Adapted Physical Activity Quarterly, (Ahead of Print)
https://doi.org/10.1123/apaq.2024-0085

First Published Online: Sept. 14, 2024

Human Kinetics
ORIGINAL RESEARCH

Examining the Effects of a 24-Week Exercise Program on Functional Capacity, Cognitive Capacity, and Quality of Life in Individuals With Intellectual and Developmental Disabilities

Miguel Jacinto,[1,2,3] Raul Antunes,[1,2] Diogo Monteiro,[1,2] Filipe Rodrigues,[1,2] Nuno Amaro,[1,2] Maria João Campos,[3,4] José Pedro Ferreira,[3,4] and Rui Matos[1,2]

[1]ESECS—Polytechnic of Leiria, Leiria, Portugal; [2]Research Center in Sport Sciences, Health Sciences and Human Development (CIDESD), Vila Real, Portugal; [3]Faculty of Sport Sciences and Physical Education—University of Coimbra, Coimbra, Portugal; [4]Research Center for Sport and Physical Activity (CIDAF), Coimbra, Portugal

This study investigated the effects of two physical exercise programs for adults with intellectual and developmental disabilities. Twenty-one participants were assigned to an indoor group (IG, $n = 7$; 24-week gym intervention with machine), an outdoor group (OG, $n = 7$; 24-week outdoor intervention with low-cost materials) or a control group. The outcomes assessed included quality of life, dementia, and functional capacity. The IG significantly improved physical well-being compared with the control group ($p = .017$). There were no significant differences in dementia score between groups and moments. Postintervention, the IG showed improvements compared with the control group for the 30-s sit-to-stand test ($p = .03$), timed up-and-go ($p = .00$), and 6-min-walk test ($p = .033$) and between moments in the IG for 30-s sit-to-stand test (pre ≠ post; $p = .007$) and 6-min-walk test (pre ≠ post; $p = .007$). Outdoor interventions appeared effective for physical well-being, while indoor interventions using weight-training machines benefited functional capacity. No significant effects were observed for dementia/cognitive decline.

Keywords: cardiorespiratory training, indoor training, outdoor training, physical fitness, resistance training

Antunes https://orcid.org/0000-0002-5485-9430
Monteiro https://orcid.org/0000-0002-7179-6814
Rodrigues https://orcid.org/0000-0003-1327-8872
Amaro https://orcid.org/0000-0001-8160-8007
Campos https://orcid.org/0000-0003-2148-3534
Ferreira https://orcid.org/0000-0002-4427-3276
Matos https://orcid.org/0000-0002-2034-0585
Jacinto (miguel.s.jacinto@ipleiria.pt) is corresponding author, https://orcid.org/0000-0002-1727-3537

For the World Health Organization, quality of life (QoL) concerns the individual's perceptions of their position in life, in the context, culture, and value system to which they are inserted, considering the relationship with their goals, expectations, standards, and concerns. The multidimensional construct was validated assuming seven domains: (a) physical health, (b) psychological domain, (c) level of independence, (d) social relationships, (e) environment, (f) spirituality, and (h) personal domain (World Health Organization, 1998). On the other hand, for Schalock and Verdugo (2002), QoL refers to a set of factors that address the individual's well-being, or the perception of their social position, in the context and culture to which they are inserted, assuming sociocultural values, needs, expectations, and individual preferences. It is a multidimensional phenomenon composed of factors: (a) Independence, (b) Social anticipation, and (c) Well-Being and Domains: (a) Personal Development, (b) Self-Determination, (c) Interpersonal Relations, (d) Social Inclusion, (e) Rights, (f) Emotional, (g) Physical, and (h) Material, influenced by personal characteristics and environmental contexts (Schalock et al., 2010).

The concept and study of QoL in individuals with intellectual and developmental disabilities (IDD) have been the topic of interest of various stakeholders with practical implications for interventions conducted with this population (Schalock & Verdugo, 2002). In individuals with IDD, characterized by a deficit of intellectual and adaptive functioning in the conceptual, social and practical domains, identified with mild, moderate, severe, and profound degrees and developed before 18 or 22 years old (Schalock et al., 2021), measuring QoL allows: (a) to understand their degree of satisfaction, (b) understand personal perceptions, (c) support decision making, (d) evaluate the intervention, and (e) evaluate theoretical models. This measurement allows us to direct the individual to the life he likes and values.

In this population early aging process starting at age 40 (Tse et al., 2018), leading to early onset of physical health problems, functional disability, visual and hearing problems, dementia, chronic diseases. In addition, this early aging affects the successful performance of their activities of daily living and consequently their perceived QoL (Lifshitz et al., 2008). Improved medical care, health care, and more targeted interventions for the individual have gradually increased the life expectancy of people with IDD. On the other hand, this increase in life expectancy has also increased the rate of individuals with IDD and dementia. The incidence of dementia in this group was found to be up to five times higher than in the general population, being the most important cause of morbidity, QoL, and mortality in this population (Janicki, 2011). People with preexisting cognitive compromise seem to be less resilient to developing symptoms when age-related neuropathological damage occurs.

At the same time, in this population, physical inactivity and sedentary lifestyles prevail (Dairo et al., 2016), not meeting the World Health Organization PA guidelines (WHO, 2020). Due to their physical inactivity and sedentary lifestyles, individuals with IDD have low levels of physical fitness (decreasing their functional capacity and success in performing activities of daily living), with increased risk of acquiring other comorbidities such as Type II diabetes, hypertension, cholesterol, and metabolic syndrome (de Winter et al., 2012), affecting their QoL.

