COMBINED EXERCISE TRAINING PROGRAMME LEADS TO DIFFERENT EFFECTS ON POWER, MUSCULAR ENDURANCE AND BALANCE OF INSTITUTIONALIZED PERSONS WITH INTELLECTUAL DISABILITIES

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Abstract:

People with intellectual disabilities have a reduced level of physical fitness. Institutionalization may be one of the important factors associated with their lower level of physical activity. Implementing a training intervention for institutionalized adults with intellectual disabilities requires an innovative and individually tailored approach that may differ from the approach for the general population. This study aims to determine the effects of a newly designed exercise training programme, consisting of neuromuscular exercises and outdoor walking training, on muscular endurance, power, and balance of institutionalized adults with intellectual disabilities. The participants were 90 institutionalized adults (43.9 ± 9.0 years), with mild to moderate intellectual disabilities, randomly assigned into a control (n=45) or an experimental group (n=45). The experimental group participated in the experimental training programme for 12 weeks (60 training sessions). In the experimental group**,** participants' muscular endurance (p=.01) and power (p=.04) were significantly improved without major changes in balance. The latter was probably due to a small amount of specific postural exercises in the applied combined exercise programme. Future research should focus on finding an appropriate volume of postural control exercises to stimulate balance improvement in this specific population.

Key words: *cognitive impairment, physical fitness, neuromuscular training, walking, postural control*

Introduction

The prevalence of sedentary behaviour in people with intellectual disability (ID) is significantly higher than in the general population (Cartwright, Reid, Hammersley, & Walley, 2017; Hsieh, Hilgenkamp, Murthy, Heller, & Rimmer, 2017; Kreinbucher-Bekerle, Ruf, Bartholomeyczik, Wieber, & Kiselev, 2023; Oviedo, Travier, & Guerra-Balic, 2017). Only a small percentage of adults with ID meet the World Health Organization's (WHO) recommendations for daily physical activity (PA), and even active individuals manage to achieve only levels of physical activity that are comparable to those of less active individuals in the general population (Hsieh, et al., 2017; Oviedo, et al., 2017). Lack of PA and a sedentary lifestyle negatively affect their physical fitness and overall health (Ferreira, et al., 2022; Hsieh, et al., 2017; Jacinto, et al., 2021; Oviedo, et al., 2017; Ptomey, et al., 2019). People with ID have a reduced level of cardiorespiratory fitness, muscle strength and endurance with the frequently accompanying balance disorder (Bahiraei, Oviedo, & Hosseini, 2023; Jacinto, et al., 2021; Ptomey, et al., 2019; Scifo, et al., 2019). As a result, they have a lower quality of life, a greater number of health problems, significantly increased living and health care costs and a shorter life expectancy compared to the general population (Jacinto, et al., 2021; Ptomey, et al., 2019; Scifo, et al., 2019; Simões, Santos, & Claes, 2015).

Individuals with ID are highly dependent on other people's help and need constant support in various aspects of everyday life (Bossink, van der Putten, Waninge, & Vlaskamp, 2017; Overwijk, Hilgenkamp, van der Schans, van der Putten, & Waninge, 2021; Reguera-García, Fernández-Baró, Diez-Vega, Varona-Echave, & Seco-Calvo, 2023). For those reasons, they are often homed in specialized rehabilitation centres or group homes, thus making institutionalization a dominant form of residential accommodation for adults with ID (Bossink, et al., 2017; Dixon-Ibarra, Driver, Vanderbom & Humphries, 2017; Overwijk, et al., 2021). In such conditions, their opportunities to engage in regular PA may be further reduced and limited. Additionally, within the centres, they can meet all their vital needs. In these circumstances, their motivation to be physically active gradually decreases. Institutionalization may be one of the important factors associated with a lower level of PA in people with ID (Bossink, et al., 2017; Dixon-Ibarra, et al., 2017). For these reasons, the process of planning and implementing a physical exercise intervention for institutionalized adults with ID requires an innovative and tailored approach that may differ from the approach for the general population (Oviedo, et al., 2017; Rodrigues, Jacinto, Figueiredo, Monteiro, & Forte, 2023). The potential effect of programmed physical exercise on the physical fitness of institutionalized persons with ID is an insufficiently explored area, and numerous physical exercise interventions for the people with ID used in daily practice are based on studies carried out with the general population (Pitchford, Dixon-Ibarra, & Hauck, 2018).

