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General information

Protocol title: **The Effects of Tailored Judo Training and Nutritional Counseling on Physical Fitness and Body Composition in Children With Autism: A Study Including Blood Morphology and Genetic Analysis**

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

To date, despite ongoing research, no effective pharmacological therapy has been discovered to reduce the symptoms of autism. However, it has been demonstrated that therapy should focus on environmental variables. Research shows that through exploration and imitation during maturation, interactions with the social and physical environment enable cognitive and motor development, as well as the learning process (Serrada-Tejeda, Santos-del-Riego et al., 2021; Wang, Wang et al., 2023). For individuals with Autism Spectrum Disorder (ASD) to function correctly, various therapies are essential, including pedagogical, behavioral, speech, and developmental interventions. Much contemporary scientific research focuses on identifying forms of physical activity that yield positive effects for neurodivergent individuals. It has been shown that children and adolescents with ASD experience motor difficulties, such as abnormal gait, irregular muscle tone, balance problems, and poor motor control (Gueity-Rodrigueaza, Ogonowska-Słodownik et al., 2021). Furthermore, they have been noted to be less physically active and perform fewer exercises compared to their typically developing peers (Pace & Bricout, 2015; Coffeey, Sheehan et al., 2021).

It is documented that children with ASD should begin sports training immediately after diagnosis and participate in physical activities alongside neurotypical peers (Arslan, Ince et al., 2019), ensuring the proper functioning and development of the cardiometabolic system and cardiorespiratory fitness (Pierantozzi & Morales, 2022). Current research indicates that judo training, although a contact sport, reduces the intensity of symptoms in individuals with ASD (Morales et al., 2022). This suggests that its format can serve as a valuable therapeutic intervention. Therefore, this study plans to implement a tailored judo training program as a form of therapy for children and adolescents aged 7 to 14. The sessions will be conducted over a 10-month period in integrated training groups, where individuals with ASD and those without such a diagnosis train together. The aim of this program is to analyze the effectiveness of environmental adaptation, overcoming resistance to physical contact through a contact sport, and performing a comparative analysis of changes in the studied variables between individuals with and without ASD.

The training program will be based on movement games and activities that influence psychosocial behavior, peer interaction, and the learning of new motor tasks to expand functional abilities. Additionally, it will include comprehensive physical fitness components and judo-specific elements (safe falling, movement, applying and escaping holds, body rotations, unbalancing/kuzushi, etc.). Sessions will take place twice a week for 60 minutes. The program will include 50 children and adolescents (aged 7–14) with a diagnosed ASD, possessing at least functional communication skills and no diagnosed aphasia, and a control group of 50 individuals without any diagnosed disorders. The effectiveness of the therapy will be evaluated through an environmental adaptation test (assessing comfort in contact and cooperation with others during training) and an analysis of physical fitness changes using the EUROFIT Test and stabilometric platform.

To expand the assessment of changes in participants' physical fitness levels, an analysis of postural stability under static conditions will be conducted. Measurements will be performed using the CQStab2P dual-plate stabilometric platform. The assessment will evaluate the ability to maintain balance in a standing position during two trials: with eyes open and with eyes closed (Romberg test). This analysis will serve as a key element in verifying the impact of the intervention (judo training and nutritional counseling) on the participants' neuromuscular control. The primary objective of the analysis will be to determine whether systematic judo training leads to improved postural stability, as evidenced by a reduction in center of pressure (COP) sway parameters, such as the sway area and the total staturogram path length.

While research indicates that coaches can influence the healthy eating habits of their athletes (Desbrow, 2021), such data is lacking regarding youth with ASD. A common problem among individuals with ASD is food selectivity (picky eating), involving the consumption of a very limited group of accepted food products. This can lead to vitamin or micronutrient deficiencies, as well as growth and body mass disorders. Therefore, this study proposes an innovative scientific approach consisting of nutritional counseling conducted in cooperation with legal guardians, involving the collection of dietary habit data and subsequent nutritional guidance. To assess micronutrient levels, blood morphology will be performed to analyze iron, vitamin B12, total protein, magnesium, and folic acid content. These results, combined with body composition analysis using bioelectrical impedance (BIA), will help design properly balanced diets for individual participants.

