09/05/2024

General information

Protocol title: **The Impact of Judo Training on Physical Fitness and Psychological Indicators of People with Autism Spectrum Disorders**

Name and address of the funder: **Poznań University of Physical Education, Królowej Jadwigi 27/39, 61-871 Poznań**

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Rationale & background information

Research on judo training in individuals with autism spectrum disorder (ASD) will enable a better understanding of the complex interactions between changes in physical fitness during adolescence in individuals with ASD. In the initial phase, judo training combines play-based activities and movement games, which influence psychosocial behaviors, peer interactions, and the acquisition of new motor skills, thereby expanding the functional capacities of participants. Judo constitutes a form of physical activity that provides particularly favorable conditions for ensuring the comprehensive development of children and adolescents, regardless of the presence of developmental disorders (Oblak, Karpljuk et al., 2020).

The present research project aims to analyze the effects of judo training on the level of physical fitness and generalized self-efficacy, state anxiety, and trait anxiety in individuals with ASD participating in integration groups together with neurotypical individuals. Previous studies indicate that judo training reduces the severity of symptoms in individuals with ASD (Morales et al., 2022). It has been demonstrated that a 13-week mixed martial arts (MMA) training program significantly improved executive functions (behavioral inhibition, working memory, and cognitive flexibility) in children with ASD compared to children who did not participate in the training (Phung & Goldberg, 2019). It has also been shown that grappling-based sports training exerts therapeutic effects in individuals with ASD, which may result from close-contact tactile interactions (Rassovsky, 2019). Furthermore, parents of children with ASD observed improvements in social competencies and self-esteem following an eight-week judo training program (Riviera & Renziehausen, 2020). Studies show that people with ASD have a lower quality of life than neurotypical people of the same age and developmental stage (Ayres & Parr et.al 2018)

A substantial body of contemporary scientific research focuses on identifying forms of physical activity that yield positive outcomes for individuals with neurodevelopmental disorders. It has been demonstrated that children with ASD exhibit motor impairments, such as abnormal gait patterns, atypical muscle tone, balance difficulties, and poor motor control (Gueity-Rodrigueaza, Ogonowska-Słodownik et al., 2021). It has also been reported that children with ASD are less physically active, engage in fewer exercise activities, and demonstrate lower heart rate responses compared to typically developing children (Pace & Bricout, 2015; Coffey,

Sheehan et al., 2021). Evidence suggests that children with ASD should begin sports training immediately after diagnosis and participate in physical activities alongside neurotypical peers (Arslan, Ince et al., 2019), in order to support proper cardiovascular–metabolic functioning and cardiorespiratory fitness (Pierantozzi & Morales, 2022).

However, to date, no studies have examined the effects of judo training on physical fitness levels in children and adolescents with ASD conducted within integration groups involving neurotypical individuals. Moreover, the longest reported post-training observation period has been limited to 13 weeks (Phung & Goldberg, 2019), whereas the present research project proposes a 10-month observation period conducted during the school year in Polish educational institutions. Previous studies have been carried out outside Poland and in a fragmented manner. A review of the literature indicates that no research project has yet undertaken a comprehensive analysis of changes in physical fitness levels—assessed before, during, and after the intervention—resulting from a structured judo training program consisting of two training sessions per week and adapted to the school year within a given country.

The aforementioned findings, together with the identified research gap, provided the rationale for undertaking the present study addressing a disorder that affects individuals of all genders, irrespective of race or geographical location, and for which a more than fiftyfold increase in diagnostic prevalence has been reported over the past two decades. (Takumi et al., 2020; Thapar i Rutter 2021).

Study goals and objectives

The aim of the study is analyze changes in physical fitness before, during and after of judo training and generalized self-efficacy, state and trait anxiety in children and adolescents with autism spectrum disorder before and after of judo training conducted in a group with neurotypical individuals.

Study design

This is an interventions study. The intervention included judo training sessions to evaluate their influence on physical fitness and psychological indicators. The research will be conducted among participants aged 7–14 years with a confirmed diagnosis of autism spectrum disorder (ASD), without intellectual disability and without impairments in language functioning. The planned sample size was approximately 100 participants. Only individuals without medical contraindications to engaging in physical activity were eligible for inclusion in the study.