Specific exercise programmes may develop motor abilities and, by doing so, enhance physical fitness of people with ID (Obrusnikova, Firkin, Cavalier, & Suminski, 2022). Most previous research studies indicate the possibility of positive changes in muscular strength and endurance as well as in balance under the influence of physical exercise programmes (Jacinto, et al., 2021; Scifo, et al., 2019). However, the results are predominantly based on the application of isolated exercise programmes aimed at developing targeted motor abilities. Research shows that specific strength exercises for people with ID can contribute to their better daily living performance and prevention of muscle mass loss (Jacinto, et al., 2021; Maine, et al. 2020). Targeted physical exercise programmes may also improve muscle endurance (Tamin, Idris, Mansyur, & Soegondo, 2015) and balance (Lee, Lee, & Song, 2016). Only a few studies, with inconsistent results, investigated the possibility of obtaining similar effects by the application of more complex training programmes that combine several different types of exercises so they could have a more comprehensive effect on physical fitness covering health and skill- or performance-related physical fitness (Bouzas, Ayán, & Martínez-Lemos, 2019; Rodrigues, et al., 2023). More complex training programmes may even be more interesting and maybe more successful in motivating people with ID to engage in PA and stay active.

Newer research provides encouraging evidence about the possibility of a positive effect of combined physical exercise and walking programmes on improving health of people with ID (Lin, 2021). Walking is a widespread PA and is generally accepted as an appropriate activity for the initial activation of physically inactive individuals (Matthews, et al., 2016; Melville, et al., 2015). Regular walking has a wide range of health benefits for the individual; however, this type of intervention has rarely been used with institutionalized persons with ID (Matthews, et al., 2016; Melville, et al., 2015). People with ID walk at a lower intensity, less frequently and for a shorter duration compared to the general population (Elbers, de Oude, Kastanidis, Maes-Festen, & Oppewal, 2022; Matthews, et al., 2016; Melville, et al., 2015; Van Hanegem, Enkelaar, Smulders, & Weerdesteyn, 2014). For people with ID, walking is recommended as one of the most practical forms of exercise to achieve target levels of daily PA (Matthews, et al., 2016). The main advantages of walking, compared to the other aerobic forms of physical exercise available to people with ID, are that walking does not require any additional special skills or previous knowledge, it is usually completely free, and it can be practiced by previously extremely inactive individuals (Stancliffe, & Anderson, 2017).

Finally, due to the above-mentioned specificities of the institutionalized people with ID, it is reasonable to assume that an exercise programme for the institutionalized adults with ID should be appealing to initially motivate them to get involved and to ensure their regular attendance. It should also focus on simple, quickly understandable, but effective exercises. Additionally, it may be useful if the implementation of such a programme would be independent of specialized devices because not every Centre has the same living and working conditions. The aim of this study was to determine the effects of a newly designed exercise programme combining neuromuscular and walking exercises on the power, endurance, and balance of institutionalized adults with ID. The idea was to implement an exercise programme that combined a wide range of different neuromuscular tasks as well as outdoor walking training that people with ID may find interesting and feel motivated to regularly attend training sessions.

Materials and methods

Study design

The conducted research represents a randomized control trial investigating the effects of a newly designed exercise training programme that combines neuromuscular and walking exercises on the power, endurance, and balance of institutionalized adults with ID. The research was conducted during the period from April to July 2022. It encompassed the initial (1 week) and final (1 week) testing of participants' motor abilities, an intervention training period (12 weeks) and two adaptation weeks (one for the testing procedures and one for the training protocol). Specifically, considering that people with ID need more time to familiarise themselves with new tasks (Obrusnikova, et al., 2022), a period of one week was planned before the initial testing to demonstrate the testing procedures to all the participants and let them accustomed to the tasks. An appropriate schedule was planned, and each participant had the same opportunity to see and try the tasks under the supervision of specialized therapists. After the initial testing, participants were randomly allocated either to the experimental group (EG) or to the control group (CG). The participants of the CG continued with their usual daily activities and did not engage in any organized form of physical exercise until the end of the study. On the other hand, the participants in the EG had a one-week period to adapt to the training procedures. Professional therapists explained and demonstrated the tasks in detail, and the participants had the opportunity to practice them. After that, the official 12-week intervention training period began. The exercise programme was carried out five times a week. In it, 60-minute neuromuscular training sessions (performed on Mondays, Wednesdays and Fridays) alternated with a 30-minute outdoor walking programme (performed on Tuesdays and Thursdays). The weekend was free from any organized PA.

