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RESEARCH

Judo and karate in primary school as a means for the improvement of social inclusion for autistic children

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Abstract

Purpose Autistic children are often at risk of isolation. Many studies have demonstrated the effectiveness of sport interventions for autistic children. Martial arts such as judo and karate are among the most recommended sports, but few studies have been conducted to analyze the benefits of sports in inclusive primary school contests. This research was conducted by "KATAUTISM PROJECT" of the Italian Judo, Wrestling, Karate and Martial Arts Federation (FIJLKAM), whose objective is the inclusion of autistic children through the practice of judo and karate in primary schools.

Methods The study involves 31 ASD children ($n=5$ girls, $n=26$ boys) with different level of autism between 6 and 10 years old who all partook in an inclusive judo ($n=16$) and karate program ($n=15$) at school with their classmates. Each program includes 2 weekly sessions for 24 weeks, with each session lasting 1 h. This study analyzes three different areas in autistic children: the level of autism, social compromission, and gross motor skills.

Results All ASD children completed the program with classmates that yielded statistically significant results ($p<0.05$) in all three analyzed areas.

Conclusion Judo and karate in school contest has favored the inclusion of ASD children within the classroom. Through careful monitoring of autistic mannerisms, hetero and self-aggressive behaviors, emotional regulation and a degree of tolerance, all ASD subjects greatly benefitted from the social inclusion. The study also demonstrated that the comparison groups of judo and karate produce similar average percentage improvements in GARS, SRS and TGMD-3.

Keywords Autism · Judo · Karate · Social inclusion · Primary school

Introduction

Autism spectrum disorder (ASD) refers to a range of heterogeneous neurodevelopmental conditions characterized by difficulties in communication and language development, social interaction, and the presence of restrictive and repetitive behavior patterns that are defined by American Psychiatric Association [1]. The prevalence of ASD is estimated to be at least 1.5% in developed countries [2]. Autistic children often find it difficult to be included in inclusive sports contexts [3]. In Italy, it is estimated that 1 child out of 77 between the ages of 7 and 9 has ASD, with a higher prevalence in males, who are 4.4 times more likely to have ASD than females. This national estimate was made as part of the "Observatory Project for Monitoring Autism Spectrum Disorders" coordinated by the National Institute of Health and the Ministry of Health (2021).

The ASD individuals exhibit a variety of stereotypical motor behaviors such as hand clapping and body rocking [4].

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Many studies have demonstrated the effectiveness of motor interventions in ASD people, especially if the interventions are intensive and introduced in the early stages of life [5]. However, early therapeutic intervention can be extremely expensive for families of ADS children [6], with a high cost placed on individual families and social services.

Many studies have shown that sports accessibility, despite the benefits it provides, often encounters several barriers, including the lack of specific training for coaches [7, 8]. A recent study also shows that raising awareness at school on the topic of diversity is a fundamental element for a more inclusive path [9]. Reviews of the impact of physical activity in ASD individuals [10] have highlighted significant benefits. Another review exclusively examines the impact of exercise interventions on a range of behavioral symptoms that include stereotyped behaviors [11] and also examines positive social behaviors that focuses on younger children who are often excluded by other reviews. It has, therefore, been highlighted that martial arts disciplines are among the most recommended sports for autistic subjects as they produce significant and positive change from a behavioral, communicative and relational point of view [11].

There is an association between reduced social functioning and less physical activity in autistic individuals [12, 13]. Existing studies have shown that physical activity interventions can influence ASD symptoms, such as reducing stereotyped behaviors in both autistic children and adults [14, 15]. Previous meta-analysis has revealed moderate to large effects of physical activity interventions on social functioning [16]. Increased exposure to social stimuli through physical activity can induce improvements in communication, social functions and increase self-confidence.

Since the 1970s, Italy has passed a series of laws, in particular law n°104 of 5 February 1992, which supports the integration and scholastic inclusion of people with disabilities, with particular attention to the sporting dimension. With law n°66 of 2017, the rules for promoting the educational inclusion of disabled students were defined and the term integration is replaced with inclusion. In 1999, the law n. 17 in Italy sanctioned the right of access to the university to include disabled students. These legislations highlight how Italy has worked according to its own model of inclusion in sport which combines the principles of Universal Design [17, 18].

