ORIGINAL ARTICLE

Effectiveness of an intervention program on basic physical and coordination skills and its relationship with BMI in individuals with intellectual disability

Authors' Contribution:
A Study Design
B Data Collection
C Statistical Analysis
D Manuscript Preparation
E Funds Collection

Irwin Andrés Ramírez-Granizo [1ABCD], **José Luis Ubago-Jiménez** [1ABCE], **Félix Zurita-Ortega** [1BCDE], **Pilar Puertas-Molero** [1ACDE], **Ignacio Vílchez-Polo** [2DE], **Gabriel González-Valero** [1ABCD]

[1] Department of Didactics of Musical, Plastic and Corporal Expression, Faculty of Education Sciences, University of Granada, Granada, Spain

[2] SLOC Sports Association, Granada, Spain

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Abstract

Background and Study Aim: The high levels of physical inactivity and sedentarism caused by the low mobility offered to people with intellectual disabilities are one of the main causes of the high levels of obesity observed in this group in today's society. The present study aims was knowledge about the effect of a 6-month intervention programme based on the application of SLOC (System of Oriental Struggles in Competition) as an innovative sport on indicators of health, BMI, coordination, balance, flexibility and strength.

Material and Methods: The application of SLOC (System of Oriental Struggles in Competition) as an innovative sport on indicators of health, BMI, coordination, balance, flexibility and strength. A longitudinal study was carried out with a pre-experimental design with pre-post measurements in a single group (n = 47), using as main instruments a TBF300 bioimpedance scale and Eurofit battery tests.

Results: The main results were a noticeable improvement in body mass index, strength level and flexibility which represents a small effect size in these cases. Balance and coordination also improved, representing a medium size effect for these variables.

Conclusions: Despite the limitations of this study, as it does not have a control group, the main conclusions are that SLOC together with a recreational-active methodology can be a motivational resource to adhere to healthy lifestyles and that also people with intellectual disabilities can have means for a significant improvement in their quality of life, helping to improve health status indicators in this group.

Key words: balance • Eurofit • martial arts • strength • SLOC • physical activity

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Author's address: José Luis Ubago-Jiménez, Department of Didactics of Musical, Plastic and Corporal Expression. Faculty of Education Sciences, University of Granada, Granada, Spain; e-mail: jlubago@ugr.es

INTRODUCTION

For a long time individuals with special needs have suffered discrimination and social exclusion, above all those with intellectual disabilities (ID) are at risk [1]. This term has acquired different definitions but generally speaking it refers to a decrease, deficiency, or difference in ability or disability that can be presented by an individual in comparison to what is considered normal [2]. This type of condition is aggravated further by the negative interactions that occur between the individual and their environment. These interactions incorporate physical, social and human aspects [3, 4]. Amongst the most visible characteristics of this disability, the following stand out: poor motor skills, lack of ability to pay attention and concentrate, coordination problems, poor balance and high levels of sedentary behaviour that can provoke inactivity and lead to obesity within the population [5, 6].

For this reason, engagement in physical activity (PA) is considered as a factor that improves quality of life when an individual engages regularly [7, 8]. The benefits afforded by PA are numerous, particularly with regards to social, physical and psychological aspects [9]. Adapted sport engagement is of fundamental importance to the personal and social development of the individual who engages in it [10]. Authors such as Mckeon et al. [11] and Oviedo et al. [12], highlight that some of the main benefits are those of a psychological nature. This is due to the fact that those individuals who experience some type of impediment to their capacities have to tackle a society that is based on "normal" indicators, indirectly resulting in a barrier that this population must navigate on a daily basis [13]. On the other hand, authors such as Einnarson et al. [14] and Collins and Staples [15] comment that improved circulation, and reduced risk of suffering cardiovascular illnesses, type 2 diabetes, obesity, hypertension and osteoporosis are the principal advantages of engaging in PA. This is in agreement with studies conducted by Chien et al. [16] and Jeng et al. [17]. These studies concluded that those individuals with ID who are more active have better balance, strength, resistance, flexibility and weight loss.