Sample

The research was conducted with a sample of 90 persons with ID (31 females and 59 males) chronologically aged from 21 to 55 years (43.9 ± 9.0). Participants were adults with a diagnosed intellectual disability who were permanent residents of the Rehabilitation Centre "Nada" (Karlovac, Croatia), a specialized home for housing persons with ID. Estimates of the total sample size needed for this study were made using G*Power (version 3.1.9.7) (Faul, Erdfelder, Lang, & Buchner, 2007). A power analysis showed that a sample of at least 54 participants was required to detect a medium effect size (ES) of 0.5 (α=.05, 1−β =.95), in agreement with some previous studies (Bouzas, et al., 2019; Jacinto, et al., 2021). Considering that it is a relatively long and complex research with a specific population for which it is difficult to assess their level of cooperation in advance, and due to the presence of fear of participants dropping out, the study was planned with a total of 90 participants. Inclusion criteria were the following: diagnosed mild or moderate ID, age between 20 and 55 years, at least 12 consecutive months, without interruption, of accommodation in the Centre, and the ability to understand and follow verbal instructions. Exclusion criteria encompassed the following: musculoskeletal and/or neurological deficits, inability to walk independently, visual and hearing impairment, and presence of acute cardiovascular and/or respiratory diseases. The research was conducted in accordance with the Declaration of Helsinki (World Medical Association, 2013) and approved by the Ethics Committee of the Faculty of Kinesiology of the University of Zagreb (Protocol Code 34; date of approval 8-10 December 2021). Consent was also obtained from the Rehabilitation Centre "Nada".

Randomisation

To ensure a balance between the experimental and control group during the randomisation process, pairs of participants were formed according to the following criteria: age, gender, body mass index (BMI) and degree of ID. One member of the pair was assigned to the experimental (n = 45) and the other to the control group (n = 45) using the method of random selection with computer program R, v.3.5.1. At the beginning of the research, the differences between the groups according to the randomisation criteria were determined using the chi-square test for categorical variables (gender, BMI and degree of ID) and the Mann-Whitney U test for continuous variable (age) .

Measures

Anthropometry

Body weight and body height were measured in accordance with the standardised measurement procedures and carried out in the morning, before breakfast (Hsu, et al., 2021). During the measurement, all participants wore lightweight clothing and were barefoot. Body height was measured with an anthropometer (Seca 220, Seca BmbH & Co., Hamburg, Germany), and the result was recorded in centimetres (cm) with an accuracy of 0.5 cm. Body mass was measured with a medical decimal scale with a floating weight (Seca 711, Seca BmbH & Co., Hamburg, Germany), and the result was recorded in kilograms (kg) with an accuracy of 0.1 kg. BMI was calculated as weight in kilograms divided by height in squared metres (kg/m²).

Power

Power was assessed using the standing long jump test (Martínez-Aldao, Martínez-Lemos, Bouzas-Rico, & Ayán-Pérez, 2019). This test has been considered a reliable method for assessing lower-body muscle power in adults with ID (Martínez-Aldao, et al., 2019). The test was performed on a standard, non-slip, solid surface intended for the performance of the long jump test with marked starting position and distances in centimetres (0-300 cm). Participants stood with both feet over the edge of the starting line, crouched down and jumped as far as possible using a double-leg take-off and an arm swing. After each jump, the distance from the starting line to the part of the participant's body that was closest to the starting line was recorded. The result was recorded in centimetres with an accuracy of 1 cm.

Muscular endurance

Abdominal and hip flexors' muscular endurance was tested using the 60-second sit-up test (Hsu, et al., 2021). This fitness testing protocol was chosen because it is easy to administer and it has been used often in clinical research to test the muscular endurance of adults with ID (Hsu, et al., 2021). The participants lay on their backs with their knees bent at 90° and arms crossed over the chest with palms on the opposite shoulders. The examiner fixed the participants' feet while the participants were raising their upper bodies as quickly as possible to a sitting position, touching their upper legs with their elbows, and then returning to the initial position. The examiner counted the correctly performed sit-ups for a period of 60 seconds.

