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Impact of Muscle Mass and Muscle Strength on Quality of Life of Individuals with Intellectual and Developmental Disabilities

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Abstract: This study aimed to investigate the relationship between muscle strength and perceived quality of life in individuals with Intellectual and Developmental Disabilities (IDDs). A cross-sectional study was carried out, which involved 37 participants with a mean age of 39.08 years (SD = 0.05), ranging from 20 to 58 years. The participants were assessed on anthropometric and body composition parameters, a 30 s chair stand test and isokinetic dynamometry. Quality of life was assessed using the Portuguese version of the Personal Outcomes Scale. Pearson's correlation analyses were carried out to examine the associations between strength measures and quality of life. Significant correlations were observed between strength measures and quality of life. In addition, lower limb muscle strength, particularly in flexion (left: r = 0.450; $p \leq 0.001$; right: r = 0.504; $p \leq 0.001$) and extension (r = 0.328; $p = 0.05$), showed positive correlations with quality of life. These findings provide preliminary evidence suggesting that muscle mass and strength may serve as potential predictors of quality of life in individuals with IDD.

Keywords: intellectual disability; muscle mass; neuromuscular capacity; peak torque

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1. Introduction

Quality of life is a multidimensional concept that concerns an individual's well-being or perception of their social position in the context and culture in which they live, encompassing socio-cultural values, needs, expectations and individual preferences, and is especially relevant in populations with Intellectual and Developmental Difficulties (IDDs) [1]. IDD is characterized by significant limitations in intellectual functioning and adaptive behavior, occurring before the age of 22 [1,2]. Assessing quality of life in this population is extremely important due to the complexity of their needs and the direct influence that quality of life has on the development and well-being of these individuals [1,3]. It is a multidimensional phenomenon composed of domains and factors influenced by individual characteristics and extrinsic factors. Although they may vary from person to person in terms of value and importance, these domains are transversal to all people [4]. Although they may differ from individual to individual in terms of value and importance, these domains are transversal for all people. On the other hand, assessing the quality of life of

individuals with IDD is a way of giving them a voice, respecting their perceptions and experiences, which is essential for their development, while always respecting their rights and responsibilities [1,3].

Muscle strength has a fundamental role to performance in lives of individuals with IDD, directly influencing their functionality, independence and quality of life [5,6]. These individuals have deficits in muscle strength, which can affect their motor skills, coordination, balance and resistance [7,8]. These limitations can make it difficult to successfully perform basic activities such as walking, climbing stairs, dressing and carrying out domestic tasks, increasing dependence on carers. In addition, reduced muscle strength in this population is associated with less autonomy and a higher incidence of early fatigue, negatively affecting self-esteem and perceived quality of life [9]. Understanding the relationship between muscle strength and quality of life in this population is crucial for developing effective and adapted interventions aimed at promoting greater independence and well-being [5,6].

These individual characteristics become more accentuated due to the inactive and sedentary lifestyles often observed in the IDD population [10,11]. Although the World Health Organization recommends that adults with IDD engage in at least 150 min of moderate-intensity physical activity per week, or 75 min of intense physical activity and muscle-strengthening activities on two or more days per week, this population does not meet the recommendations [10]. Not only does this increase the risk of developing cardiovascular and metabolic diseases, but it also compromises mobility and independence, negatively affecting quality of life. The lack of adherence to and maintenance of physical activity programs may be due to the existence of barriers/obstacles/constraints that can hinder practice [12]. It is important to analyze quality of life and function from various perspectives in the field of rehabilitation [13,14].

Despite the potential benefits of muscle strength in individuals with IDD, its relationship with perceived quality of life is still little explored in the scientific literature. Most of the literature focuses on specific physical health variables, such as functional capacity, reducing the risk of falls or preventing chronic diseases, without necessarily considering the direct impact of these variables on the quality of life of this population. Muscle strength is known to be related to greater functional independence, making it easier to carry out daily activities and perform tasks independently [5,6]. However, the lack of studies correlating these variables with subjective quality of life indicators means there is a gap in the literature.

This study aims to analyze the correlation between muscle strength and perceived quality of life in adults with IDD. Understanding this relationship is crucial for developing more effective, personalized interventions that not only promote physical health but also enhance the well-being and overall life satisfaction of this population. By highlighting the potential link between muscle strength and quality of life, this study aims to underscore the importance of incorporating physical activity and muscle strengthening into health promotion strategies for individuals with IDD. Furthermore, the findings of this research could inform the creation of targeted public policies and social inclusion programs, advocating for the integration of physical fitness initiatives as fundamental components of strategies designed to improve the quality of life for individuals with Intellectual and Developmental Disabilities.