Amongst the sport modalities investigated, martial arts are highlighted as they enable individuals to remove themselves from daily problems, whilst also strengthening their psyche (affectivity, emotionality, control, perception and cognition). This conclusion has also been shared by other researches [18, 19]. Likewise, studies such as that carried out by Lakes and Hoyt [20] highlight that the most important aspect of PA engagement is the promotion of self-improvement, where the individual seeks to establish achievement goals which enable them to better themselves every day. Further, self-improvement does not only permit psychological benefits but also social benefits, such as emotional control [21, 22].

In recent years various studies have emerged which have analysed this topic from different disciplines within martial arts. These research such as that presented by Patatas et al. [23] and Ortenburger et al. [24] and studied the influence of taekwondo on the development of social skills and analysed the main problems to arise when working with disabled students. Likewise, the way in which this discipline is linked with the psychological development of the user has been observed. It was seen to improve aspects such as respect, appropriate behaviours, empathy and self-development, as much in the mental ambit as in the physical ambit [22]. On the other hand, Tsos et al. [25] showed that regular kickboxing and yoga practice, influenced physical and mental health.

Here is where SLOC appears as a new sport and martial art, with its own characteristics and a competition format that is totally different to what is currently accepted. It is set apart from other sports by its ability to accommodate both competitors and non-competitors, regardless of age, sex or culture. It is definitively a sport for all. This a pilot study based on the application of a modern Oriental Fighting System in Competition (SLOC), through its own technology. These new technologies enable us to ensure fairer and more effective competition that is easy to score accurately with the naked eye. It also mandates protective clothing (chest protector and head gear) which seeks to transmit information on point scoring actions, whilst also covering and protecting impact zones. This sport is characterised by the idea of improving the system for future competition, marking its own identity patterns with content goals and balanced scoring. Studies such as that undertaken by Vílchez et al. [26] focused on this new discipline within the school context. Findings highlighted the importance of the competitor's motivation to engage in a diverse form of combat, and concluded that the sport offered a great sporting spectacle and exceptional nobility without K.O.

Physical activity – *noun* exercise and general movement that a person carries out as part of their day [51].

Motor skills – *plural noun* the ability of a person to make movements to achieve a goal, with stages including processing the information in the brain, transmitting neural signals and coordinating the relevant muscles to achieve the desired effect [51].

KO – *noun* a knockout, especially in boxing [51].

Training session – *noun* a period of time during which an athlete trains, either alone, with a trainer or with their team [51].

Eurofit – in 1983 the Council of Europe developed the Eurofit standard battery of exercises for precise measurement of physical fitness that are detailed in the Eurofit Handbook [52]. The key indicators measured are: core strength, lower body strength, agility, balance, flexibility, endurance.

The present study aims was knowledge about the effect of a 6-month intervention programme based on the application of SLOC as an innovative sport on indicators of health, BMI, coordination, balance, flexibility and strength.

We formulated the following hypotheses:

• Hypothesis 1 (H1): Basic descriptive will show greater flexibility and balance within the female gender. Males will present greater strength and a higher BMI. Levels of coordination will be the same within both groups.

• Hypothesis 2 (H2): The intervention program will improve coordination and body mass index, in addition to flexibility, strength and balance within users with intellectual diversity.

• Hypothesis 3 (H3): Levels of sedentary behaviour will diminish, quality of life will increase and lifestyle will improve following application of the intervention program in participating individuals.

Thus, the present project included the following main research tasks: (a) To establish body mass index, flexibility, strength, balance and coordination in a sample of users with intellectual diversity as a function of sex; (b) to verify the effect of an intervention program based on the SLOC and active motor games on the previously described variables; (c) to analyse the connection or relationship between these variables following execution of the intervention program.

MATERIAL AND METHODS

Design

The intervention was conducted within a natural group that came from a population with an intellectual disability, or that was later determined to show functional diversity. A pre-experimental design with randomised natural groupings was developed. The study was carried out with a pre-test-post-test using a single group without a control group. The design was unifactorial and multivariate with only a single independent variable (group) and various dependent variables: Coordination, balance, strength...etc.