One of the reasons found in the literature for physical inactivity and sedentary lifestyles in individuals with IDD is the existence of barriers that prevent/hinder

their practice namely lack of adapted physical exercise (PE) programs, limited financial resources, and lack of places to practice (Jacinto, Vitorino, et al., 2021). Therefore, there is a scarcity of research, including little clarity in intervention protocols used and a variety of methodologies addressing the applicability of nonpharmacological, psychological, and psychosocial interventions, as is the case of PE programs, for the promotion of the several variables.

One of the most studied relationships is between exercise and the promotion of physical fitness, confirming its direct impact on functional capacity. Taking into account, studies about dementia and cognitive decline only assess a few number of variables that may be associated but that alone do not represent it, such as attention (Ptomey et al., 2018), memory (Ptomey et al., 2018), and language fluency (Ringenbach et al., 2016). Regarding QoL, an 8-week multidisciplinary exercise intervention program aiming to improve muscle strength, flexibility, balance, aerobic fitness, and educational advice to increase physical activity found significant differences, $F = 4.18$, $p = .04$; however, the PE program is not clarified (Pérez-Cruzado & Cuesta-Vargas, 2016). On the other hand, a previous systematic review associated the effects of PE on variables that are related to QoL, namely pain, general health, and anxiety (Bartlo & Klein, 2011). In studies that focus on physical activity, this variable has been found to be a predictor of QoL (Carbó-Carreté et al., 2016); however, studies with PE programs are still care or unclear. Therefore, alternative and innovative solutions to promote/maintain physical function, reduce the risk of onset of dementia/cognitive decline early in life, and promote/maintain QoL of individuals with IDD should include PE.

However, the situation of institutions providing support to individuals with IDD differs greatly, depending on the country or region (Hunt et al., 2022; Kroneman et al., 2012), and the possibilities of assessing and prescribing PE can be compromised. First, there are the financial difficulties, as these institutions depend largely on donations, government subsidies, or private funding (Beadle-Brown et al., 2021; Hunt et al., 2022; Mitra et al., 2017; Sim et al., 2017). In addition, the cost of maintaining functioning installations is high due to the need for specialized equipment, therapies, and qualified professionals (Beadle-Brown et al., 2021; Clemente et al., 2022; Hunt et al., 2022). Sometimes the availability and maintenance of this specialized equipment are inadequate, making it deteriorate more quickly, limiting accessibility and the effectiveness of the support provided (Clemente et al., 2022; Hunt et al., 2022; Mitra et al., 2017). We are also talking about places where the remuneration of professionals is low, as well as the working conditions, which can lead to high staff rotation, affecting the continuity of care for individuals with IDD (Bogenschutz et al., 2014; Lindsay et al., 2023). Although some institutions can offer a wide range of services, the quality can differ, with some institutions offering high-quality services and other basic services (Hunt et al., 2022).

Considering all the barriers to the practice of physical activity presented herein, and that not all institutions that support individuals with IDD have the same financial, space, and material conditions, we aimed to build these two proposals for differentiated intervention programs (indoor and outdoor) so that any institution, regardless of its conditions, can offer regular practice. In addition, apart from the impact that these two strategies/proposals could have on the variables that will be assessed, they could also attenuate/reduce the barriers to practice that have been highlighted.

Taking this introductory approach into consideration, the present nonrandomized experimental study aimed to assess the effects of two 24-week exercise program (indoor and outdoor) on functional capacity, dementia/cognitive decline, and QoL in institutionalized individuals with IDD.

Methods

This study followed a nonrandomized experimental methodology, following the assumptions of the Declaration of Helsinki (World Medical Association, 2013) and was approved by the Ethics Committee of the Faculty of Sport Sciences and Physical Education—University of Coimbra. All participants and family members were informed about the purpose of the study, potential implications and methodological procedures, and signed an informed consent form before participating in the study. This study followed a predetermined published protocol (Ferreira et al., 2022), carried out following several previously guidelines (American College of Sports Medicine & Medicine, 2021; Jacinto, Oliveira, et al., 2021; Jacinto, Matos, et al., 2023; Jacinto, Oliveira, et al., 2023), using exercise as a major intervention tool to improve functionality, cognitive function, and QoL in individuals with IDD.

Participants

Adult institutionalized volunteers from Leiria region (Center Portugal) participated in the exercise intervention program. Participants were selected using the following inclusion criteria: (a) adults with IDD; (b) without medical contraindications; (c) age over 18 years; (d) with mild, moderate, or severe IDD diagnosis (Down syndrome inclusive); (e) success in performing movements such as pulling/pushing; (f) ability to carry out the intended assessments; and (g) no participation in PE in the previous 6 months. Additionally, we also used the following exclusion criteria: (a) individuals who cannot commit for 6 months, (b) individuals with other associated pathologies, (c) contraindications to PE, (d) inability to walk unassisted, (e) profound IDD, (f) inability to communicate, and (g) nondelivery of the duly signed informed consent.

Due to the special characteristics of IDD population and to the logistic intrinsic constraints related with the development of intervention studies, the sample size included 21 participants aged between 18 and 65 years (10 women, 11 men, $M_{age} = 43.04 \pm 11.18$ years) who agreed to participate in the intervention program. A power analysis (calculated using G*Power, version 3.1.9.7) showed that a sample of at least 15 was required to detect a medium effect size of 0.5 ($\alpha = .05$, $1 - \beta = 0.95$) using a repeated-measures analysis of variance, in agreement with some previous studies (Cicone et al., 2018; Fujita et al., 2021). Effect size of 0.5 was chosen given that this value was verified from studies investigating the effects of exercise on the variables of interest in our study (Bartlo & Klein, 2011; St. John et al., 2020).

Instruments

Quality of Life

The Portuguese version of the Personal Outcomes Scale (Simões et al., 2016) was used. The instrument was applied by technicians with specific training aiming to

evaluate QoL in people with IDD. The Personal Outcomes Scale includes eight domains (Personal Development, Self-Determination, Interpersonal Relations, Rights, Emotional, Physical, and Material) grouped into three dimensions (Independence, Social Participation, and Well-Being), each containing five questions, making a total of 40 questions, presented with three response options, using the Likert format.

