

INTRODUCTION

The increased life expectancy of individuals with intellectual disability (ID), combined with greater availability and access to care services, has led to an increase in the longevity of this population and, consequently, the number of individuals with ID in developed countries (Carmeli, Zinger-Vaknin, Morad, & Merrick, 2005; Márquez-Caraveo et al., 2011). This, in turn, has resulted in a rise in the incidence of aging-related diseases and functional weakness, with this population exhibiting characteristics of premature aging and a greater tendency toward deconditioning and morbidity (Carmeli, Imam, & Merrick, 2012; Márquez-Caraveo et al., 2011).

These factors often result in individuals with ID experiencing a decline in motor skills, which can also be influenced and worsened by behavioral factors such as sedentary lifestyles and reduced participation in physical or sports activities (Kachouri et al., 2016). This change in lifestyle has severe health consequences for individuals with ID, such as reduced muscle mass and strength (A. I. Cuesta-Vargas, Paz-Lourido, & Rodriguez, 2011; Hilgenkamp, Reis, van Wijck, & Evenhuis, 2012). This, in turn, can lead to balance limitations, an increased risk of falls, and reduced independence in activities of daily living (Oppewal, Hilgenkamp, van Wijck, Schoufour, & Evenhuis, 2014a, 2014b).

Given the increasing prevalence of muscular strength issues among individuals with ID and their serious consequences, comprehensive evaluations are essential. Currently, various tests are available to measure muscle strength, though many have significant limitations and low reliability for use with individuals with ID due to their complexity and/or limited sensitivity to change (Guerra-Balic et al., 2015; Wuang, Su, & Huang, 2012). Additionally, sophisticated technological devices for muscle strength assessment have been developed, but their high cost makes them inaccessible to many professionals working with individuals with ID (Borji, Zghal, Zarrouk, Sahli, & Rebai, 2014; A. Cuesta-Vargas & Hilgenkamp, 2015; Oppewal, Hilgenkamp, van Wijck, Schoufour, & Evenhuis, 2015).

Therefore, the main objective of this study is to design a new model representing the muscular strength of adults with ID using Principal Components Analysis (PCA). A secondary objective is to process the data recorded in the PCA using a regression method to construct and validate summative scales of standardized index values, which could be useful for assessing muscle strength in individuals with ID.

METHOD

Design and Participants

The sample consisted of 978 individuals with ID (637 men and 341 women) with a mean age of 34.8 years (± 11.2), recruited from the European Special Olympics Games in 2009 and the Spanish Special Olympics Games from 2011 to 2016 ("Special Olympics", n.d.). After selecting the sample, all study participants received specific information about their physical profile and musculoskeletal health education, using adapted educational materials when necessary. All participants were healthy and had been diagnosed with mild ID by a specialist physician. Their parents and/or legal guardians confirmed the diagnosis and health status through medical history. Weekly hours of physical or sports activity were recorded to classify participants according to their activity level (Garber et al., 2011). Participants were categorized as highly physically active (PA) if they engaged in physical activities for three or more hours per week and as low PA if they engaged in fewer than three hours per week.

Exclusion criteria included contraindications for exercise identified during clinical history evaluation through a questionnaire, documented atherosclerotic heart disease, documented atlantoaxial instability, uncorrected congenital heart disease, and having an implanted pacemaker. The institutional review board of the University of Malaga approved the procedures used in this study. Written informed consent was obtained from all participants and their parents or guardians before participation. Additionally, all participants were examined beforehand by a physiotherapist trained in a four-hour session on how to interact with this specific population. Participants could choose between problem-focused or more general examinations.

The study adhered to the principles of the Declaration of Helsinki and Good Clinical Practice (GCP) standards to ensure the protection of the rights, safety, and well-being of the volunteers. Ethical approval for the study was granted by the ethics committee of the Faculty of Health Sciences at the University of Malaga. Participants and their parents or guardians were provided with an information sheet detailing the study's procedures and informed consent, emphasizing that participation was entirely voluntary, they could withdraw at any time, and their personal data would be protected according to the Organic Law on Personal Data Protection 19/55.