The studies have demonstrated the beneficial effects of exercise and sports training through a wide variety of abilities in ASD children [19]. After practicing physical exercises, subjects ASD subjects showed profound improvements in social skills [19, 20], cognitive function [21], stereotypical behavior [22], communication [23], attention [20], self-harm behavior [24], and aggressiveness [25].

Bahrami et al. [23] were among the first to examine the effects of karate exercise on communication deficits in ASD. The results of the study confirmed that karate training techniques lead to an improvement in communication deficit in ASD children. In a recent article [26–28] the benefits of a motor and behavioral judo activity were demonstrated. In another study [29] it was also shown that physical activity with physical contact contributes to a good production of oxytocin in autistic subjects.

The concept of sport inclusion is based on the fact that playing sport together, disabled children with non-disabled children, has mutual benefits [30]; even those with severe disabilities benefit from physical interaction with other groups of children [31, 32].

As such, the preparation of physical educators [33, 34] and peers as well as a strategic inclusion in physical education is critical [31].

It is proven that sports disciplines offer many social opportunities for disabled students; for example, interactions with non-disabled peers, building new friendships and learning appropriate behaviors [35, 36]. The optimal solution to a successful inclusion is to provide support to the disable students' ties through qualified coaches or peer tutors [30, 37, 38]. Studies of which, clearly show that peer tutors can be an effective method of supporting disable students in general physical education but providing them with support from trained coaches is essential [31, 39].

Starting from a theoretical background, a scientific study was conducted into the Italian Judo Fight Karate and Martial Arts Federation (FIJLKAM) project "KATAUTISM", with the aim of including autistic children through practice of judo and karate in a school environment. The study looked at adaptations related to social inclusion, gross motor skills, and behavior. Our hypothesis was that by practicing judo and karate in a school environment, behavioral, and gross motor improvements could be achieved through promotions of inclusivity.

This study aims to promote the inclusion of autistic children through the practice of judo and karate within the school environment during curricular hours. It analyzes the adaptations from a motor perspective, social impairment, and autism severity. The results of this research will contribute to defining best practices for future coaches, enhancing the accessibility of inclusive sports activities.

Furthermore, conducting sports activities within the school setting during curricular hours has had a positive impact on the entire school community and classmates, fostering inclusion. This study also seeks to bridge the gap in the literature, as there is a lack of research on inclusive sports activities for autistic children in school settings.

Implementing inclusive sports in a school environment not only engages autistic children alongside their peers but also involves the entire educational system. Throughout the project, the teachers and school staff had the

opportunity to observe and participate in judo and karate sessions, further reinforcing the inclusive approach.

Methods

Participants

The autistic children involved and analyzed ($n = 31$) were $n = 5$ girls and n = 26 boys with a mean age of 7.58 (± 0.38) years and with different level of autism. The involved classes were 31, each containing one autistic child, with a total of 573 children involved, and a mean number of 18.48 children per class. The activity took place twice a week (1 h each session) for a total of 24 weeks.

Materials

The intervention program focused on basic judo and karate skills.

All the participants had been diagnosed ASD according to the criteria of the Diagnostic and Statistical Manual of Mental Disorders—Fifth Edition (DSM-5) [1].

Procedure

The study was conducted in se Italian regions (North, Central, and South) across 10 different schools. The selection of the classes was entrusted to the school Directors who knew which classes had autistic children.

The selected classrooms were divided in two groups randomly selected and compared that was divided in: a group followed the Katautism Judo Program and a group followed the KATAUTISM karate program. The ASD children partook in inclusive activities with their classmates together during curricular school hours. The project used an adapted methodology with specific tools. To ensure predictability for autistic children, images of augmentative communication were used to facilitate understanding of the sequence and duration of individual activities.