Balance

Balance was measured using the Microgate Gyko device (Cigrovski, Franjko, Bon, Očić, & Božić, 2018). The device was positioned in the middle of a balance board, which was wobbling in the transverse plane (antero-posterior movement), on which the participant should stand as still as possible. Displacement of the board was measured with an accuracy of 1 mm. The standing surface of the balance board was 40 x 40 cm, and the maximal height between the floor and the standing surface was 12 cm. The balance board was constructed to allow movements exclusively in the anterior-posterior direction. Participants stood as still as possible with both their legs on the board in a semi-squat position with their eyes open and arms freely placed next to the body. Before the measurement, the participants (assisted by the examiner) completely calmed the balance board to carry out the calibration of the measuring device for each new measurement. Upon the sound signal produced by the Gyko device, the participants tried to stand as still as possible on the balance board for 30 seconds. The variables of interest used in this research were the total antero-posterior movement (cm) and the total frequency of movement (Hz) of the balance board.

Intervention

A newly designed exercise training programme for institutionalized adults with ID, which combines neuromuscular and walking exercises, was implemented five times per week. Neuromuscular training (three times a week for 60 minutes) alternated with outdoor walking training (twice a week for 30 minutes). During the weekend, the subjects were not engaged in any organized training. During the intervention period, a total of 60 training sessions were conducted (36 neuromuscular training sessions and 24 outdoor walking). Training attendance was monitored and a minimum required attendance of 80 % was determined in order to consider the participation in the study valid for further analysis. The exercise programme was designed by a group of specialists with twenty years of work experience in health care, kinesiology, physiotherapy, and psychology, as well as with many years of experience working with people with ID. The current guidelines for physical exercise for people with ID from the world's most influential institutions, such as WHO and The American College of Sports Medicine (ACSM) (American College of Sports Medicine, 2018; WHO, 2020), were taken into consideration. The weekly combination of separated neuromuscular and walking training sessions brings something new, more complex and challenging to people with ID compared to usual programmes that involved the implementation of very simple movement patterns. The idea was that a wide range of training tasks would be more interesting to people with ID, leading to their better compliance and, finally, to their better motor adaptation. The intervention was performed without the use of specific trainers because the goal was to check the effectiveness of an interesting but widely applicable training without the need for specialized equipment.

Neuromuscular training was conducted in smaller subgroups of 15 participants each. The participants performed a set of exercises adapted to improve muscular strength, power, endurance, and balance. Each training session was divided into four parts: the introductory part of the training (10 minutes), main part A (30 minutes), main part B (10 minutes), and the final part of the training (10 minutes).

During the introductory part of the neuromuscular training session, general whole-body exercises were performed. The goal of these exercises was to warm up the participants for the main part of the training and to prepare their body for increased physiological efforts and activities. Main part A of the training was divided into two units: muscular strength, power, and endurance exercises (20 minutes), and balance exercises (10 minutes). A combination of eight endurance, power and strength exercises involving large muscle groups was performed as well as five different balance exercises. Main part B of the training was planned for sports games and four different sports games were used in this programme. In the final part of the training session, stretching exercises for large muscle groups were carried out. During the entire exercise programme, participants performed the same five stretching exercises. Each exercise was performed two times for 30 seconds, and the rest between each repetition lasted 30 seconds as well. During the 12-week training period, load progression was applied at two time points. Firstly, after four weeks of exercise, and secondly, after the next four weeks, i.e., after a total of eight weeks of exercise. All load progressions were predefined and were carried out by increasing the intensity, volume and demands of the exercises in accordance with current recommendations for physical exercise for people with ID (American College of Sports Medicine, 2018; WHO, 2020). For endurance, power, and strength, the number of repetitions were progressively increased, while load progression for the balance tasks was achieved by replacing the existing exercises with more demanding ones. In addition, before each load progression, a subjective assessment of the perceived exertion from 0 (not tired at all) to 10 (very, very tired) was done using the Children's OMNI Scale of Perceived Exertion, which was previously demonstrated valid for subjective assessment of training load of adult people with ID (Stanish & Aucoin, 2007). The exercises as well as the training load are presented in Tables 1 and 2.