Procedure

Participants completed various functional tests in this study:

Timed-Stand Test (TST): This functional test quantifies the muscle strength of the lower limbs (hip and knee extension). In this test, the participant sits on a straight-backed chair without armrests, with feet flat on the floor. From this position, they must rise and sit down as quickly as possible, without using their arms to push off the chair or their legs, for 10 repetitions. The execution time of these repetitions is recorded using a stopwatch. If the participant cannot complete 10 repetitions, the number of repetitions

and execution time are recorded. The reliability of this test can be found in Newcomer et al. (1993).

Partial Sit-Up Test (PSUT): This functional test evaluates abdominal muscle strength and endurance by quantifying the number of sit-ups performed in one minute. The participant lies supine on a mat with heels resting on a chair to maintain hips and knees at a 90° angle, and arms extended. This test has demonstrated test-retest reliability above 0.80 (Jackson et al., 1998).

Seated Push-Up (SPU): This test evaluates the strength of the triceps, shoulders, and scapular muscles. The participant pushes their body upward from a seated position, then slowly lowers back to the seat. They begin with the lower limbs at a right angle, feet fully on the floor, and hands on the armrests. The participant pushes their body up using their upper limbs until the elbows are flexed, maintaining posture for 20 seconds before slowly returning to the seat. Reliability for the revised push-up test protocol in individuals without disabilities ranged from 0.80 to 0.96 (Hong et al., 2011).

Handgrip Test (HGT): This test evaluates the strength of hand and forearm muscles, as it correlates with upper limb function. The participant completes three grips with each hand using an adjustable-handle dynamometer, recording the best of the three. The grip is performed with the upper limb flexed at 90° (elbow flexion) against the torso. The Jamar dynamometer has shown excellent reliability (ICC = 0.98) and validity (ICC = 0.99) for measuring manual grip strength in previous studies (Bellace, Healy, Besser, Byron, & Hohman, 2000; Savva, Giakas, Efstathiou, & Karagiannis, 2014).

Data Analysis

All variables were log-transformed to approximate a normal distribution. Data were analyzed using principal components analysis (PCA) with Oblimin rotation and Kaiser normalization. The Kaiser-Meyer-Olkin (KMO) measure of sampling adequacy was computed to assess the suitability of the data for factor analysis. KMO values greater than 0.5 and significant results from the Bartlett test of sphericity were considered acceptable. PCA scores were recorded using the regression method, and data were standardized to a mean of 0 and a standard deviation of 1.

RESULTS

Descriptive Statistics

The study included 978 participants with intellectual disabilities. The mean BMI was 27.49, with an average weight of 72.99 kg and an average height of 163.19 cm. The mean and standard deviation for each item are shown in Table 1.

(Table 1 omitted for brevity)

The correlation matrix, preliminarily evaluated by the Bartlett test of sphericity, rejected the null hypothesis of an identity matrix (df: 6; Sig < 0.001), with a KMO sampling adequacy measure of 0.71, indicating the sample was suitable. Eigenvalues >1, a value greater than 10% of variance, and the scree test were used as criteria for factor extraction (Cattell, 1966; Kaiser, 1960); one factor was extracted under these conditions, meeting all three criteria. The total variance explained by the four factors was 100.00%.

DISCUSSION

This study identified underlying components of muscle strength in individuals with ID using the multivariate statistical technique of factor analysis, enabling the development of a new index to evaluate muscle strength in individuals with ID using a single value. The one-factor model generated by PCA provided preliminary evidence of construct validity and explained a significant proportion of the variance.

The new strength index offers a comprehensive and efficient method for assessing muscle strength in adults with ID. Its simplicity and cost-effectiveness make it suitable for both clinical and research settings, facilitating better evaluation and monitoring of muscular health in this population.

This study highlights the importance of regular strength assessment in individuals with ID, as their reduced muscle mass and strength significantly impact their physical capabilities and daily life activities. Future studies should consider incorporating cognitive, community, and social factors to further refine the model and ensure broader applicability across diverse populations.