The images of the augmentative communication were given to coaches and psychologists, with a visual weekly agenda issued in the classroom which allowed the autistic child and his classmates to understand on which day of the week the activity took place.

All the staff, made by specialized coaches and psychologists of autism, followed a specific training course of 40 h where topics concerning autism were treated by psychologists, neuroscience experts, adapted motor activity experts, and pediatricians.

The focus of the lessons was based on the objective of research into the methodology, specific equipment, reading and management of children on the autistic spectrum in inclusive school contests.

Prior to starting the project, the meetings were organized with the parents of all the children and teachers in the classes to clearly explain the objectives of the project and clarify any doubts. In addition, individual meetings were held with the parents of autistic children with the coordinator of the research, psychologists and coaches of the staff to gather information on the child, state the objectives and explain the test of the research.

There were two specialized coaches in ASD during the sessions so, if required, a coach was dedicated to the ASD child. The psychologist was an observational figure who supported the coaches throughout lessons; their role was to observe and provide feedback to the coaches. At the end of each training session, the synergistic work between coaches and psychologists formulated the intervention plan to be able to equally satisfy the needs of both the ASD children and the classmates. The synergistic work of specialized coaches and a psychologist with expertise in autism, who was present at every session, allowed for a deeper understanding of each child's needs, defining not only the motor activities but also the timing of breaks. When discussing autism spectrum disorder, it is crucial to emphasize that the adaptation of the training program was designed based on the specific needs of each individual child. Throughout the research project, video and in-person supervision were present to ensure the achievement of the objectives and support the martial art teachers and psychologists in the different phases. This was useful for monitoring the behaviors and relationships of autistic and non-autistic children.

The sporting activities of judo and karate aligned with the accessibility criteria as the lessons were held in a spacious and comfortable space so that the safety of the participants was guaranteed. The equipment required for this project included a tatami, a high-density mattresses of 100 m^2, to help prevent injuries. The methodological progression of the motor activities was the same for all participants. However, for autistic children, specific tools were implemented, when needed and useful, such as augmentative and alternative communication, to ensure predictability. Additionally, an autism specialist psychologist was present at every session to ensure appropriate adaptations and a proper progression tailored to each child's needs. This approach facilitated greater engagement of the children in participating in activities alongside their classmates. The staff consisted of two specialized coaches (one tutor and one assistant) and one autism specialist psychologist. The presence of the assistant ensured 1:1 support when needed, further enhancing the inclusivity and effectiveness of the program.

Judo began with the didactic progression of falls in all its forms (backward, sideways forward), before moving on to individual practice and then gradually in pairs with

immobilization techniques on the ground. The individualized program for the autistic child resulted from the synergistic work of the specialized coaches and the expert psychologist in autism who was always present during the lessons.

Karate began with teaching the basics of karate, (such as correct posture, breathing and movements fundamentals), before progressing to the first kata (pinan nidan). The importance of how to use these techniques in a controlled and responsible way was also explained to the children.

The research design involved the analysis of 3 areas of autistic children at the beginning (T0) and at the end of the project (T1). These areas refer to the level of autism on the Gilliam Autism Ration Scale—GARS [40] which is assessed by psychology experts, the area that relates to social impairment on the Social Responsiveness Scale—SRS [41] which is administered by class teachers, and Test of Gross Motor Development 3rd edition—TGMD-3 [42] which is evaluated by experts in adapted motor sciences.

The study analyzed three key areas in autistic children before (T0) and after (T1) a 24-week intervention involving judo and karate in an inclusive school setting. These areas were assessed using three scientifically validated tools:

1. Level of autism

Measured by the *Gilliam Autism Rating Scale (GARS)*, administered by psychologists specializing in autism. Is a checklist developed for use by professionals, educators and rehabilitators both to identify autism and to rate the severity of its symptoms for individuals aged 3 to 22 years. GARS subscale evaluates 4 domains: stereotyped behaviors, communication, social interaction, and developmental disorders.