Cognitive Function/Dementia

The Mini-Mental State Examination (MMSE) is a simple paper and pencil test with an easy and quick application (about 5–10 min) aiming to screen cognitive deficit or dementia. MMSE test was adapted to the Portuguese population by Guerreiro et al. (1994) and used with IDD population (Paiva et al., 2020). The thirty items questionnaire (scored 0 value—when the person gives an incorrect answer, or simply does not answer, or scored 1value—when the person answers correctly), is organized in six domains: *Orientation* (which assesses recent memory, attention and the temporal-spatial orientation), *Retention* (assesses attention and short-term or primary memory), *Attention and Calculation* (assesses calculation ability, attention and immediate and working memory), *Evocation* (assesses recent or secondary memory), and *Language* (assesses spontaneous speech, listening, repetition, naming, reading, and writing). The maximum test score is 30 points, with higher scores indicating better results. Its score ranges from 0 to 30 points, and the cut-off values that classify individuals into cognitive profiles are: (a) severe cognitive impairment (1–9 pts), (b) moderate cognitive impairment (10–18 pts) mild cognitive impairment (19–24 pts), and (c) normal cognitive status (25 pts and above).

Functional Capacity

The Fullerton battery of functional tests (Rikli & Jones, 1999) was used to assess physical fitness, namely:

a. The "sit-to-stand" 30-s test, validated for the IDD population (Cabeza-Ruiz et al., 2019) evaluated the strength and resistance of the lower limbs. The purpose of the test is to assess the strength and the resistance of the lower limbs (number of executions in 30 s without using the upper limbs). The test begins with the participant sitting in the middle of the chair, with the back straight and feet shoulder-width apart and fully supported on the floor;
b. The "timed up-and-go" test, validated for the IDD population (Cabeza-Ruiz et al., 2019), aimed to assess physical mobility, namely speed, agility, and dynamic balance;
c. The "6-min-walk" test validated for IDD population (Cabeza-Ruiz et al., 2019) aimed to assess aerobic resistance by covering the greatest distance in 6 min.

Procedures

Participants were taken to a laboratory environment (Faculty of Sport Sciences and Physical Education, University of Coimbra) where the evaluations were carried out. The space was large and isolated, the temperature was controlled (with

exception the 6-min walk test which was performed abroad), and each step of the evaluation was organized to provide maximum comfort and privacy for the participants. The team of researchers provided all the information on the procedures and objectives and answered all the participant's questions.

Three moments of evaluations were carried out during the PE program (initial, Week –1; intermediate, Week 12; final, Week 24.) To minimize differences in procedures, the same team carried out the assessments at different times. All assessments were carried out in a controlled environment, during the morning or with only breakfast, due to the characteristics of the participants themselves and the taking of medications. The researchers responsible for the evaluations did not have any knowledge of the group belonging to each participant, with the exception of the principal researcher.

Participants were allocated to one of the three groups: (a) indoor training group (IG) with sessions carried out in a gym, using weight machines and cardio fitness equipment, (b) outdoor training group (OG) with sessions using low-cost materials, and (c) control group (CG) with participants continuing to do their normal activities based on their interests and availability to get involved with PE programs. The training groups underwent a 24-week combined exercise intervention twice a week for approximately 45 min. Intervention programs of this duration were prescribed because one of the barriers to physical activity is that current programs are short term (Jacinto, Vitorino, et al., 2021). CG participants were encouraged to maintain their usual lifestyle. Throughout the 24 weeks, participant's attendance sessions were recorded with an IG attending average of 78% and an OG attending average of 76%.

Intervention

Indoor Training Program

The indoor PE program was carried out in a gym with weight machines and cardio fitness equipment. The PE program was divided into four parts. Part I: playful game or shuttle run (5–7 min). Part II: aerobic training (treadmill; 10 min; 40%–80% of heart-rate reserve; between 12 and 17 according to the Borg Rating of Perceived Exertion (RPE) Scale (Borg, 1982); between 5 and 8 according to the Borg CR-10 Scale (Borg, 1998). Part III: strength training (more or less 25 min; leg press + chest press + leg extension + lat pull down + leg curl + shoulder press; 40%–80% of 3-repetition maximum; 10–15 repetitions; two to three sets). Part IV: four static stretches (30–60 s each).

Outdoor Training Program

The outdoor PE program was carried out in a natural environment near the institution. Natural environments, which for the purpose of this experimental study, are defined as "any outdoor spaces with elements of nature, from pure or seminatural areas, to urban green or blue spaces, including green infrastructure" (Silva et al., 2018). The PE program was divided into four parts. Part I: playful or shuttle run (5–7 min). Part II: aerobic training (walking; 10 min; 40%–80% of heart-rate reserve; between 12 and 17 according to the Borg RPE Scale [Borg, 1982]; between 5 and 8 according to the Borg CR-10 Scale [Borg, 1998]). Part III:

strength training (more or less 25 min; Sit to stand from the chair + TheraBands; Low row + TheraBands; Low row + TheraBands; Sitting unilateral knee extension + shin guards; Chest press + TheraBands; Standing unilateral knee flexion + shin guards; High row or seated shoulder press + TheraBands; ≥15 reps depending on the OMNI resistance-exercise scale [Robertson et al., 2003]; three sets). Part IV: four static stretches (30–60 s each). Progression of exercises with changing the resistance of the TheraBands and shin guards.