Participants

The sample was composed of 47 individuals of which 46.8% were male (n = 22) and 53.2% were female (n = 25). Average age was 30.23 ±9.854 years with a minimum age of 18- and a maximum age of 55 year. Participants were selected according to convenience. The following inclusion criteria were considered: a) those interviewed must be 18 years or older, b) participants must not suffer from any type of cardiovascular illness, c) individuals must have a mild or moderate degree of intellectual disability.

Variables and instruments

Pre and post data was collected, respectively, during the week prior to (the beginning of January) and immediately after (end of June) the program. Data collection included basic physical characteristics and coordination abilities. The present article describes the effects of the intervention program on variables such as coordination, balance, strength and flexibility. In addition, body mass index was calculated for each participant.

The physical tests administered were as follows:

• **Coordination (tapping)** Eurofit battery test: this test is conducted using a table with two circumferences separated by a distance of 80 centimetres. In the centre exists a 10 centimetre rectangle where the individual being tested must place their non-moving hand. The protocol requires the individual to touch the two circles alternately as many times as possible during a time period of 1 minute.

• **Balance (flamenco)** Eurofit battery test: this test has the aim of measuring balance in general. The individual being tested is required to maintain a support position on one leg for a period of one minute.

• **Strength (dynamometer)** Eurofit battery test: this test measures static strength of the hands. To this end it utilises a dynamometer with adaptable pressure and a precision of 500 grams. It is also used to measure the isometric strength (kg) generated by students with the forearm [27]. For this, a digital calibrated dynamometer with a manual grip and certified precision was used (5030J1, Jamar®, Sammons Preston, Inc, United Kingdom). The same has also been used by authors such as Escalona et al. [28]. Prior to the test, the dynamometer measurement was adjusted according to the age of the performers. The dynamometer must be held with the dominant arm extended so as not to bring it into contact with any part of the body, whilst applying as much pressure as possible [29]. Recovery time between each recorded effort was 1 minute.

• **Flexibility test:** this was analysed my measuring trunk flexion. For this, a measurement device or a strip marked on the floor and a foot stop was used. This test is to be completed slowly and consists of flexing the whole body, reaching forward with the arms between the legs in order to move the distance marker as far as possible.

Procedure

Firstly, all required permissions and informed consent was solicited. Research approval on behalf of the Ethical Committee for Human Research at the University of Granada was sought and approval was granted with the code 462 / CEIH / 2017. With regards to participants, all participating individuals belonged to the Pure Conception Private Centre for Special Education of the City of Granada. An information pack that described the main characteristics of the study was provided to all individuals. Information also explained the purpose of the scientific research and guaranteed that data would be kept anonymous. The study sample was formed by those participants who decided to participate and provided written informed consent.

The study was conducted between January and June of 2019. For its execution, study researchers completed two training sessions which detailed the characteristics of the intervention plan, in addition to the tasks to be carried out by each project member. The intervention consisted of a weekly one hour session that was divided into four phases and incorporated an experiential, participatory and playful methodology.

Methodology

The methodology was based on respect and teamwork, and gave high importance to the cognitive and affective processes used during play to reach proposed goals and research tasks.

SLOC is a modern Oriental Fighting System in Competition that has emerged over the last generation. It uses its own applied technology which is important for the positive development of fighters and guarantees the reliability of point scoring. Its objective-element and main axis of competition is the Short Staff, called the SLOC. It is designed and created as a form of combat that avoids injuries by minimising the impact of the blow during point actions (regardless of the use of protective gear).

Foot and short staff techniques – SLOC, are fused to produce a new sport that uses a balanced competition system (of upper and lower body) combining the sum of its maximum expressions into a spectacular competition. It includes actions that demand speed, strategy, creativity… with the Short Staff – an exceptional and high quality SLOC results from the mobility of the turns of the staff and wrist gestures (fundamental). This is obligatory in training sessions and combat.