2. Social compromission

Social Responsiveness Scale (SRS) is used to measure the degree of social impairment associated with ASD. The SRS is a 65-item questionnaire that assesses social awareness, cognition, communication, motivation, and autistic mannerisms. The SRS with the completed by classroom teachers after specific training.

3. Gross motor development

Evaluated using the *Test of Gross Motor Development—3rd edition (TGMD-3)*, conducted by experts in Adapted Motor Sciences. is eligible for special education services in physical education and consists of 13 skills: 6 for locomotor skills (running, gallop, single foot hops, hopping step, standing long jump, lateral canter) and 7 for ball skills (two-handed hitting of a ball at rest, forehand, dribbling in place with one hand, catching a ball with two hands, kicking a ball at rest, high pass and low pass).

All analyses are realized using IBM SPSS Statistics software in version 28 and a significance level of 0.05 was used for all the analysis.

The research design includes the analysis, following the practice of judo or karate in an inclusive school setting, of three different areas in autistic children: the level of autism (GARS), social impairment (SRS), and gross motor skills (TGMD-3) (Fig. 1).

Results

At the end of the data collection and scoring, a univariate descriptive analysis of the variables will be first carried out for the total of 31 observations.

Paired sample t-tests and Wilcoxon tests will be then performed, for both the samples, to assess if there are statistically significant differences in the mean score of GARS, SRS and TGMD3 scales and subscales before and after the experiment (Table 1).

A contingency table is presented to analyze the average variations (Delta) in GARS TGMD3 and SRS scales and subscales (Table 1).

Each paired t-test conducted on GARS subscales and on Autism Quotient is statistically significant ($p < 0.05$): the differences between average scores before and after practicing sport are statistically significant. Wilcoxon tests lead to the same conclusions for all the tests. The Cohen's d for all the subscales is in absolute value greater than 0.8, meaning that the effect is great in size. The differences between the SRS scores before and after practicing sports are statistically significant for all the subscales ($p < 0.05$), both considering the paired t-test and the Wilcoxon test: it is possible to conclude that the decrease in scores due to practicing sport is statistically significant. Using Cohen's d to evaluate the magnitude of the effect on the SRS subscales, it can concluded that the effect is of great size (absolute value of $d > 0.8$) for all the subscales except for the SRS CgS, for which the effect is of medium size. Cohen's *d*, used in TGMD-3 to evaluate the effect size for each pair tested, is in absolute value greater than 0.8 for all the pairs pre-mid and pre-post, meaning that the effect is of great size (Table 1).

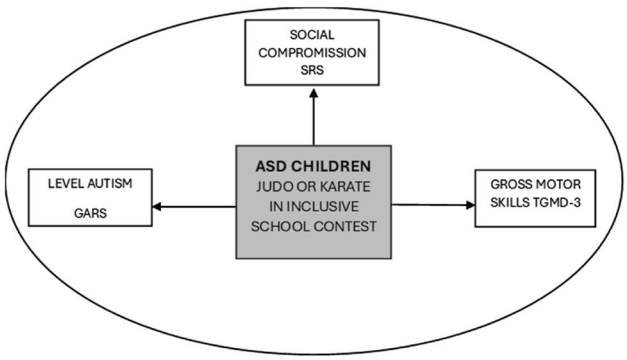

Fig. 1 Design of the research

Table 1 Results mean pre/post, delta, variation%, *t*-test, Wilcoxon test, Cohen's *d*, in $n = 31$ ASD children