The judo training process was conducted in accordance with the school year in the Polish educational system, from September to June, over a period of 10 months. Participants' health status was monitored throughout the study, including injuries and medical conditions that could be exacerbated during sports activities and physical fitness testing, with particular attention paid to cardiovascular conditions and musculoskeletal disorders. Individuals participating in other extracurricular sports activities were not eligible for inclusion in the study.

Participants could be withdrawn from the study at any time at their own request (or at the request of their legal guardians), for health-related reasons, or for other reasons at the discretion of the principal investigator or a member of the research team.

Methodology

Changes in physical fitness levels will be assessed using the European Physical Fitness Test (EUROFIT), comprising eight test items (Council of Europe, 1983). The 20-m multistage shuttle run test was excluded from the assessment due to the auditory signals required during its execution and the unpredictable behaviors of the study participants. In order to standardize the results obtained in the individual test items, participants' raw scores will be converted into age-adjusted point scores, with age calculated to the nearest three months. The normative values used to convert raw scores into points are based on reference standards for children and adolescents from the Polish population (Dobosz, 2012; Dobosz, 2012).

Measurements were performed at three time points: before the commencement of the training process, after five months, and upon completion of the training program

The European Physical Fitness Test - EUROFIT
The European Physical Fitness Test (EUROFIT) was employed to determine the level of physical fitness. The EUROFIT test was used to measure the level of balance (Flamingo Balance Test), hand movement speed (Plate Tapping Test), explosive power (Standing Broad Jump), flexibility (Sit and Reach Test), static strength (Hand Grip Test), trunk strength (Sit-Ups Test), functional strength (Bent Arm Hang) and agility (10 x 5 m Shuttle Run).

Flamingo Balance Test
The balance test was performed using a wooden beam measuring 50 × 4 × 3 cm, equipped with two supports (15 × 2 cm each) and end stops to provide stability. Participants were instructed to maintain balance while standing on the beam on one self-selected leg, aligned with the longitudinal axis of the beam. The free leg was flexed at the knee, and the participant had to grasp the foot of the free leg with the hand on the same side, maintaining an upright posture. Before the main trial, participants were allowed to use the shoulder of an assistant to achieve the correct starting position. The trial commenced at the moment the participant released the assistant's shoulder. The task was to maintain the prescribed position for 60 seconds. The trial was terminated whenever balance was lost, after which the participant repeated the attempt. The test was evaluated based on the number of attempts required to maintain balance for the full 60-second duration.

Hand Movement Speed Test (Plate Tapping Test)
The hand movement speed test was conducted using a height-adjustable table (or a gymnastic box of equivalent height). Two rubber discs (20 cm in diameter) were horizontally affixed to the table surface, with the centers of the discs positioned 80 cm apart. A rectangular plate (10 × 20 cm) was placed midway between the discs to serve as the central reference area. A digital stopwatch was used for timing. Participants stood in a small straddle stance in front of the table. The non-dominant hand was placed flat on the central rectangular plate, while the dominant hand was positioned on one of the outer discs. Upon the command "ready—start," participants were instructed to move the dominant hand alternately between the two discs, passing it over the stationary non-dominant hand as quickly as possible. Each disc had to be touched on every movement. One trial consisted of 25 complete cycles (50 total touches). Participants stopped the movement on the command "stop." To maintain consistency, participants were instructed to count each completed cycle aloud. Each participant performed two trials, with a brief rest

interval between them. The best (shortest) time obtained across the two attempts was recorded as the final score.

Explosive Power Test (Standing Long Jump)
The assessment of lower-limb explosive power was performed using two connected gymnastic mats (or an exercise mat), chalk, and a measuring tape. Participants stood in a parallel stance with feet shoulder-width apart, positioned just behind a designated starting line. From this position, they executed a preparatory movement involving a slight forward lean of the trunk, knee flexion, and a backward arm swing. This was immediately followed by a vigorous forward arm swing and a simultaneous two-foot take-off, jumping forward as far as possible. The landing distance was measured from the starting line to the nearest heel mark left on the mat. Each participant performed three jumps, and the longest distance (in centimeters) was recorded as the final result.

Flexibility Test (Sit and Reach Test)
The flexibility test was carried out using a custom-built measuring table (length: 35 cm; height: 32 cm; width: 45 cm) with an extended top surface measuring 55 cm in length. The tabletop extended 15 cm beyond the front vertical board, which served as a foot support. A measurement scale (0–50 cm) was marked along the longitudinal axis of the tabletop. A movable measuring ruler, approximately 30 cm in length, was placed perpendicularly across the table surface, allowing participants to slide it forward with their hands during trunk flexion. Participants were seated on the floor in an upright position with their legs extended and the soles of the feet placed flat against the front wall of the table (or box). Keeping the knees fully extended, they slowly leaned forward, reaching as far as possible with both hands, and moved the ruler forward along the tabletop in a smooth, continuous motion. Each participant performed two trials. The greater of the two reach distances (measured in centimeters) was recorded as the final result.