2. Materials and Methods

This study follows a cross-sectional design, in which participants were assessed at a single moment. Prior to the implementation of the study, the project was submitted to and approved by an Ethics Committee (CE/FCDEF-UC/00872021), ensuring that all procedures complied with established ethical principles. The research was carried out in accordance

with the principles of the Helsinki declaration for studies involving human beings [15], ensuring respect for the dignity, rights and well-being of the participants. Participants, family members or guardians were given clear information about the objectives, procedures and possible risks and benefits of the study. Participation was voluntary and took place only after signing the Informed Consent Form. The data were collected guaranteeing confidentiality and anonymity, respecting the privacy rights of the participants.

2.1. Participants

The participants in this study were 37 IDD individuals, whose ages ranged from 20 to 58 years (mean 38.46 ± 11.45 years). The sample was equally balanced in terms of sex, composed of 18 men and 19 women. All the participants received daily support from a specialized institution located in the city of Leiria, Portugal, which offers support and rehabilitation services for individuals with IDD. The diagnoses ranged from mild, moderate and severe IDD, classified according to international diagnostic criteria such as the DSM-5 or ICD-11. To ensure their suitability for the methodology and objectives of the study, specific inclusion criteria were established, which included the following: (i) an age over 18, ensuring that the participants were adults; (ii) a formal diagnosis of mild, moderate or severe IDD, according to reports provided by the institution; and (iii) an ability to understand and participate in the pre-defined assessments, such as anthropometric measurements, questionnaires and physical tests. Similarly, exclusion criteria were applied to avoid potential bias in the results and guarantee the safety of the participants as follows: (i) the presence of other pathologies or associated disabilities, such as cerebral palsy or neurodegenerative diseases; (ii) an inability to walk independently, as many of the assessments required basic movement; (iii) a diagnosis of profound IDD, due to significant difficulties in communication and participation in the protocol activities; (iv) an inability to communicate or respond adequately to the questionnaires; and (v) failure to provide informed consent, either from the participant or their legal guardian for participation in this study.

2.2. Procedure

All the assessments were carried out in the morning to ensure uniform measurement conditions and minimize possible interference and variations in the participants. The morning period was also chosen to facilitate the availability of the participants and various logistical issues, promoting greater adherence to the study.

The researchers responsible for carrying out the assessments had specialized training in the field of sports sciences and had previous knowledge of applying the instruments and associated procedures. Before the study started, all the researchers participated in a meeting to ensure standardization in the data collection procedures, avoiding variations between researchers and reducing potential measurement errors.

The data obtained in each assessment and for each individual were carefully transcribed into a specific record sheet, previously prepared for this study, without collecting any data that could identify the participant. This procedure followed rigorous quality control protocols, ensuring the accuracy of the information and compliance with all ethical principles. In addition, the data were subsequently saved securely in a folder on the principal investigator's computer, respecting confidentiality and personal data protection guidelines.

To ensure the safety and comfort of the participants, clear and detailed instructions were provided before the tests were carried out. The explanations were adapted to the profile of the participants, using accessible and simple language. In addition, all the procedures were demonstrated in a practical way. The researchers also ensured that

the participants fully understood the guidelines and felt comfortable carrying out the assessments.

Throughout the process, the team ensured that the environment was suitable for the assessments, with controlled lighting, temperature and privacy conditions, to provide a favorable environment for the participants' performance and well-being. If any participant showed any doubt or discomfort, the procedure was immediately interrupted to offer support or clarification.

The scale will be applied in a room isolated from noise and possible distractions in a 1:1 ratio (one trained specialist to one participant) for individuals with IDD. The entire protocol for applying the scale was followed.