$n = 31$	Mean pre	Mean post	Delta	Variation %	*P*-value (paired *t*-test)	Wilcoxon test	Cohen's d
GARS stereotyped behaviors	10.87	8.48	−2.39	−21.99	<0,001	<0,001	−1,100
GARS communication	8.58	7.06	−1.52	−17.72	<0,001	<0,001	−1,024
GARS social interaction	8.32	6.23	−2.09	−25.12	<0,001	<0,001	−,879
GARS developmental disorders	8.13	8.13	0	0.00			
GARS total	35.9	29.9	−6	−16.71	<0,001	<0,001	−1,115
GARS autism quotient	93.16	83.32	−9.84	−10.56	<0,001	<0,001	−1,108
SRS CnS (social awareness)	71.19	65.23	−5.96	−8.37	<0,001	<0,001	−,999
SRS CgS (social cognition)	79.74	73.55	−6.19	−7.76	<0,001	<0,001	−,710
SRS CmS (social communication)	79.13	70.26	−8.87	−11.21	<0,001	<0,001	−1,074
SRS MS (social motivation)	75.87	68.42	−7.45	−9.82	<0,001	<0,001	−,877
SRS MA (autistic mannerism)	86.87	78.58	−8.29	−9.54	<0,001	<0,001	−,841
SRS TOT Punteggio T	82.9	74.32	−8.58	−10.35	<0,001	<0,001	−1,083
TGMD3 locomotor	2.48	8.68	6.26	252.42	<0,001	<0,001	2,280
TGMD3 ball control	2.42	8.68	6.2	256.20	<0,001	<0,001	2,243
TGMD3 total	4.9	17.68	12.78	260.82	<0,001	<0,001	2,429
TGMD3 gross motor index (GMI)	55.61	92.03	36.42	65.49	<0,001	<0,001	2,480

Table 2 Percentage variations of the GARS, SRS, and TGMD−3 averages in the judo and karate comparison groups

	Judo Mean	Karate Mean
GARS stereotyped behaviors standard variation (%)	−23,12	−19,10
GARS communication standard variation (%)	−17,65	−19,93
GARS social interaction standard variation (%)	−22,90	−24,39
GARS developmental disorders standard variation (%)	,00	,00
GARS total standard variation (%)	−16,23	−16,73
Autism quotient variation (%)	−10,55	−9,94
SRS CgS VARIATION (%)	−5,45	−9,71
SRS CnS VARIATION (%)	−6,63	−9,93
SRS CmS VARIATION (%)	−9,02	−12,91
SRS MS VARIATION (%)	−10,97	−7,75
SRS MA VARIATION (%)	−9,18	−9,51
SRS TOT T score VARIATION (%)	−9,12	−11,27
TGMD3 BALL POST PRE VAR (%)	436,82	339,67
TGMD3 LOCOMOTOR POST PRE VAR (%)	399,38	338,48
TGMD3 TOTAL POST PRE VAR (%)	434,71	307,07
TGMD3 GMI POST PRE VAR(%)	68,73	64,00

Finally, to analyze the variations considering the martial art practiced, a contingency table is presented to show variations of GARS, SRS and TGMD3 subscales split up by sport practiced (Table 2).

Discussion

The main hypothesis of the research were to if the practice of judo and karate, conducted by specialized coaches supported by psychologists expert in autism in an inclusive school context can contribute to improve in all level of ASD children, behaviors, the gross motor development, and the social inclusion. Many studies have shown that sports accessibility, despite the benefits it provides, often encounters several barriers, including the lack of specific training for coaches [7, 8]. Having coaches specialized in autism in inclusive settings, supported by psychologists expert in autism, has indeed enabled proper inclusion. Specific training has allowed for a better understanding of the needs of each child with ASD, leading to significantly positive results.

Our results confirm the benefits of sports activity for children with autism [11, 14, 20, 22, 23, 27, 28] and demonstrate that inclusive sports practice is feasible when led by specialized coaches. This study also fills a gap in the scientific literature, as it was conducted in a school setting during curricular hours.

The differences between the GARS, SRS and TGMD-3 scores before and after practicing sports are statistically significant in all levels of autism for all the subscales ($p < 0.05$) and the effect is of great size (absolute value of $d > 0.8$) for all the subscales (GARS, SRS, TGMD-3) except for the SRS CgS, for which the effect is of medium size.

The study also compared two sports disciplines, judo and karate, across 10 different schools distributed throughout Italy (North, Center, and South). The results demonstrated

significantly positive outcomes in all regions, in all schools, and across both disciplines.

All the 31 ASD children completed the 24 weeks with a frequency of twice a week, without interruptions. Every child finished the program, and none had to make up any lessons. From a physical and physiological perspective, the autistic children actively participated in all the sessions, showing significant results in all three areas analyzed.