Beyond the definition of SLOC in its denomination as a martial art, it has led to the evolution of two arts that count on a singular and high tech competition system of combat. This evolution is based on and characterised by new technology, the refinement and perfection of techniques, ability and skill when combining gestures, and a greater channelling of inner energy. With respect to the phases of each session, the first phase (1) consisted of a brief introduction and audio-visual demonstration that explained the work content and lasted for 10 minutes. During the second phase (2) general warm-up exercises were performed for 10 minutes through games. Next, the third phase (3) represented the main phase that lasted for 1h and a half. The nature of work sessions had the objective of initiating an affective closeness between participants, facilitating relatedness, and serving to create an atmosphere of trust and security for participants. At the same time it taught the greeting, which is so important in this new sport. Further, the group becomes familiar with the necessary equipment through motor games. Familiarisation of students with the material includes allowing them to make a selection (colour) which acts as an interactive form of better understanding the object. In this way, students make the sport their own and the instructor visualises the degree of satisfaction or indifference they have to capitalise on, correct or strengthen themselves with these tools. The fourth phase (4) consists of recovery following the exercise by playing motor games with a much lower internal load. It has the aim of favouring the recovery of normal bodily functions.

We must emphasise that the intervention program was designed and analysed with the mentioned characteristics at its heart. It was created and supervised by professional researchers in the fields of Physical Education, Physical Activity and Sport Sciences, and SLOC. In the same way, we must point out that this research study abides by the ethical principles for research established by the Declaration of Helsinki. The right of participants to confidentiality was also respected throughout.

Data analysis

Statistical analysis was carried out using the software IBM SPSS® 22.0 (IBM Corp, Armonk, NY, EE.UU.). Frequencies, medians (M) and standard deviation (± or SD) were used as basic descriptors, whilst the associative study between variables was conducted via t-tests for independent samples. In order to analyse the effects of the intervention program, we employed the t-test for related samples and Cohen's d, alongside the associated confidence interval (95%). Normality of the data was verified through the Kolmogorov-Smirnov test using Lillieforts correction, whilst homoscedasticity was examined using the Levene test.

RESULTS

Statistically significant differences were observed between the flexibility scores recorded for males and females. Trunk flexion for males was established at 5.09, whilst females recorded a value of 7.82. In relation to BMI, a higher mean was found for females (25.53 ±5.07 vs. 24.86 ±3.75), whilst the strength test revealed a greater value for males (19.85 ±6.40 vs. 18.96 ±5.91) in comparison to females (4.36 ±2.55 vs. 4.12 ±3.40). Higher mean scores were found with regards to balance, identifying statistically significant differences (4.36 ±2.55 vs. 4.12 ±3.40). Statistically significant differences were found for the level of coordination, this being higher amongst females (85.68 ±19.67 vs. 70.57 ±19.14) (Table 1).

Statistically significant differences are found at the level of p = 0.001 between the data obtained in the pre-test and the post-test for the variables of BMI, flexibility, strength, balance and coordination. Perusing the mean values we see that higher values were obtained in the post-test for flexibility(8.13 ±4.87 vs. 6.54 ±4.17) with a medium effect size (d = 0.350), and for strength(21.06 ±5.95 vs. 19.38 ±6.10) with a small to medium effect size (d = 0.27). In the case of balance, higher mean values were obtained in the pre-test (4.23 ±3.01 vs. 3.04 ±2.71), with this value representing a medium effect size (d = 0.415). Finally, the scores obtained over time for coordination show an improvement at post-test (85.68 ±19.67 vs. 70.57 ±19.14), representing a medium effect size (d = 0.362) (Table 2).

With regards to flexibility there was a significant relationship with coordination, demonstrating a positive direct association (r = 0.443, p<0.01), whilst it was negatively and indirectly related with strength and balance (r = −0.036; r = −0.098, respectively). With regards to BMI, this was negatively and indirectly correlated with flexibility and strength (r = −0.213; r = −0.48, respectively), and

Table 1. Sample characteristics according to gender prior to receiving the intervention.