Static Strength (Hand Grip Test)
Static muscular strength was assessed using a calibrated hand dynamometer. Participants stood in a small straddle stance with the testing arm extended naturally along the side of the body, ensuring that the hand did not touch the torso during measurement. The dynamometer handle was held firmly in the fingers, adjusted to fit the participant's hand size. Upon the examiner's signal, participants performed a brief maximal contraction by squeezing the dynamometer with maximal effort for approximately 2–3 seconds. The non-testing arm remained relaxed alongside the body. Each participant completed two trials with the dominant hand. The higher of the two readings was recorded as the final score, expressed in kilograms (kg) with an accuracy of 1 kg. Due to the specific nature of the study group, measurements were taken on both hands, and the hand that achieved the better result was selected for analysis.

Trunk Strength Test (Sit-Ups Test)
Trunk muscle strength was evaluated using the 30-second sit-ups test. Participants lay in a supine position on a gymnastics mat with the knees flexed at a 90° angle and the feet positioned approximately 30 cm apart. The fingers were interlaced and placed behind the head. An assistant kneeling between the participant's feet stabilized them by pressing gently against the mat. At the examiner's signal, participants performed repeated sit-ups by lifting the upper body until both elbows touched the knees, then returning immediately to the supine position so that the interlaced fingers briefly contacted the mat. During the movement, participants were instructed not to use their elbows or arms to push off the mat.

Performance was evaluated as the total number of correctly executed sit-ups completed within 30 seconds.

Functional Strength Test (Bent Arm Hang)

Functional upper-body strength was assessed using the bent arm hang test. Participants stood on a raised platform and grasped a horizontal bar with a pronated (overhand) grip, ensuring that the elbows were bent and the chin positioned above the bar without making contact. Upon removal of the support from under the feet, the participant maintained the initial position for as long as possible without any part of the body touching the bar or swinging excessively. Performance was recorded as the total duration of the hang, measured in seconds, from the moment the support was removed until the chin dropped below the level of the bar.

Agility Test (10 x 5 m Shuttle Run)

Running - Agility were assessed using a 10 x 5 m shuttle run test. Two parallel lines were marked 5 m apart on a flat, non-slip surface. Participants began from a standing split stance position behind the starting line. Upon the command "start," they sprinted to the opposite line, crossed it completely with both feet, and immediately returned to the starting line. This sequence was repeated until completing a total of ten 5 m segments (five full cycles). Each participant performed the test once. The total time required to complete the 50 m distance (five cycles) was recorded to the nearest 0.1 second using a stopwatch (Council of Europe, 1983; Cvejic et al., 2013).

The Maximal Multistage 20-m Shuttle Run Test was not used in this study. This test is a part of the EUROFIT test but was excluded due to the presence of audible signals during the test, signaling the start of the next stage of the run. This raised concerns among the research team about potential reactions in individuals with autism spectrum disorder, which could affect the proper conduct of the test, and the failure to provide a true measurement of aerobic endurance.

The results obtained by the subjects in each term were converted into points adjusted to the age and gender of the subjects, in accordance with the scoring tables developed for Polish children and adolescents (Dobosz, 2012; Dobosz, 2012).

Generalized Self-efficacy (GSES)

Self-efficacy was measured using the Polish adaptation of the Generalized Self-Efficacy Scale (GSES), developed by Z. Juczyński. This instrument assesses the strength of an individual's general belief in their ability to effectively cope with difficult situations and obstacles. The scale consists of 10 items, which participants rated using a four-point Likert scale (1 = "No", 2 = "Rather no", 3 = "Rather yes", 4 = "Yes"), (Juczyński, 2012).

State and Trait anxiety (STAI-C)

State and trait and anxiety were assessed using the Polish adaptation of the State-Trait Anxiety Inventory for Children (STAI-C). This instrument consists of two separate subscales: C-1 (State Anxiety), which evaluates anxiety as a transient and situationally determined emotional state, and C-2 (Trait Anxiety), which measures anxiety as a relatively stable personality trait.