Limited genetic research on individuals with ASD has shown that identifying targeted, highly effective therapeutic and preventive actions is crucial for optimizing their functioning. Studies (Wilczyński et al., 2023) suggest a link between polymorphisms in genes encoding oxytocin receptors or those responsible for its secretion (e.g., the *CD38* gene) and the functioning of individuals with ASD. Based on these observations, the *CD38* gene polymorphism will be examined in participants using Real-Time PCR genetic analysis.

Assessments of physical fitness, dietary habits, blood morphology, and body composition will be conducted three times: before, at the midpoint, and after the completion of the training process. The genetic polymorphism analysis will be performed once, toward the end of the process. This scientific endeavor will enable the analysis of the therapeutic effectiveness achieved through a tailored judo training program and nutritional counseling for individuals with Autism Spectrum Disorder. To date, no study has combined a long-term (10-month) tailored close-contact sports program in integrated groups with nutritional counseling.

Study goals and objectives

The objective of this research project is to evaluate the feasibility of utilizing a tailored judo training program as a supportive therapy, alongside nutritional counseling, to influence physical fitness levels, dietary habits, body composition, and blood morphology. The study will account for genetic polymorphisms in children and adolescents with Autism Spectrum Disorder (ASD) who demonstrate functional communication skills and no diagnosed aphasia.

Study design

This is an interventions study. Current research demonstrates that judo training, despite being a contact sport, reduces the severity of symptoms in individuals with autism spectrum disorder (ASD) (Morales et al., 2022). This suggests that, due to its specific format, judo may serve as a valuable therapeutic intervention for children and adolescents with ASD. Consequently, this study plans to implement adapted judo training as a form of therapy for participants aged 7 to 14. The sessions will be conducted over a 10-month period in integrated training groups, comprising both individuals with ASD and neurotypical peers. The objective of this training program is to analyze the effectiveness of environmental adaptation, the overcoming of resistance to interpersonal contact through contact sports, and to perform a comparative analysis of changes in examined variables between the ASD and non-ASD groups.

The training program will be based on movement-based games and activities designed to influence psychosocial behavior, peer interaction, and the acquisition of new motor skills to enhance functional abilities. Furthermore, it will include components of general physical literacy and judo-specific techniques (e.g., safe falling, displacement, applying and escaping holds, body rotations, and off-balancing/kuzushi). Sessions will be held twice weekly for 60 minutes. The study will enroll 50 participants aged 7–14 with a confirmed ASD diagnosis, possessing at least a "fair" level of communication skills and no diagnosed aphasia, alongside a control group of 50 neurotypical individuals. Therapeutic efficacy regarding physical fitness will be assessed through environmental adaptation tests (evaluating social comfort and cooperation), the EUROFIT Test battery, and stabilometric platform measurements.

It has been shown that coaches can influence the conscious healthy eating habits of their trainees (Desbrow, 2021); however, there is a lack of such data regarding children and adolescents with ASD. A frequent issue in the ASD population is food selectivity, characterized by the consumption of a highly restricted range of accepted food products. This may lead to micronutrient deficiencies as well as weight and growth disturbances. Therefore, this study proposes an innovative scientific intervention involving nutritional counseling conducted in cooperation with legal guardians, based on the collection of dietary habit data. To evaluate micronutrient status, blood morphology will be performed to analyze levels of iron, vitamin B12, protein, magnesium, and folic acid. These results, combined with body composition analysis via bioelectrical impedance (BIA), will facilitate the design of appropriately balanced diets for individual participants.

Existing, though limited, genetic studies in individuals with ASD highlight the importance of identifying targeted, highly effective therapeutic and preventive measures to optimize functional outcomes. Research (Wilczyński et al., 2023) suggests a correlation between polymorphisms in genes encoding oxytocin receptors or those responsible for its secretion (e.g., the CD38 gene) and the functioning of individuals with ASD. Based on these observations, CD38 gene polymorphisms will be examined in the study participants using real-time PCR

genetic analysis. Assessments of physical fitness, body stability, blood morphology, body composition will be conducted at three intervals: baseline (pre-intervention), mid-point, and post-intervention. Genetic polymorphism analysis assessments will be performed once, towards the conclusion of the training process.

Methodology

Physical fitness level

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).