Variable	Gender	M	SD	Levene Test		T Test Sig. (Bilateral)
				F	Sig.	
Body weight (kg)	Male	70.92	12.36	0.869	0.356	**0.005****
	Female	68.95	14.64			
BMI (kg/m^2)	Male	24.86	3.75	0.258	0.614	**0.001*****
	Female	25.53	5.07			
Flexibility (cm)	Male	5.09	3.63	5.499	**0.024****	**0.001*****
	Female	7.82	4.25			
Strength (Kg)	Male	19.85	6.40	0.245	0.245	**0.001*****
	Female	18.96	5.91			
Balance (nº attempts)	Male	4.36	2.55	0.075	0.075	**0.001*****
	Female	4.12	3.40			
Coordination (nº repetitions)	Male	63.50	20.19	6.300	6.300	**0.001*****
	Female	76.80	16.09			

Statistically significant differences at the level of: **p<0.05; ***p<0.001

Table 2. Effects of the intervention program on the variables studied.

Variable	Study conducted	M	SD	T	Sig. (p)	d.	R-size	I.C. 95%
BMI (kg/m^2)	(Pre-test)	25.22	4.468	2.968	**0.001**	−0.033	−0.016	(23.79-26.36)
	(Post-test)	25.07	4.385					
Flexibility (cm)	(Pre-test)	6.54	4.171	−7.048	**0.001**	0.350	0.172	(6.70-9.56)
	(Post-test)	8.13	4.875					
Strength (Kg)	(Pre-test)	19.38	6.101	−7.017	**0.001**	0.278	0.137	(19.31-22.81)
	(Post-test)	21.06	5.958					
Balance (nº attempts)	(Pre-test)	4.23	3.008	7.892	**0.001**	0.415	−0.203	(2.24-3.83)
	(Post-test)	3.04	2.710					
Coordination (nº repetitions)	(Pre-test)	70.57	19.142	−9.279	**0.001**	0.778	0.778	(79.91-91.46)
	(Post-test)	85.68	19.670					

Statistically significant differences at the level of p<0.01

positively and directly correlated with balance and coordination (r = 0.001; r = 0.028). A direct positive association is observed between balance and coordination (r = 0.105), and a negative indirect association is seen between strength and balance (r = −0.024), and balance and coordination (−0.076), respectively (Table 3).

DISCUSSION

The present research study analyses the effect of the intervention program based on an introduction to SLOC and adapted games, within a sample of users with an intellectual diversity/disability. The program lasted for 24 weeks. Specifically, its objective was to improve indicators of health, fat mass percentages, and levels of coordination, balance, flexibility and strength. Other studies similar to the present one have been conducted by Wu et al. [30], Golubovic et al. [31], Stanish et al. [32], or Witkowski et al. [33]. All of these sought to examine the use of a martial arts and physical activity on populations with similar characteristics.

Measurements prior to administering the program showed that BMI was higher in females, whilst body weight was higher in males. These results seem reasonable given the physiological characteristics of females who present a higher fat mass percentage than males [34]. With regards to measures of body weight according to gender, males obtained higher mean values than females. This may be due to the larger size of individuals of this gender and the fact they tend to possess a higher percentage of muscle mass [35, 36]. Further, females were more flexible and coordinated, whilst males had greater strength and poorer balance in comparison.

Similar results [37, 38], remark that females are more flexible due to their higher levels of oestrogen. This provokes higher liquid retention in women, which results in them having less dense connective tissue and lower lean mass. In the same way, males tend to have greater strength due to the production of androgens which favours muscle growth and strengthens the body.

Table 3. Bivariate correlations between the variables following the intervention program.

Variable	Flexibility	Strength	Balance	Coordination
BMI	−0.213	−0.48	0.001	0.028
Flexibility	1	−0.036	−0.098	**0.443****
Strength		1	−0.024	0.105
Balance			1	−0.076

** The correlation is significant at the level of p<0.01

It is also observed that the scores obtained for the balance test were higher in females than in males. Studies such as that conducted by Rodríguez-Negro and Yanci [39] demonstrated similar characteristics, following analysis of differences in static and dynamic balance as a function of gender within primary education students. The principal reason for differences in balance according to gender could be due to differences between males and females in neuromuscular control. This leads to differences in the development of abilities such as muscular strength, coordination and muscular balance, as has been previously shown [39, 40]. In add it ion highest mean values for coordination were oriented towards the female gender, with these differences being significant. These results do not coincide with those obtained by Guijarro-Romero et al. [41], where males were found to have higher mean values than females with regards to coordination.