Extant research indicates that the C-1 scale is particularly effective in experimental designs requiring the monitoring of fluctuations in anxiety intensity, whereas the C-2 scale is utilized to identify children with neurotic tendencies. State Anxiety (C-1): This subscale comprises 20 items. Participants responded using a 3-point Likert scale (1 = "Yes", 2 = "Rather yes", 3 = "No"). The questionnaire included 11 reverse-scored items. The total score was calculated as the sum of points across all items. Trait Anxiety (C-2): This subscale also consists of 20 items, with responses provided on a 3-point scale (1 = "Rarely", 2 = "Sometimes", 3 = "Often"). The final result was determined by the aggregate score of all responses (Jaworska, 2018).

The psychological assessments were measured at two times: before and after judo training. Participants completed the questionnaires without time limited, ensuring sufficient time for thoughtful responses.

Safety considerations

During the training sessions, two coaches will always be present. During the fitness assessments, only verified and certified measurement equipment will be used, and the testing area will be prepared prior to the commencement of each measurement. Participants will be divided into groups to ensure that an excessive number of individuals are not present at the testing site at the same time. Only the assessed participants will be informed of their results, and this information will be provided individually.

Follow-up

For interested participants, groups will be established to continue the judo training process. This will allow for the monitoring of their progress, the acquisition of specialized skills, and the development of physical fitness and their behaviours (e.g. psychological indicators).

Data management and statistical analysis

Each participant was assigned an individual identification number, on the basis of which the results obtained in the respective tests were recorded. This procedure ensured the protection of personal data by preventing their association with the research results.

In accordance with Article 13 of Regulation (EU) 2016/679 of the European Parliament and of the Council of 27 April 2016 on the protection of natural persons with regard to the processing of personal data and on the free movement of such data (Official Journal of the European Union L 2016, No. 119), it is hereby stated that the controller of personal data is the University of Physical Education, located at ul. Królowej Jadwigi 27/39, 61-871 Poznań. Personal data shall be processed by the data controller exclusively for the period necessary to fulfil the purposes for which they were collected. The legal basis for the processing of personal data is the freely given consent of the data subject. The provision of personal data is voluntary; however, it is indispensable for the attainment of the purpose for which the data were collected, namely the implementation of the research project. Personal data may be transferred by the controller to entities processing data on the basis of data processing agreements, as well as to other entities authorized under separate legal provisions. The data subject has the right of access to personal

data, the right to rectification, erasure, restriction of processing, the right to data portability, the right to object, and the right to withdraw consent at any time. Withdrawal of consent shall not affect the lawfulness of processing carried out on the basis of consent prior to its withdrawal. The data subject also has the right to lodge a complaint with the President of the Personal Data Protection Office, located at ul. Stawki 2, 00-193 Warsaw. Personal data shall not be processed by automated means and shall not be subject to profiling.

Quality assurance

Only certified devices were used for the measurements. Data management was conducted in accordance with Article 13 of Regulation (EU) 2016/679 of 27 April 2016 on the protection of personal data (Official Journal of the European Union L 2016, No. 119).

Expected outcomes of the study

The method of conducting the classes is innovative and has not been previously examined. The analysis of changes in the level of physical fitness and state and trait anxiety, general self-efficacy scale resulting from judo training conducted in integration groups will make it possible to assess whether this constitutes a justified form of educational intervention for individuals with ASD as well as neurotypical participants. At the same time, it will allow for the identification of functional changes and an increase in the level of environmental tolerance and social acceptance among children and adolescents through physical activity.

Duration of the project

04.2024 – 05.2024 – Obtaining approval from the Bioethics Committee

05.2024 – 09.2025 – Recruitment of study participants,

09.2024 – 06.2025 – Implementation of the training protocol and data collection

06.2025 – 12.2025 – Data analysis and manuscript preparation

Problems anticipated

Failure to recruit an adequate sample size.

High attrition rate within a specific study group (ASD/neurotypical).

Participant non-compliance or reluctance to perform physical fitness tests

Social interaction difficulties within the training groups

Disruption or loss of funding, precluding the completion of the project.

Ethics

The study received approval from the Bioethics Committee at the Poznan University of Medical Sciences (Decision No. 324/24, issued on May 9, 2024). The research team obtained informed consent based on documentation completed by both the participants and their legal guardians. The informed consent forms used in this study were reviewed and approved by the Bioethics Committee.

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