Table 1. Neuromuscular training – muscular strength, power and endurance exercises

Exercise		*Sets x reps*			
		Training week 1-4	*Training week 5-8*	*Training week 9-12*	*Rest*
Muscular strength, power and endurance exercises					
1.	Flexion of forearms with 1.5 kg weights	3 x 10	3 x 12	3 x 14	1-2 min
2.	Lifting 1.5 kg weights anteriorly and laterally	3 x 10	3 x 12	3 x 14	1-2 min
3.	Lying in a supine position, sit-ups with the hands placed on the chest	3 x 10	3 x 12	3 x 14	1-2 min
4.	Lying in a supine position with support on the forearms. Raising the legs to the chest with knee flexion	3 x 10	3 x 12	3 x 14	1-2 min
5.	Lying in a pronated position, the hands above the head, dynamic trunk extensions	3 x 10	3 x 12	3 x 14	1-2 min
6.	Lying in a pronated position, the hands next to the body, dynamic trunk extensions	3 x 10	3 x 12	3 x 14	1-2 min
7.	Parallel squat	3 x 10	3 x 12	3 x 14	1-2 min
8.	Alternation of left and right lunges	3 x 10	3 x 12	3 x 14	1-2 min

Table 2. Neuromuscular training – balance exercises

Training week	*Exercise*		*Sets x Duration*	*Rest*
1-4	1.	Parallel stance, the arms extended above the head, alternating trunk flexion (anteriorly) and extension (posteriorly)	2 x 30 sec.	1 min
	2.	Parallel stance, the hands next to the body—turning in place around one's own vertical axis	2 x 30 sec.	1 min
	3.	Semi-tandem stance with the eyes closed—the hands above the head	2 x 30 sec.	1 min
	4.	Tandem stance with the eyes closed—the hands above the head	2 x 30 sec.	1 min
	5.	Standing on one leg, alternating the standing leg, lateral arms rise	2 x 30 sec.	1 min
5-8	1.	Walking straight, placing each foot in front of the other (15 m)	2 x 30 sec.	1 min
	2.	Walking sideways, placing each foot parallel to the other (15 m)	2 x 30 sec.	1 min
	3.	Walking straight backwards, placing each foot behind the other (15 m)	2 x 30 sec.	1 min
	4.	Tandem stance, holding the ball with both hands anteriorly at shoulder height—alternating trunk rotations to the right and left	2 x 30 sec.	1 min
	5.	Standing alternately on the right and left leg, holding the ball with both hands anteriorly at shoulder height—alternating rotation of the trunk to the right and left	2 x 30 sec.	1 min
9-12	1.	Walking straight, placing each foot in front of the other (15 m) with sudden stopping and eyes closing at the sound signal	2 x 30 sec.	1 min
	2.	Walking sideways, placing each foot parallel to the other (15 m) with sudden stopping and eyes closing at the sound signal	2 x 30 sec.	1 min
	3.	Walking straight backwards, placing each foot behind the other (15 m) with sudden stopping and eyes closing at the sound signal	2 x 30 sec.	1 min
	4.	Tandem stance, holding the ball with both hands anteriorly at shoulder height—alternating trunk rotations to the right and left with sudden stopping and eyes closing at the sound signal	2 x 30 sec.	1 min
	5.	Standing alternately on the right and left leg, holding the ball with both hands anteriorly at shoulder height—alternating rotation of the trunk to the right and left side with sudden stopping and eyes closing at the sound signal	2 x 30 sec.	1 min

The outdoor walking training was conducted in small homogeneous subgroups of a maximum nine participants having similar motor abilities. Walking training took place in the courtyard of the Rehabilitation Centre over a specially marked polygon with a rectangular shape and a total length of 100 m (dimensions: 40 m x 10 m). The training load progression was carried out following the recent ACSM recommendations for people with ID, which suggested a gradual increase from light to moderate-intensity activities (American College of Sports Medicine, 2018). In accordance with this, for the first four weeks, the participants walked at a speed of up to 4.8 km/h, which corresponded to an activity of light intensity. For the next four weeks, the participants walked at a speed of 4.8-6.4 km/h, while in the last four weeks, walking speed was 6.4-7.2 km/h. Walking speed applied in the period of 5th to 12th week of the programme (4.8-7.2 km/h) corresponded to moderate intensity of physical activity (American College of Sports Medicine, 2018). During the outdoor walking training, the participants were continuously informed about the remaining time and at the same time, they received instructions if their walking speed needed to be corrected.

Main analyses

During the research, two participants from the EG did not meet the criterion of regular attendance (attendance less than 80%), and one participant from the CG fell ill and was not present at the final testing. For this reason, statistical analysis was performed on the total sample of 87 participants. For power assessment, each participant performed the test three times, and the best result was used for data analysis. The balance task was also performed three times, but the arithmetic mean of three repetitions was used in the statistical analysis. The endurance test was performed only once.

