., Bodasinska, A., & Slupczynski, B. (2018). Level of psychomotor abilities in handball goalkeepers. *Baltic Journal of Health and Physical Activity*, *10*(3), Article 7. https://doi.org/ 10.29359/BJHPA.10.3.07

Lenik, P., Przednowek, K., Śliż, M., Bobula, G., & Lenik, J. (2017, December). The impact of exercises with a reaction ball on the eye-hand coordination of basketball players [conference session]. *11th International Conference on Kinanthropology "Sport and Quality of Life",* Brno, Czech Republic.

Negru, I. N. (2023). Relationship between strength/power and dynamic balance in 1st-year undergraduate students: Pilot study. *Studia UBB Educatio Artis Gymnasticae*, *67*(2), 49–55. https://doi.org/10.24193/subbeag.68(2).14

Niechwiej-Szwedo, E., Wu, S., Nouredanesh, M., Tung, J., & Christian, L. W. (2021). Development of eye-hand coordination in typically developing children and adolescents assessed using a reach-to-grasp sequencing task. *Human Movement Science*, *80*, 102868. https://doi.org/10.1016/j.humov.2021.102868

Predoiu, R. (2015). Intersegmental and Eye-hand Coordination in Elite Junior Tennis Players. *Procedia - Social and Behavioral Sciences*, *187*, 107–112. https://doi.org/10.1016/j.sbspro.2015.03.021

Prodea, C. C. I., & Pătrașcu, A. (2011). The errors in communication influence on the efficiency of physical exercises. *Studia UBB Educatio Artis Gymnasticae*, *56*(4), 31–37.

Rizzo, J.R., Beheshti, M., Tahereh, N., Feiz, F., Fatterpekar, G., Balcer, L., Galetta, S., Shaikh, A., Rucker, J., & Hudson, T. (2020) The complexity of eye-hand coordination: a perspective on cortico-cerebellar cooperation. *Cerebellum Ataxias, 13*; 7:14. doi: 10.1186/s40673-020-00123-z

Szabo, D., Neagu, N., Teodorescu, S., Panait, C.M., & Sopa, I.S. (2021). Study on the Influence of Proprioceptive Control versus Visual Control on Reaction Speed, Hand Coordination, and Lower Limb Balance in Young Students 14-15 Years Old. *Int J Environ Res Public Health.*, *18*(19), 10356. doi: 10.3390/ijerph181910356

Yadav, D. R. (2019). Evaluation of hand eye coordination between sportsmen and nonsportsmen. *International Journal of Physical Education, Sports and Health*, *6*(4), 121–124.