It is also important to highlight that individuals with ASD are often sedentary, which frequently leads to increased screen time [47], potentially raising the risk of obesity and cardiovascular diseases [48]. Enhancing sports accessibility in various settings for children with ASD, supported by specialized coaches, would be beneficial in maintaining overall health and immune function while simultaneously reducing sedentary screen time [47].

Studies with neurotypical people have shown that participating in judo increases empathy, reduces aggressive behavior [43] and contributes to the development of self-discipline, serenity, problem solving efficiency, and socio-moral sensitivity [44]. Other studies on martial arts that have demonstrated significant adaptations in reducing stereotyping behaviors in ASD person and improving social interactions [19, 22, 27]. In this study, conduce in KATAUTISM project, we can confirm that Judo and karate has contributed significantly to the reduction of hetero and self-aggressive behaviors, emotional regulation and has improved the degree of tolerance with respect to the times of expected, which greatly compromised the subject's social inclusion.

One study has shown that ASD children have greater difficulties with motor development than their peers [45]. They also found a relationship between gross and fine motor skills and ASD severity, specifically they observed that the most severe cases of ASD were associated with lower fine and gross motor skills [46].

This study did not include a control group because, when dealing with the autism spectrum, it is very challenging to recruit a control group with similar characteristics for a proper comparison. However, the study compared two different sports disciplines, and the activities were conducted in 10 different schools, ensuring a fair distribution and comparison.

In this study, all ASD children ($n = 31$) completed the 24 weeks of inclusive sports program with their classmates. All autistic children have significantly improved their gross motor skills along with behavior and social inclusion.

Conclusion

The study highlighted significant improvements in children with ASD through the practice of judo and karate in a school setting during curricular hours. A key factor was the presence of two specialized coaches, which in some cases allowed for a 1:1 support ratio, along with the continuous assistance of psychologists specialized in autism during the judo and karate lessons.

This study confirmed that specific coach training plays a fundamental role in sports accessibility.

For future perspectives, it would be valuable to analyze autism awareness among coaches from various sports disciplines and encourage national sports federations to implement training courses for their coaches. These courses would enhance autism awareness and promote greater sports accessibility.

The importance of specific training and coordination allows the coaches, through the support of psychology experts in autism, to recognize the needs of ASD children, and provide the right motor proposals.

The study also compared the results of two groups, judo and karate. The results demonstrated that the comparison groups analyzed, judo and karate, both produce average percentage improvements. This underscores the inclusive potential of both disciplines, confirming their adaptability in inclusive settings. In the future perspective of research, it would be interesting to compare other sports disciplines in order to outline the best practices for sports accessibility of different disciplines and increase the range of sports choices for autistic people.

It would be interesting in the future to further analyze, across all levels of autism, the benefits of other inclusive sports, including team sports.

In this study we can confirm that the practice of Judo and karate in inclusive school contest has significantly improved in autistic children gross motor skills, behavior and favored the inclusion ASD children.

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Author Contribution N.M conceptualised the study, analysed the data, and wrote the manuscript. E.P assisted with data collection, and writing/editing the manuscript. R.M.assisted with data collection, and writing/editing the manuscript. A.M. assisted with conceptualising the study, and writing/editing the manuscript.

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Data Availability Data is provided within the supplementary material information files.

Declarations

Conflict of interest The authors declare no competing interests.

Ethic Committee All interventions by project participants involving data collection for research purposes have been subject to approval by the Ethics Committee of the University of Rome Foro Italico (cod.186/2024), in accordance with the directives set out in the updated version of the Helsinki Declaration. This has ensured the respect of all participants' rights and the full protection of data confidentiality and the right to withdraw from the experiment at any time.

Community involvement statement In the development of the research, in the study design, measures, implementation, interpretation, and dissemination of results, the school community, autistic children, families of autistic children, judo coaches, and psychologists specializing in autism were involved.

Informed consent Informed consent was obtained from all individual participants included in the study.

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