In data processing, standard statistical methods were used to determine descriptive parameters: arithmetic mean (M) and standard deviation (SD). The normality of the distribution was analysed using the Shapiro-Wilk test. The test showed a normal distribution only for the variable measuring power in both groups. The data for all the other variables (measuring muscular endurance and balance in both groups) were not normally distributed. For further analysis, parametric statistics was used on normally distributed variables, while non-parametric tests were used for variables with a non-normal distribution.

To assess the statistical significance of changes between the initial and final testing within the tested groups, the Student's t-test for dependent samples was performed on the normally distributed variables, while the Wilcoxon Signed-Rank test was used for the ones with a non-normal distribution. To check for the practical significance of the achieved results, the effects size was calculated using the Cohen's index (normal distribution) or the r parameter (non-normal distribution).

According to Muhammad (2023), when variables are non-normally distributed, it is not possible to perform a repeated-measure ANOVA. Since, in our case, not all the variables were normally distributed, to test the between-group statistical significance of change between the initial and final measurement new variables were formed (derived by calculating the differences between the results of the final and initial testing, that is "final - initial"). These new (difference) variables were also tested for normality of distribution by means of the Shapiro-Wilk test. The variables measuring power and balance with total frequency of movement of the balance board had a normal data distribution, while the one measuring muscular endurance and balance with antero-posterior movement of the balance board had not. To check for between-group differences in normally distributed data, the Student t-test for independent samples was performed, while in case of non-normal distribution, the Mann-Whitney U test was used.

Statistical data processing was performed using the Statistica for Windows 14.0 software package (StatSoft Inc., Tulsa, OK). Statistical significance was set at $p<.05$.

Results

At the beginning of the study, there were no significant differences between the two groups in age (p=.18), gender (p=.15), BMI (p=.24) and degree of ID (p=.16). Also, there were no significant differences in the tested motor abilities between the two groups (power: p=.89; muscular endurance: p=.55; balance [antero-posterior movement]: p=.42; balance [frequency of movement]: p=.67).

Table 3 points out descriptive statistical parameters and statistical significance between the initial and final testing for the CG and EG separately. In the EG, although a positive trend of change was observed in all the variables, statistical significance was obtained only for power ($p<.01$), with a medium effect size. No statistically significant changes were detected between the initial and final measurements in the CG.

As stated before, since not all the variables had normally distributed data, in order to check for the between-group differences in changes from the initial to final measurement, a new variable consisting of the difference between the final and initial testing (final – initial) for each measured motor ability in each group was calculated. Table 4 shows descriptive statistical parameters of these new variables. It also shows the between-

Table 3. Descriptive statistics for the initial and final testing as well as the results of the Student t-test for dependent samples and Wilcoxon sign test for each variable for both groups

Variables	*Control group*				*Experimental group*			
	Initial testing	*Final testing*	*p*	*ES*	*Initial testing*	*Final testing*	*p*	*ES*
	M ± SD	*M ± SD*			*M ± SD*	*M ± SD*		
PowerSt	80.07 ± 47.69	78.52 ± 48.99	0.94	-0.03	81.49 ± 44.94	84.23 ± 48.59	0.11	0.11
Endurance^{W}	12.14 ± 10.64	13.7 ± 10.89	0.12	0.12	13.42 ± 10.67	19.21 ± 9.81	<0.01*	0.43
Balance_ movement^{W}	67.12 ± 34.52	68.17 ± 36.55	0.55	0.01	61.09 ± 29.58	59.87 ± 23.84	0.63	-0.04
Balance_ freequency^{W}	0.54 ± 0.22	0.52 ± 0.22	0.35	-0.04	0.52 ± 0.26	0.46 ± 0.23	0.07	-0.17

Note. M-arithmetic mean; SD-standard deviation; p-significance indicator; ES-effect size; Balance_movement-measure of balance indicating the total antero-posterior movement of the balance board; Balance_freequency-measure of balance indicating the total frequency of movement of the balance board; St-Student t-test for dependent samples, used to process normally distributed data; W-Wilcoxon test, used to process non-normally distributed data; *-significant interaction (p<.05)

Table 4. Descriptive statistics of the newly derived difference variables, and between-group differences assessed by means of the Student t-test for independent samples and Mann-Whitney U test

Variables	*Control group*	*Experimental group*	*p*
	M ± SD	*M ± SD*	
Power_*diff*St	-1.55 ± 6.55	2.74 ± 14.65	0.04*
Endurance_*diff*^{MW}	1.57 ± 7.25	5.79 ± 8.03	0.01*
Balance_movement_*diff*^{MW}	1.05 ± 25.77	-1.22 ± 24.35	0.53
Balance_frequency_*diff*St	-0.01 ± 0.16	-0.06 ± 0.19	0.13