2.3. Anthropometric and Body Composition Assessment

The participants' body mass and height were measured using a digital scale and a SECA 870 stadiometer (SECA, Hamburg, Germany), devices recognized for their accuracy in anthropometric assessments. During the procedure, the participants were instructed to wear light, comfortable clothing, to avoid metal accessories and to perform the test completely barefoot. In addition, they were instructed to adopt an aligned and upright body posture, with their ankles against the base of the stadiometer and their eyes directed horizontally, guaranteeing the accuracy of the measurement. After collecting anthropometric data, body composition was assessed using an InBody 770 (InBody Co., Ltd., Seoul, Republic of Korea) multifrequency tetrapolar instrument. This instrument performs detailed analyses of various body compartments, including skeletal muscle mass, using multifrequency electrical bioimpedance technology. The evaluation protocol followed the manufacturer's guidelines and the best practices described in the literature [16]. To ensure the validity and reproducibility of the assessments, the participants were instructed to comply with the following pre-assessment recommendations: avoid caffeine and alcohol for at least 12 h before the measurements; refrain from intense physical exercise during the same period; and empty their bladders before the measurements began. These precautions were taken to minimize possible interferences in the readings and ensure that reliable and representative data were obtained.

2.4. Neuromuscular Capacity Assessment

An isokinetic dynamometer (BIODEX Multijoint System 3 Pro, Shirley, NY, USA), suitable for the target population [17], was used to measure lower limb strength through knee flexion and extension, using maximum concentric contractions. Three repetitions of movement at 60°/s were used to test concentric action. An interval of 60 s was established between the familiarization of the 3 repetitions and the test. The dynamometer was properly adjusted both vertically and horizontally according to the participant's specifications, ensuring the following: (a) the participant was seated in a chair with solid back support (85° hip flexion); (b) stabilization straps (Velcro straps) were applied to the trunk, thighs, pelvis, and tibia to prevent unwanted joint movements; (c) the tested knee was positioned at 90° flexion (with 0° representing full knee extension); (d) the limb being assessed was aligned parallel to the dynamometer's lever arm; (e) the anatomical axis of the joint's rotation was aligned with the axis of rotation of the dynamometer, with the distal point of the lateral femoral condyle being considered (the fixing strap of the cushion was adjusted 2 cm above the upper edge of the fibular malleolus); (f) the lever cushion was placed on the distal anterior tibia, 3 to 5 cm above the lateral malleolus; and (g) the participant's arms were comfortably crossed over the chest. The evaluation procedures for these variables were established prior to this study [18]. The researchers ensured that the participants were constantly encouraged to perform the test at their maximum capacity.

The '3 kg medicine ball throw test' [19], a valid and reliable protocol for people with IDD [20], was also used to assess upper limb muscle strength. In the protocol, the participant throws the 3 kg medicine ball horizontally with both hands in an aim to throw the ball as far as possible. The distance reached by the ball is recorded, providing an indicator of the strength produced by the muscles of the upper limbs. This assessment is simple, easy and direct to carry out and can be adapted to different levels of motor skill, making it particularly suitable for the population of individuals with IDD.

The 30 s chair test, a component of the Fullerton Functional Fitness Test battery [21], was used to assess the strength and muscular resistance of the participants' lower limbs. The test consists of assessing the number of repetitions the participant can stand up and sit down from a chair without using their upper limbs for 30 s. The total number of repetitions performed correctly in 30 s is used as an indicator of the strength and muscular resistance of the lower limbs. The higher the number of repetitions, the greater the strength and resistance of the participants' lower limbs [20,22]. The chair used in the test was specifically selected to have no armrests or any other structures that could provide support to the upper limbs, ensuring that the movement relied solely on the strength and endurance of the lower body muscles.

2.5. Quality of Life Assessment

The Portuguese version of the Personal Outcomes Scale [23–25], in self-report form, was analyzed as the main assessment tool in this study. The application was carried out by previously trained and qualified technicians, ensuring the standardization of the process and consistency in the administration of the instrument. The scale assesses the participants 'quality of life and is composed of eight specific domains, encompassing crucial areas of the individuals' daily lives. Each domain is represented by 5 questions, making a total of 40 questions on the full scale. The questions explore various subjective aspects of individuals' lives, including emotional well-being, interpersonal relationships, self-determination, social inclusion, rights, personal development, physical well-being and material well-being. Responses are recorded using a three-point Likert scale, allowing participants to express their perceptions clearly and concisely. For the purposes of analysis, the overall quality of life score was adopted as the main variable. This score was calculated by adding up the values assigned to each question answered, reflecting a comprehensive measure of the participants' perception of their quality of life.

2.6. Statistical Analysis

To characterize the sample, descriptive statistics were presented, namely the mean, standard deviation and minimum and maximum values. The normality of the data was verified using the Shapiro–Wilk test. The relationship between variables was verified using the Pearson correlation test, allowing the magnitudes of the associations to be determined (r = 0.10 to 0.29-small; r = 0.30 to 0.49-moderate; r = 0.50 for 1-strong) [26]. The data were analyzed using IBM SPSS Statistics software (version 29, IBM Corporation, SPSS Inc., Chicago, IL, USA), with the significance level set as $p < 0.05$.