Body composition
Body composition will be evaluated using the bioelectrical impedance analysis (BIA) method. The measurements will be performed with a professional multi-frequency analyzer - Tanita. The following parameters will be recorded for each participant: Fat Mass (FM), Fat-Free Mass (FFM), Total Body Water (TBW), and Skeletal Muscle Mass (SMM). The measurements will be taken in the morning, in a fasting state. Participants will stand barefoot on the analyzer electrodes according to the standardized measurement protocol. Body composition changes will be analyzed with adjustments for age and baseline measurements.

Postural stability
Postural stability will be assessed using the CQStab2P stabilometric platform. The device will record the Center of Pressure (COP) position using six sensors. The measurement will last 30 seconds in a free-standing position (arbitrary, non-forced foot placement) with eyes open, and 30 seconds in a free-standing position with eyes closed. The platform will be placed 10 cm from the wall, and subjects will focus their gaze on a point in front of them. Prior to the measurement, subjects will be rested and will not have performed a warm-up. The analysis of changes in postural stability will be one of the elements evaluating the impact of the intervention on the

participants' fitness levels. It will be analyzed whether judo training leads to a reduction in body sway in a standing position, both with eyes open and eyes closed.

Blood morphology

The subject will be seated in a comfortable, relaxed position on a prepared chair. The nurse will position the arm downward and proceed with the blood collection procedure. The vein will be punctured, and once blood appears in the test tube, the previously applied tourniquet will be released. Immediately after the procedure, a dry sterile swab will be pressed onto the puncture site until bleeding stops. Following the collection, blood samples will be analyzed for iron, vitamin B12, total protein, magnesium, and folic acid content. These analyses will be conducted by qualified specialists in a professional laboratory. Blood morphology results will be analyzed in relation to the duration of the training process, changes in physical fitness levels, and body composition parameters.

Genetic Polymorphism Analysis

Buccal swabs will be collected for genetic polymorphism analysis. The subject will be seated in a comfortable position, and the sample will be obtained by rubbing a sterile swab against the oral mucosa. Immediately following collection, the swabs will be placed in sterile tubes and stored in a portable cooler to maintain the required temperature during transport to the laboratory. The CD38 gene polymorphism will be examined to investigate its potential association with changes in physical fitness, body composition and morphology during adapted judo training. Genetic analyses will be conducted using the Real-Time Polymerase Chain Reaction (Real-Time PCR) method.

Safety considerations

During the training sessions, two coaches will always be present. For assessments of physical fitness, body posture, body composition, blood morphology, and genetic polymorphism, only verified and certified measurement equipment will be used. 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 simultaneously. Only the participants being assessed (and their legal guardians) will be informed of their results, and this information will be provided individually.

Follow-up

Long-term participation in the integrated judo training program is expected to yield significant psychosocial benefits for children with ASD. Beyond physical improvements, the continuation of the training process fosters social integration, reduces performance-related anxiety, and enhances self-esteem. Through structured interactions in mixed groups (neurodivergent and neurotypical peers), participants develop better communication skills and emotional regulation, which are crucial for their daily functioning in society. For interested participants, groups will be established to continue the judo training process. This will allow for the monitoring of their progress, skill acquisition, and overall development (e.g., physical fitness, postural stability, and social communication.

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 methodology of the classes is innovative and has not been previously investigated. Analyzing changes in physical fitness levels, postural stability, body composition, and blood morphology, while accounting for nutritional habits and genetic polymorphisms, will allow for an assessment of whether adapted judo training in integrated groups constitutes a justified educational intervention for both individuals with ASD and neurotypical participants. Furthermore, it will enable the identification of functional changes and promote an increase in environmental tolerance and social acceptance among children and adolescents through physical activity.

Duration of the project

04.2024 – 06.2024 – Obtaining approval from the Bioethics Committee
06.2024 – 09.2025 – Recruitment of study participants,
09.2024 – 06.2025 – Implementation of the training protocol and data collection
07.2025 – 03.2026 – Data analysis
03.2026 – 12.2026 - Manuscripts 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.

Reluctance to undergo blood morphology examinations (needle phobia and anxiety related to venipuncture)

Ethics

The study received approval from the Bioethics Committee at the Poznan University of Medical Sciences (Decision No. 416/24, issued on June 27, 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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