Statistical Analysis

Descriptive statistics including mean and *SD* were calculated for studied variables. The Shapiro–Wilk ($n < 50$) and Levene's test were used to verify data normality and homoscedasticity, respectively. Thus, to understand whether there were differences between groups, a Kruskal–Wallis test was performed. For comparison and identification of possible differences in each group, the Wilcoxon signed-rank test and Friedman's test were used. Both of these tests are nonparametric analysis of variance's correspondence and adjusted for small samples testing. The multiple comparison test used the Bonferroni correction (i.e., alpha level/number of tests) to avoid error Type I (Ho, 2014). The effect size η^2 (appropriate for the Wilcoxon test, which allows two paired groups to be compared) was calculated and the assumed reference values were as follows: "small" effect ≥.01, "medium" effect ≥.3, and "large" effect ≥.5 (Cohen, 1988; Fritz et al., 2012). In turn, Kendall's *W* effect size (suitable for Friedman's test, which allows comparing two paired groups) was calculated and the assumed reference values were as follows: "small" effect ≥0.01, "medium" effect ≥0.3, and "large" effect ≥0.5 (Cohen, 1988; Fritz et al., 2012). The significance level to reject the null hypothesis was set at 5%, and analyses were performed in IBM SPSS.

Results

Table 1 presents descriptive statistics for the groups regarding QoL assessment. The results of the initial and final moment are presented for each domain of the questionnaire.

The descriptive statistics of the MMSE scale results are presented in Table 2 for all intervention and control groups.

Table 3 shows the results of the functional tests, namely: 30-s sit to stand, timed up and go, 6-min walk test, in the three moments, for the three groups.

At the initial moment, there were no differences between groups in the most diverse domains ($p \geq .05$). After 24 weeks of intervention, significant differences between groups were found only in the Physical Well-Being ($p = .021$). After Bonferroni correction, these differences were only observed between OG and CG ($t = 2.762$; $p = .017$; $\eta^2 = .545$). At the same time, there were no differences between moments taking into account the groups and the domains (Table 4).

The groups were not different at the initial assessment ($p \geq .05$). Nonsignificant differences were found in MMSE scores before and after the 24-week intervention in terms of group and moments (Table 5).

Table 1 Global Sample Descriptive of the Quality of Life Scale, *M* ± *SD*

	Indoor group		Outdoor group		Control group	
	Pre	Post	Pre	Post	Pre	Post
Personal Development (5–15)	9 ± 1.63	8.71 ± 2.13	10.42 ± 2.37	9.42 ± 2.14	9.28 ± 1.6	8.85 ± 1.34
Self-Determination (5–15)	10 ± 2	10.83 ± 1.83	12.57 ± 2.37	12.57 ± 1.9	10.85 ± 1.06	12 ± 2.16
Interpersonal Relations (5–15)	12 ± 1.82	12.5 ± 1.87	11.42 ± 1.71	13.14 ± 1.95	10.71 ± 2.98	11.28 ± 1.6
Social Inclusion (5–15)	12.57 ± 2.14	12 ± 2.09	9.42 ± 2.5	10.85 ± 2.85	10.14 ± 1.34	10.14 ± 1.34
Rights (5–15)	10.14 ± 1.67	10.66 ± 2.42	10 ± 1.15	9.71 ± 0.48	8.14 ± 1.86	8.71 ± 1.88
Emotional Well-Being (5–15)	14.28 ± 0.95	13 ± 2.28	13.57 ± 1.39	14.28 ± 1.11	13 ± 2.08	14.57 ± 0.78
Physical Well-Being (5–15)	13.14 ± 1.34	13.5 ± 0.95	13.42 ± 2.07	14.42 ± 0.78	12.57 ± 0.53	12.57 ± 1.27
Material Well-Being (5–15)	8.57 ± 2.93	7.16 ± 2.13	7 ± 0.81	6.71 ± 1.79	7.71 ± 1.79	6.85 ± 2.11

Table 2 Global Sample Descriptive of the Mini-Mental State Examination, *M* ± *SD*

Indoor group		Outdoor group		Control group	
Pre	Post	Pre	Post	Pre	Post
20.28 ± 4.82	20.83 ± 5.67	22.42 ± 7.61	22 ± 7.23	21.57 ± 4.61	21.14 ± 4.56

The groups showed no differences between each other at the initial moment, given the three functional tests ($p \geq .05$; Table 6).

There were differences between groups postintervention for 30-s sit to stand ($p = .037$). After Bonferroni correction, these differences were only observed between IG and CG ($t = 2.572$; $p = .03$; $\eta^2 = .47$). Similarly, there was a difference between moments in IG (pre ≠ post; Bonferroni corrected: $t = -3.031$; $p = .007$; $W = 0.65$).

Regarding timed up and go test, there were differences between groups at the intermediate moment ($p = .009$). After Bonferroni correction, these differences were only visible between IG and CG ($t = -2.973$; $p = .009$; $\eta^2 = .631$). Similarly, there were differences between group in postintervention moment ($p = .004$). After Bonferroni correction, these differences were only observed between IG and CG ($t = -3.253$; $p = .003$; $\eta^2 = .756$). There were also differences between moments in IG (pre ≠ post; Bonferroni corrected: $t = 3.031$; $p = .007$; $W = 0.656$).

Considering 6-min walk test, there were differences between groups at the intermediate moment ($p \leq .001$). After Bonferroni correction, these differences were only observed between IG and CG ($t = 3.747$; $p = .001$; $\eta^2 = 1.003$). Similarly, there were differences between groups at postintervention moment ($p = .037$). After Bonferroni correction, these differences were only detected between IG and CG ($t = 2.541$; $p = .033$; $\eta^2 = .461$).

Discussion

Taking this introductory approach into consideration, the present nonrandomized experimental study aimed to assess the effects of 24-week exercise program on functional capacity, dementia, and QoL in individuals with IDD. To our knowledge, this is the first study to evaluate the effects of a PE program on the evaluated variables, considering the two different contexts.