3. Results

The demographic data and characteristics of the participants are shown in Table 1. Table 1 presents detailed information on the main variables related to the sample, which are relevant to interpreting the results of the study.

Table 1. Demographics and participant characteristics.

Variables	Mean ± SD	Min–Max
Age (years)	38.46 ± 11.45	20.00–58.00
Height (cm)	159.77 ± 8.51	138.00–177.70
Weight (kg)	73.38 ± 17.11	48.60–127.40

The following table (Table 2) presents the results of the evaluation of the neuromuscular capacity. The data are presented with the mean, standard deviation, minimum and maximum values for each variable.

Table 2. Neuromuscular results.

Variables	Mean ± SD	Min–Max
Muscle Mass (kg)	26.22 ± 5.30	14.50–42.40
30 s Chair Test (s)	13.08 ± 3.35	4.00–20.00
3 kg Medicine Ball Throw (m)	2.36 ± 0.67	1.19–4.33
Peak Torque Right (Extension 60°/s)	71.05 ± 38.44	6.90–182.70
Peak Torque Left (Extension 60°/s)	72.02 ± 37.59	5.10–211.10
Peak Torque Right (Flexion 60°/s)	40.70 ± 27.03	0.40–103.00
Peak Torque Left (Flexion 60°/s)	38.83 ± 22.80	0.50–90.20

Finally, the results of the quality of life are presented in Table 3.

Table 3. Quality of life results.

	Mean ± SD	Min–Max
Quality of life (score)—37 participants	91.21 ± 10.44	71–108

Table 4 shows the correlation matrix between anthropometric variables, body composition, strength and quality of life.

Table 4. Correlation matrix.

Variables	Correlation Matrix								
	1	2	3	4	5	6	7	8	9
1. Weight (kg)	1								
2. Muscle Mass (kg)	0.485 **	1							
3. 30 s Chair Test (s)	−0.078	−0.001	1						
4. 3 kg Medicine Ball Throw (m)	0.157	0.449 **	0.492 **	1					
5. Peak Torque Right—Extension (°/s)	0.206	0.550 **	0.366 *	0.681 **	1				
6. Peak Torque Left—Extension (°/s)	0.154	0.388 *	0.487 **	0.756 **	0.806 **	1			
7. Peak Torque Right—Flexion (°/s)	0.123	0.524	0.203	0.528 **	0.865 **	0.618 **	1		
8. Peak Torque Left—Flexion (°/s)	0.018	0.334 *	0.463 **	0.625 **	0.748 **	0.793 **	0.805 **	1	
9. Quality of Life (Score)	0.003	0.366 *	0.161	0.187	0.328 *	0.168	0.504 **	0.450 **	1

Notes: * $p < 0.05$; ** $p < 0.01$.

The relationship between weight and quality of life was not significant, suggesting that one variable does not significantly influence the other. The correlation between muscle mass and quality of life is moderate (r = 0.366; $p = 0.05$), indicating that more muscle mass may be associated with a better perception of quality of life. The correlation with quality of life is weak and non-significant (r = 0.161), indicating that performance in the chair test does not have a significant impact on participants' quality of life. The 3 kg medicine ball throw test did not correlate significantly with quality of life (r = 0.187), indicating that upper limb strength is not significantly associated with perceived quality of life. Quality of life was moderately associated with the Peak Torque Right test (Extension) (r = 0.328;

$p = 0.05$) and Peak Torque Left (Flexion) (r = 0.450; $p \leq 0.001$) and strongly associated with the Peak Torque Right test (Flexion) (r = 0.504; $p \leq 0.001$).

4. Discussion

The results of this study showed significant correlations between quality of life and the variables of muscle mass and peak torque in different movement conditions in individuals with IDD.

A moderate association was observed between quality of life and muscle mass, suggesting that an increase in the amount of muscle mass can contribute positively to the perception of quality of life in our study sample. This association corroborates previous studies in the population without disabilities that show the importance of muscle mass for functionality and independence and, consequently, for quality of life. Muscle mass plays a fundamental role in mobility, autonomy and the successful execution of activities of daily living, which may justify the observed association with quality of life [27,28].