When analysing the effects of the intervention program, a reduction in BMI was observed, revealing that this represented a small effect size. In a similar way, Walaszek et al. [42] obtained an improvement in body mass index values, with this reduction being achieved through adapted games within martial arts such as judo or simply martial arts in general. This same outcome was also reported by Origua et al. [43]. On the other hand, there was an increase in flexibility and strength following intervention, suggesting that the practice of SLOC should be taken into account for producing these relevant improvements.

The present results are in line with those produced by other studies which uncovered improvements in flexibility, such as those offered by or Malesa et al. [44], Roebers et al. [45] or Hartman et al. [46]. This may be due to the approach taken during the SLOC sessions which enabled a greater activation time in users, provoking changes in one's body, strength, flexibility and even cardiovascular resistance after 24 weeks of intervention. With regards to coordination, evaluation following the intervention showed a moderate improvement, with statistically significant differences being found. This demonstrates the efficacy of martial arts (SLOC) and moderate intensity motor games for enabling physical improvements. This was also concluded following an intervention program administered over 15 weeks. Specifically, the confidence interval obtained shows that improvements could reach a medium to moderate effect size, with this being achieved by increasing the number of sessions each week [47]. Along similar lines, Jankowicz-Szymanska et al. [48] obtained an improvement in coordination in their study. For this, they administered physical static balance training which improved the physical conditions of users with intellectual diversity. This corroborates the findings of the present study.

Thus, practice of SLOC can be an effective means of improving quality of life, decreasing BMI, and developing strength, flexibility and even coordination. Results of the present research with regards to the physical state and health of participants are congruent with those reported in some researches. These studies [49, 50] also saw improvements at a muscular level, and in strength, resistance and coordination in adults with an intellectual disability following a 20 week intervention.

CONCLUSIONS

In consideration of the research question, it can be established that an intervention program based on a new sport such as SLOC and adapted games can improve various health indicators and basic physical qualities. These include flexibility and strength, and coordination skills such as balance and coordination, targeting individuals with a disability.

Hypothesis 1 (H1) was partially fulfilled, that scores for flexibility and balance were better amongst females. Further, the opposite trend was observed for BMI, with this being higher amongst the masculine sex. However, higher values for coordination were obtained in females than males, this did not comply with the hypothesis established.

Hypothesis 2 (H2) was fulfilled in its totality. The intervention program improved levels of coordination, balance, strength and flexibility. Further, BMI decreased as a result of the degree to which physical activity was engaged in.

Hypothesis 3 (H3) was partially fulfilled, as following the SLOC intervention there was an improvement to a certain degree in aspects such as BMI, coordination and flexibility. This is thanks to the role of physical activity in combating sedentary behaviour, in this way improving quality of life "during" the intervention.

This research study shows how an intervention program based on a new sport such as SLOC and adapted motor games, can have slight positive effects on specific properties that indicate the physical and cognitive health of users with intellectual diversity. It was demonstrated that 24 weeks of intervention permitted a tenuous improvement in body mass index, flexibility and strength, bearing in mind the limitations and specific characteristics presented by the study population. In addition, some coordination skills such as balance and coordination also improved, assuming a medium to moderate effect size thanks to the characteristics of the chosen sport.

As a principal conclusion, it can be established that SLOC presents an innovative, playful and non-harmful resource for engaging in physical exercise for the improvement of health and quality of life in users with intellectual diversity.

The present pilot study demonstrates some of the potential benefits of this new sport within this type of population, in addition to its utility for different ages. In this way, the study opens a new line of research in order to replicate this study in populations with a higher prevalence of overweight, due to its ease of use and the advantages associated with its application.

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