Quality of Life

After the intervention with the exercise program, we found significant differences in Physical Well-Being when comparing the OG with the CG. Our results indicate that an intervention with outdoor PE has a significant impact on Physical Well-Being, when compared with the CG. On the other hand, analyzing the dispersion measures of the IG at the postintervention moment, the values also seem to have increased, showing that any of the interventions seem to increase the perception of Physical Well-Being.

Table 3 Global Sample Descriptive of Functional Capacity, *M* ± *SD*

	Indoor group			Outdoor group			Control group		
	Pre	Intermediate	Post	Pre	Intermediate	Post	Pre	Intermediate	Post
30-s sit-to-stand	14.57 ± 3.77	17 ± 4.12	17.33 ± 2.94	14.14 ± 4.29	13.85 ± 4.67	14.85 ± 5.75	11.85 ± 3.62	11.71 ± 3.63	11.71 ± 3.72
Timed up-and-go	6.04 ± 0.77	6.02 ± 1.59	5.3 ± 0.63	8.7 ± 4.4	7.39 ± 3.07	8 ± 3.71	11.74 ± 4.01	11.9 ± 3.77	12.96 ± 4.51
6-min walk	530.14 ± 62.38	567 ± 44.97	509.33 ± 62.14	463.28 ± 51.78	485.14 ± 44.66	451.14 ± 117.1	429.14 ± 58.76	409.28 ± 58.39	394.85 ± 58.57

Table 4 Kruskal–Wallis and Wilcoxon Analysis of the Quality-of-Life Scores (5–15) for the Three Groups

	Indoor group		Outdoor group		Control group		Pre				Post				
	Median (interquartile range; min–max)														
	Pre	Post	Pre	Post	Pre	Post	t^a	df^a	p^a	PCG[a,c]	t^a	df^a	p^a	PCG[a,c]	PCM[b,c]
Personal development	9 (2; 7–12)	8 (3; 7–13)	11 (4; 7–14)	9 (4; 6–12)	9 (2; 7–12)	9 (1; 6–10)	1.772	2	$p > .05$	[d]	1.047	2	$p > .05$	[d]	[d]
Self-determination	10 (3; 7–13)	10 (2; 9–14)	13 (3; 8–15)	13 (2; 9–15)	11 (1; 10–13)	12 (4; 9–15)	5.617	2	$p > .05$	[d]	2.899	2	$p > .05$	[d]	[d]
Interpersonal relations	11 (3; 10–15)	12.5 (3; 10–15)	12 (4; 9–13)	14 (4; 10–15)	11 (6; 7–15)	12 (3; 9–13)	0.538	2	$p > .05$	[d]	3.824	2	$p > .05$	[d]	[d]
Social inclusion	13 (4; 9–15)	11.5 (4; 10–15)	9 (5; 6–13)	11 (5; 6–14)	10 (2; 8–12)	10 (2; 8–12)	5.154	2	$p > .05$	[d]	2.606	2	$p > .05$	[d]	[d]
Rights	10 (2; 8–13)	9.5 (3; 9–15)	10 (2; 9–12)	10 (1; 9–10)	7 (3; 6–11)	9 (4; 6–11)	4.381	2	$p > .05$	[d]	2.37	2	$p > .05$	[d]	[d]
Emotional well-being	15 (2; 13–15)	13.5 (3; 9–15)	14 (2; 11–15)	15 (1; 12–15)	14 (4; 10–15)	15 (1; 13–15)	1.847	2	$p > .05$	[d]	3.515	2	$p > .05$	[d]	[d]
Physical well-being	13 (3; 12–15)	13.5 (1; 12–15)	14 (4; 10–15)	15 (1; 13–15)	13 (1; 12–13)	13 (3; 11–14)	1.603	2	$p > .05$	[d]	**7.7**	**2**	**$p = .021$**	**$2 \neq 3$**	[d]
Material well-being	9 (6; 5–12)	6.5 (2; 5–11)	7 (2; 6–8)	7 (3; 4–9)	7 (3; 6–11)	6 (4; 5–10)	0.975	2	$p > .05$	[d]	0.093	2	$p > .05$	[d]	[d]

Note. min = minimum; max, maximum; PCG = pairwise comparisons (groups); PCM = pairwise comparisons (moments). Bold values highlight significant results.
[a]Kruskal–Wallis. [b]Wilcoxon. [c]Bonferroni correction. [d]No differences detected.

Table 5 Kruskal–Wallis and Wilcoxon Analysis of the Mini-Mental State Examination Scores for the Three Groups

Indoor group		Outdoor group		Control group										
Median (interquartile range; min–max)						Pre				Post				
Pre	Post	Pre	Post	Pre	Post	t^a	df^a	p^a	PCG[a,c]	t^a	df^a	p^a	PCG[a,c]	PCM[b,c]
20 (7; 15–29)	21 (7; 14–30)	25 (8; 7–30)	25 (10; 8–29)	22 (8; 16–29)	22 (6; 14–28)	1.752	2	$p > .05$	[d]	0.86	2	$p > .05$	[d]	[d]

Note. min = minimum; max, maximum; PCG = pairwise comparisons (groups); PCM = pairwise comparisons (moments).
[a]Kruskal–Wallis. [b]Wilcoxon. [c]Bonferroni correction. [d]No differences detected.