Quality of life also showed a moderate correlation with Peak Torque Right in the extension and flexion movements and a strong correlation with Peak Torque Right in the flexion movement. These correlations indicate that the ability to produce strength in the lower limbs during extension and flexion may be directly related to the perception of quality of life. Peak torque in these movements is essential for functional activities such as walking, stability and postural control, as well as daily actions such as going up and down stairs and getting up/sitting down from a chair. Reduced lower limb strength has been consistently associated with mobility limitations, increased fall risk, and the loss of independence [29]. Therefore, lower limb muscle strength can positively influence autonomy and success in activities of daily living, positively impacting quality of life [30]. Lower limb muscle strength is not merely a measure of physical capability but a key modulator of independence, psychological well-being, and overall quality of life.

The lack of a significant association between upper limb strength (measured by throwing the 3 kg medicine ball test) and quality of life can be explained by the fact that the most critical daily activities for the perceived quality of life of participants with IDD depend mostly on lower limb functionality [31,32].

Neuromuscular capacity seems to be a determining factor in the perceived quality of life of the participants in our study. Knowing that lower levels of muscle strength are often observed in individuals with IDD [33], interventions aimed at increasing or maintaining them can be effective strategies for optimizing functionality and promoting a better quality of life. The literature suggests that intervention programs, namely with a prescription based on strength training and muscular resistance, can provide a number of benefits for individuals with IDD, including increased muscle mass and improvements in mobility and functional capacity, factors directly related to quality of life [5,6].

These strategies are particularly relevant when physical activity levels are the greatest predictor of quality of life in this population [9]. In fact, the practice of physical activity, physical exercise and/or sport seems to contribute to a higher quality of life in this population compared to control groups or non-exercisers [34–36]. In the study by Pérez-Cruzado and Cuesta-Vargas [9], an 8-week physical activity intervention program increased the physical fitness and quality of life of 40 individuals with IDD. The presence of qualified professionals who can assess, prescribe, adapt exercises and provide continued support is essential to ensure long-term adherence and motivation [37].

Limitations and Future Recommendations

Although our study provides valuable insights, it is not without its limitations, which must be considered when interpreting the results. Firstly, the cross-sectional design adopted

does not allow causal relationships to be established between the variables analyzed. This type of design limits the ability to determine whether the associations observed are a direct result of the variables studied or whether they are influenced by other uncontrolled factors. For example, although we have identified correlations between muscle mass, peak torque and quality of life, it is not possible to say with certainty whether the increase in muscle mass is the direct cause of improvements in quality of life or whether other intervening factors are masking the results. Furthermore, the size of the sample used in the study may limit the generalizability of the results. A larger and more diverse sample, including individuals from different geographical, socio-economic and clinical backgrounds, would be necessary to ensure that the results can be extrapolated to other populations or to individuals with different degrees of IDD if there is a possibility of examining in detail the relationship between physical fitness and the subdomains of quality of life. Our results only characterize the IDD population of the institution recruited. Another relevant limitation is the possible influence of external variables that were not controlled in the study, such as environmental, social and family factors and physical activity, which can impact on the participants' quality of life. Similarly, social and family factors, such as the support received, the presence of support networks and the quality of social interactions, can play a crucial role in the perceived quality of life of individuals with IDD. Finally, it is important to emphasize that the results of our study suggest promising associations between increased muscle mass, peak torque and quality of life, but future longitudinal studies are needed to confirm these relationships over time. Longitudinal studies would make it possible to assess whether the improvements observed are sustainable and translate into lasting benefits for the participants' quality of life. In addition, it would be interesting to explore the impact of specific interventions, such as personalized strength training programs, on maintaining these gains and promoting healthy aging in individuals with IDD. The inclusion of subjective and objective measures of quality of life, as well as the assessment of biological and psychosocial markers, could enrich future research and provide a more comprehensive understanding of the factors that contribute to well-being in this population.

5. Conclusions

Muscle mass and peak torque show significant correlations with quality of life, suggesting that muscle strength (especially in the lower limbs) can influence the perceived quality of life of this group of individuals with IDD. Interventions focused on increasing muscle mass and strength can be effective in promoting functionality and autonomy and, consequently, improving perceived quality of life. Such interventions can contribute to greater independence in everyday activities, favoring general well-being. However, it is essential that future studies investigate the causality of these relationships and deepen the understanding of the mechanisms that connect neuromuscular capacity to quality of life in individuals with IDD so that more effective and evidence-based strategies can be developed.

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Abbreviations

The following abbreviations are used in this manuscript:

IDD Intellectual and Developmental Disability

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