Note. M-arithmetic mean; SD-standard deviation; p-significance indicator; Balance_movement-measure of balance indicating the total antero-posterior movement of the balance board; Balance_freequency-measure of balance indicating the total frequency of movement of the balance board; St-Student t-test for independent samples, used to process normally distributed data; MW-Mann-Whitney U test, used to process non-normally distributed data; diff-indicating that the variable has been calculated by subtracting the result achieved in the initial testing from the result achieved in the final testing; *-significant interaction (p<.05)

group differences in these variables. Statistically significant between-group differences were found for power (p=.04) and muscular endurance (p=.01).

Discussion and conclusions

The aim of this study was to determine the effects of a newly designed exercise training programme, combining neuromuscular and walking exercises, on the power, endurance and balance of institutionalized adults with ID. The obtained results showed that the newly designed exercise training programme led to a significant improvement in power and muscular endurance without statistically significant changes in balance. This indicates an improvement in health-related (muscular endurance) as well as performance-related physical fitness (power) indicators. It has been well-documented that people with ID have suboptimal levels of power, muscular endurance, and balance, compared to persons without ID (Bahiraei, Oviedo, & Hosseini, 2023; Elbers, et al., 2022; Graham, & Reid, 2000; Jacinto, et al., 2021). This is especially true for institutionalized people with ID, who tend to spend a large portion of the day in sedentary behaviours (Bossink, et al., 2017; Dixon-Ibarra, et al., 2017). The here documented level of muscular endurance is still below the expected value for the general population (Yanardag, Arikan, Yilmaz, & Konukman, 2013); however, the fact that the institutionalized adults with ID had significantly improved it may have an important implication in their everyday life. Muscular power may be crucial to promote mobility, cardiovascular capacity, and performance of daily living like recreational and vocational activities in adults with ID (Obrusnikova, et al., 2022). In previous research, specific training programmes were used to enhance muscular properties (Jacinto, et al., 2021), rather than a more complex one like in our study. A few studies included a combined type of training, but most of them did not plan a comprehensive programme that combined strength exercises, balance exercises, and daily activities. Calders et al. (2011) planned a 20-week specific aerobic training with two training sessions per week and compared it to a combination of aerobic and strength exercises performed in a gym. Their results show a better improvement of muscle fatigue resistance measured by a sustained handgrip contraction in people with ID, mean age 42 ± 9.2 years, after the combined training. The training period used by Calders et al. (2011) had in total fewer training sessions than the one carried out in our study; however, it was a specific one and aimed only at muscular strength and endurance improvement, without additional exercise for postural control or outdoor walking. Stanish and Temple (2012) studied the effect of a 15-week aerobic training, weight training and stretching, performed twice a week, on muscular fitness of adolescents with ID. The programme led to a significant improvement in muscular endurance. Although this research was carried out with adolescents with ID, it might be interesting to point out that they exercised peer support in order to increase their training attendance. Regardless of that, the authors stated that weight training exercises were completed less consistently, which might indicate a lower motivation for this kind of exercise in people with ID. Since muscular endurance may help people with ID to better perform daily activities and improve their physical fitness and overall health, it is important to find new ways of training to encourage them to get involved as much as possible and develop this health-important muscular feature. Since the overall attendance in our study was very high (only two participants failed to attend 80% of the training sessions), the here presented complex training may be one way to deal with this challenge.

The significant improvement in the muscular power of the institutionalized adults with ID registered in our study is most probably due to the neuromuscular component of the implemented training programme. The comparison with similar previous studies is difficult because researchers have mostly focused on targeted strength and power training. Recent systematic reviews reported the possibility of obtaining positive effects on power using a combined exercise intervention in people with mild to moderate ID (Bouzas, et al., 2019; Farías-Valenzuela, et al., 2022; Jacinto, et al., 2021). However, in most previous studies resistance training was used (combining exercises to develop muscular strength, power and endurance) to improve power. The authors achieved similar results using resistance training interventions lasting from nine to 12 weeks with one to three training sessions per week (Bouzas, et al., 2019; Jacinto, et al., 2021). Here, a 12-week complex training programme was carried out with three neuromuscular sessions and two outdoor walking sessions weekly. Another important difference between our exercise programme and the ones usually used in previous studies is that we did not use a specialized gym or equipment for resistance training like chest press, leg extension, abdominal muscle trainer and others. The exercises were body-weight exercises with the addition of simple weights that are available in any sports stores. The focus was on the study of the effectiveness of the newly designed exercise programme, which can later be easily implemented in any rehabilitation centre, regardless of the equipment at their facilities. According to the obtained data, the programme could lead to a significant improvement in the muscular power of institutionalized adults with ID. Great power means a large amount of work or energy developed in a short time. This may help adults with ID to climb stairs and move faster in daily activities, thus enhancing their physical functioning. The importance of enhancing power in such a specific population like institutionalized adults with ID is even greater when taking into consideration that comparative studies have found muscle power is more strongly associated with physical function than muscle strength and has been independently associated with mortality, even to a greater extent than muscle strength (Alcazar, Guadalupe-Grau, García-García, Ara, & Alegre, 2018). Thus, the here obtained enhancement in muscle power may preserve the health and physical independence of adults with ID.