Table 6 Kruskal–Wallis and Friedman Analysis of the Functional-Capacity Scores for the Three Groups

	Indoor group			Outdoor group			Control group													
	Median (interquartile range; min–max)									Pre				Int				Post				
	Pre	Int	Post	Pre	Int	Post	Pre	Int	Post	t^a	df^a	p^a	PCG[a,c]	t^a	df^a	p^a	PCG[a,c]	t^a	df^a	p^a	PCG[a,c]	PCM[b,c]
30-s sit-to-stand	12.5 (5.75; 11–19)	15 (6; 13–22)	17 (5; 14–22)	13 (5.75; 7–18)	13 (5; 6–17)	13.5 (6.5; 7–18)	13 (4.25; 4–15)	13 (4.25; 4–15)	13 (6; 5–14)	0.866	2	$p > .05$	[c]	5.348	2	$p > .05$	[c]	6.617	2	**$p = .037$**	**1 ≠ 3**	**pre ≠ post (IG)**
Timed up-and-go	5.93 (1.1; 5.59–6.92)	5.93 (2.05; 5.35–8.98)	5 (1.21; 4.9–6.24)	7.08 (7.4; 5.58–17.03)	7.2 (3.6; 5.16–13.62)	7.1 (6.2; 4.29–14.63)	11.12 (6.6; 7.09–17.75)	13 (6.2; 7.56–17.78)	13.2 (7.7; 8.2–20.19)	5.18	2	$p > .05$	[c]	9.513	2	**$p = .009$**	**1 ≠ 3**	10.896	2	**$p = .003$**	**1 ≠ 3**	**pre ≠ post (IG)**
6-min walk	551 (75; 400–562)	582 (36.5; 466–597)	509 (104.5; 422–588)	456 (101.3; 98–524)	485 (89; 423–545)	482 (193.5; 228–594)	434 (48.3; 410–525)	414 (50.5; 404–468)	394.85 (86; 354–512)	5.875	2	$p > .05$	[c]	14.048	2	**$p \leq .001$**	**1 ≠ 3**	6.597	2	**$p = .037$**	**1 ≠ 3**	[d]

Note. Int = intermediate;min = minimum; max, maximum; PCG = pairwise comparisons (groups); PCM = pairwise comparisons (moments). Bold values highlight significant results.
[a]Kruskal–Wallis. [b]Friedman. [c]Bonferroni correction. [d]No differences detected.

Besides being a low-cost and accessible intervention for all socioeconomic statuses, this interaction between outdoor/nature and physical health in the general population has demons (Thompson Coon et al., 2011). Although the significant differences concern general well-being ($p \leq .001$), a meta-analysis carried out by (Brito et al., 2022) also demonstrated better outcomes for OG. An outdoor intervention seems to be more effective in promoting Physical Well-Being in agreement with the ecological dynamic framework, given that exploration and involvement in nature promote well-being (Araújo et al., 2019). These benefits can be explained by the synergies of the benefits of PE and the benefit of interaction with nature.

On the other hand, for an impact on all factors of QoL it seems other multidisciplinary approaches or interventions are needed that, combined with a PE intervention, have a direct impact on the remaining factors of QoL (Pérez-Cruzado & Cuesta-Vargas, 2016). Individuals with IDD prefer to choose sedentary lifestyle activities rather than engage in physical activity, PE, or a regular sport practice. Support and guidance provided to this population should be reviewed and based on self-determination theory (Deci & Ryan, 1985), to encourage their practice/choice.

Cognitive Function/Dementia

After a 24-week intervention with exercise, there were no significant differences in the dementia/cognitive decline score between groups and moments. However, analyzing the dispersion measures of the groups at the postintervention moment, the values seem to have increased in the IG (providing indications that an IG program may promote the risk of onset of dementia/cognitive decline). In the population with IDD, there is little investigation of this subjective relationship because, so far, there is no validated questionnaire for this population. The tool used in this study, although also used in previous studies, may not be adapted to the population under study, and the lack of significant results may be justified by this. However, our literature review indicates that PE may be related to some variables on the MMSE subscales, in other words, associated with dementia/cognitive decline (Ptomey et al., 2018). Several authors associate the practice of PE with brain development, namely the frontal and temporal area, due to the cortical activity it incites, derived from the state of excitability, affecting brain plasticity, promoting the production of angiogenesis, neurotrophins, synaptogenesis, and neurotransmitters such as serotonin, noradrenalin, and dopamine, a process that may justify this apparent relationship (Corbett et al., 2013). Additionally, in the intervention programs no task was assigned that directly focused on the MMSE subscales (orientation, registration, attention and calculation, recall, language, and complex commands), and a multitask exercise intervention should be considered in future studies.

Functional Capacity

There were differences between groups postintervention for the 30-s sit to stand test, namely between the IG and CG and differences between the initial and final moment in the IG. Although not significant, the OG also showed a slight improvement in postintervention values. Our results show that an intervention with PE, namely using weight-training equipment, seems to be effective in improving the strength and resistance of the lower limbs. The results for the study sample, confirm previous

results, where exercise was associated with improved muscle strength/endurance were associated with moderate-to-large average effect sizes ($g = 0.777$, $p < .001$; Kapsal et al., 2019). Another meta-analysis com 351 participants that showed a strong effect when comparing the intervention group to the CG, $SMD = 0.86$, 95% confidence interval [0.30, 1.42] (St. John et al., 2020).

Regarding the timed up and go test, there are differences between groups at the intermediate moment between IG and CG. Likewise, there was a difference between groups postintervention between IG and CG. There was also a difference between moments in the IG (pre ≠ post; Bonferroni corrected: $p = .007$; $\eta^2 = 1.31$). Similar to what happened in the 30-s sit to stand, an intervention with PE, namely using weight-training equipment, may significantly impact the mobility, namely speed, agility, and dynamic balance. Our results are in accordance with a previous systematic review, where the authors mentioned that PE is a good method to promote the variable in focus (Bartlo & Klein, 2011).

For the 6-min walk test, there are differences between groups at the intermediate moments only between IG and CG. Likewise, there were differences between groups postintervention only between IG and CG. For this test, the differences found are the same as in the other two functional tests, showing that an indoor exercise program can be effective in promoting cardiorespiratory capacity. The 6-min walk test was performed outdoors, so the temperature was not controlled. Since the third assessment moment occurred during a hot week in Portugal, the inexistence of significant differences between moments and the decrease in the values of the dispersion measures can be explained by this fact and not by the existence of some gap in the prescription of the intervention programs (intensity adjusted according to the recommendations [American College of Sports Medicine & Medicine, 2021]).

Although there were no significant differences, the OG dispersion measures also seem to have been promoted postintervention. For a sample where sedentary behaviors prevail and there is low adherence to PE, the assessment and prescription of adapted exercise in any context seem to promote physical fitness and functional capacity. This improvement in physical fitness and functional capacity has a direct impact on the successful performance of activities of daily living (Bartlo & Klein, 2011) and consequent QoL (Schalock & Verdugo, 2002). On the other hand, the inexistence of significant results in physical fitness in OG can be justified with the difficulty in controlling the training intensity, namely the participants associating the perceived effort to a numerical scale. Likewise, gripping the TheraBand can also be performed in different ways by the participants (with hands nearer or farther apart), thus creating different tensions, which may have influenced the results.

Adverse Effects

Some adverse events were recorded, such as muscle pain and fatigue resulting from the prescribed intensity. On rest days, these participants were referred to the physiotherapy office.

Strengths and Limitations

The strength of our study is that it provides two fully available exercise programs that seem to be effective and may mitigate/attenuate the barriers this population has

to exercise and the constraints that support institutions face. To the best of our knowledge, this is the first experimental study with PE that relates the variables studied to the IDD population, in different practice contexts, and can be replicated by all support institutions regardless of their material, physical/spatial, and monetary conditions. Regarding the material and financial barrier, outdoor PE presents a low-cost strategy (not requiring gym subscriptions and monthly fees) or even zero-cost, since it can also be implemented without buying materials or the equipment itself can be built from recycled materials. Regarding the barrier of a lack of appropriate places to implement PE, outdoor PE does not need a specific space to be implemented and can be reproduced anywhere. Knowing that exercise is beneficial to the general population, we did not want to advise against it to the GC, whatever activities they may have performed may have influenced our results. The inclusion of various levels of IDD in the groups (although we made sure that all the groups had members from different IDD levels) and the fact that the exercise sessions were only conducted by two accredited instructors may also have limited our results. Knowing that this is the reality of support institutions, that is, the great heterogeneity of their clients, it is important that the strategies used can be adapted to suit everyone. The quality/quantity of support provided in explanation, demonstration, support, and feedback is not the same for all individuals, leading to the fact that the rest time between sets may have been longer than prescribed. The fact that the study did not follow a randomized controlled design can also be seen as a limitation. Improvements to institutions and the services they offer are constantly needed in areas, such as funding, infrastructure, professional training, and public policies, to ensure that these institutions can provide adequate support, and promote the inclusion, well-being, and QoL of individuals with IDD.

For future studies, we suggest monitoring the quantity of physical activity practiced by all study participants (e.g., accelerometers; IPAQ), nutrition, and medication intake. The prescription of PE with cognitive stimulation tasks or multidisciplinary interventions (PE plus: cranial electrotherapy stimulation, socialization, health education, and educational advices) should be prescribed in the future, in order to reach more robust conclusions across the domains of QoL or dementia. Future studies should also ensure that all stakeholders are blinded to interventions and/or assessments. They should also try to include a larger sample, so as not to limit the conclusions, as well as carry out a follow-up to see whether the effects of the intervention were maintained, or what happened in the long term. We recommend that all assessments be performed in a laboratory setting, so that as many variables as possible (e.g., temperature and humidity) are controlled. Similarly, we suggest investigating the effects of sports practice on all the variables assessed in this study, that the prescribed exercises may be varied throughout the intervention program, and that other motivational interventions take place (e.g., games), to increase their motivation and adherence.

Conclusions

An outdoor, low-cost intervention in contact with nature seems to be effective in improving physical well-being. None of the interventions showed significant differences for the variable dementia/cognitive decline. Finally, an indoor

intervention using weight-training machines seems to be a good method to promote functional capacity and physical fitness.

Knowing that the study of quality of life of individuals with intellectual and developmental disabilities has been the object of study by several researchers, the results of the present experimental study justify the importance of regular physical exercise for this population.

Perspective

This study provides two fully available exercise programs that seem to be effective and may mitigate/attenuate the barriers this population has to exercise. These two programs can be implemented by any institution/organization, taking into consideration the economic and environmental possibilities, and seem to be feasible for any individual with IDD. OG can also be performed with body weight only, using bottles with sand or other low-cost materials.

An outdoor, low-cost intervention in contact with nature seems to be effective in improving Physical Well-Being. None of the interventions showed significant differences for dementia/cognitive decline. An indoor intervention using weight-training machines seems to be a good method for promoting functional capacity.

Acknowledgments

Funding: This work was funded by National Funds by FCT—Foundation for Science and Technology: under project UIDB/04045/2020 (https://doi.org/10.54499/UIDB/04045/2020).

References

American College of Sports Medicine. (2021). *ACSM's guidelines for exercise testing and prescription* (7th ed.). Lippincott Williams & Wilkins.

Araújo, D., Brymer, E., Brito, H., Withagen, R., & Davids, K. (2019). The empowering variability of affordances of nature: Why do exercisers feel better after performing the same exercise in natural environments than in indoor environments? *Psychology of Sport and Exercise, 42*, 138–145. https://doi.org/10.1016/j.psychsport.2018.12.020

Bartlo, P., & Klein, P.J. (2011). Physical activity benefits and needs in adults with intellectual disabilities: Systematic review of the literature. *American Journal on Intellectual and Developmental Disabilities, 116*(3), 220–232. https://doi.org/10.1352/1944-7558-116.3.220

Beadle-Brown, J., Beecham, J., Leigh, J., Whelton, R., & Richardson, L. (2021). Outcomes and costs of skilled support for people with severe or profound intellectual disability and complex needs. *Journal of Applied Research in Intellectual Disabilities, 34*(1), 42–54. https://doi.org/10.1111/jar.12782

Bogenschutz, M., Hewitt, A., Nord, D., & Hepperlen, R. (2014). Direct support workforce supporting individuals with IDD: Current wages, benefits, and stability. *Intellectual and Developmental Disabilities, 52*(5), 317–329. https://doi.org/10.1352/1934-9556-52.5.317

Borg, G. (1998). *Borg's perceived exertion and pain scales*. Human Kinetics.