The ability to quickly exert maximum force, which stands in the background of power, is highly correlated with the ability of the neuromuscular system to quickly and timely correct the body position in space (Lauber, Gollhofer, & Taube, 2021). Muscle contraction speed is important for power as well as for balance tasks performance. In line with that, one would expect that the established improvement in power would be accompanied by a significant improvement in balance. However, although there was a positive trend of progress in balance, statistical significance was not reached. Oviedo, Guerra-Balic, Baynard, and Javierre (2014) managed to improve balance in adults with ID by implementing a 14-week exercise programme consisting of aerobic, strength and balance exercises performed three times a week. More recently, the possibility of enhancing balance in adults with ID aged 18 to 50 years with a 4-month multicomponent balance-specific exercise programme performed twice a week has also been proven; however, participants were younger and belonged to a population defined as "athletes that did not match the WHO recommendations for daily activity" (Kovačič, Kovačič, Ovsenik, & Zurc, 2020). Although participants in previous studies were younger (Kovačič, et al., 2020) or trained longer (Oviedo, et al., 2014), it is possible that the exercise intervention in our study was not sufficiently focused on improving balance in institutionalized people with ID. If improving balance is the aim, then more postural-oriented tasks should be implemented in the training programme. This issue is extremely important since people with ID present postural control deficits that can be attributed to several sources and that may be a cause of support needed in different aspects of daily life for better individual functioning (Bahiraei, et al., 2019; Reguera-García, et al., 2023).

There is a limited number of studies confirming positive changes in the deficient motor abilities of institutionalized adults with mild to moderate ID following a combined exercise intervention. Lower levels of motor abilities and connected health issues are highly prevalent in this population (Ferreira, et al., 2022; Hsieh, et al., 2017; Oviedo, et al., 2017; Vancampfort, et al., 2022). Our study findings showed that a 12-week complex training protocol, consisting of neuromuscular exercises and outdoor walking, may improve muscular endurance and power in institutionalized adults with ID but may be too general to develop balance. The exercise intervention used in this randomised control trial was designed to be easily applicable and incorporable into the daily routine of institutionalized people with ID. It was also planned to make it interesting and motivating for the participants to ensure regular attendance. This study design has several limitations which need to be discussed. Generalizing the obtained results to all individuals with ID should be done with caution, since the study was performed with the institutionalized persons with mild to moderate ID. Furthermore, the here used training programme is not adapted to individuals with profound ID. Also, the lack of blinding of the examiner during the measurement may introduce measurement bias. The duration of our exercise programme was 12 weeks, and no follow-up measurements were done to determine whether the achieved changes had been maintained.

In summary, the results of the conducted research indicate that a 12-week complex training, including strength, endurance, power, and balance exercises as well as regular outdoor walking, may develop performance and health-related physical fitness of institutionalized adults with ID through muscular endurance and power enhancement, but it was not specific enough to enhance balance in this population. Considering the less developed motor abilities of people with ID and the lower quality of their overall health, the need to include people with ID in regular physical exercise is constantly emphasized. Recently, the importance of finding a way to motivate this population to exercise regularly has also been expressed. The programme applied here was planned as a simple and feasible training that can be performed in almost any working condition. It also included a considerable variability of exercises to be more interesting to people with ID and thus hopefully motivate them to attend it regularly. High attendance was achieved, and muscular endurance and power were developed. However, it seems it did not focus enough on balance improvement in this specific population. Future research should focus on exploring the ideal balance between the attractiveness of tasks and their effectiveness in developing targeted motor skills and abilities in people with ID.

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