Borg, G.A.V. (1982). Psychophysical bases of perceived exertion. *Medicine & Science in Sports & Exercise, 14*(5), 377–381.

Brito, H.S., Carraça, E.V., Palmeira, A.L., Ferreira, J.P., Vleck, V., & Araújo, D. (2022). Benefits to performance and well-being of nature-based exercise: A critical systematic review and meta-analysis. *Environmental Science & Technology, 56*(1), 62–77. https://doi.org/10.1021/acs.est.1c05151

Cabeza-Ruiz, R., Alcántara-Cordero, F.J., Ruiz-Gavilán, I., & Sánchez-López, A.M. (2019). Feasibility and reliability of a physical fitness test battery in individuals with Down syndrome. *International Journal of Environmental Research and Public Health, 16*(15), 2685. https://doi.org/10.3390/ijerph16152685

Carbó-Carreté, M., Guàrdia-Olmos, J., Giné, C., & Schalock, R.L. (2016). A structural equation model of the relationship between physical activity and quality of life. *International Journal of Clinical and Health Psychology, 16*(2), 147–156. https://doi.org/10.1016/j.ijchp.2015.11.001

Cicone, Z.S., Sinelnikov, O.A., & Esco, M.R. (2018). Age-predicted maximal heart rate equations are inaccurate for use in youth male soccer players. *Pediatric Exercise Science, 30*(4), 495–499. https://doi.org/10.1123/pes.2017-0281

Clemente, K.A.P., Silva, S.V.D., Vieira, G.I., Bortoli, M.C., Toma, T.S., Ramos, V.D., & Brito, C.M.M. (2022). Barriers to the access of people with disabilities to health services: A scoping review. *Revista de Saude Publica, 56*, 64. https://doi.org/10.11606/s1518-8787.2022056003893

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Routledge. https://doi.org/10.4324/9780203771587

Corbett, D.B., Peer, K.S., & Ridgel, A.L. (2013). Biomechanical muscle stimulation and active-assisted cycling improves active range of motion in individuals with Parkinson's disease. *NeuroRehabilitation, 33*(2), 313–322. https://doi.org/10.3233/NRE-130961

Dairo, Y.M., Collett, J., Dawes, H., & Oskrochi, G.R. (2016). Physical activity levels in adults with intellectual disabilities: A systematic review. *Preventive Medicine Reports, 4*, 209–219. https://doi.org/10.1016/j.pmedr.2016.06.008

de Winter, C.F., Bastiaanse, L.P., Hilgenkamp, T.I.M., Evenhuis, H.M., & Echteld, M.A. (2012). Cardiovascular risk factors (diabetes, hypertension, hypercholesterolemia and metabolic syndrome) in older people with intellectual disability: Results of the HA-ID study. *Research in Developmental Disabilities, 33*(6), 1722–1731. https://doi.org/10.1016/j.ridd.2012.04.010

Deci, E., & Ryan, R.M. (1985). *Intrinsic motivation and self-determination in human behavior*. Springer. https://doi.org/10.1007/978-1-4899-2271-7

Ferreira, J.P., Matos, R., Campos, M.J., Monteiro, D., Antunes, R., & Jacinto, M. (2022). Effects of physical exercise program in adults with intellectual and developmental disabilities—A study protocol. *Journal of Clinical Medicine, 11*(24), 7485. https://doi.org/10.3390/jcm11247485

Fritz, C.O., Morris, P.E., & Richler, J.J. (2012). Effect size estimates: Current use, calculations, and interpretation. *Journal of Experimental Psychology, 141*(1), 2–18. https://doi.org/10.1037/a0024338

Fujita, R., Peterossi, D., Negri Barbosa, R., Palucci Vieira, L., Santiago, P., Zagatto, A., & Gomes, M. (2021). Auditory information reduces response time for ball rotation perception, increasing counterattack performance in table tennis. *Research Quarterly for Exercise and Sport, 94*, 55–63. https://doi.org/10.1080/02701367.2021.1939252

Guerreiro, M., Silva, A., & Botelho, M. (1994). Adaptação à população portuguesa da tradução do 'Mini Mental State Examination' (MMSE). *Revista Portuguesa de Neurologia, 1*, 9–10.

Ho, R. (2014). *Handbook of univariate and multivariate data analysis with IBM SPSS*. CRC Press.

Hunt, X., Bradshaw, M., Vogel, S., Encalada, A., Eksteen, S., Schneider, M., Chunga, K., & Swartz, L. (2022). Community support for persons with disabilities in low- and

middle-income countries: A scoping review. *International Journal of Environmental Research and Public Health, 19*, 8269. https://doi.org/10.3390/ijerph19148269

Jacinto, M., Matos, R., Monteiro, D., Antunes, R., Caseiro, A., Gomes, B., Campos, M.J., & Ferreira, J.P. (2023). Effects of a 24-week exercise program on anthropometric, body composition, metabolic status, cardiovascular response, and neuromuscular capacity, in individuals with intellectual and developmental disabilities. *Frontiers in Physiology, 14*, Article 1205463. https://doi.org/10.3389/fphys.2023.1205463

Jacinto, M., Oliveira, R., Brito, J.P., Martins, A.D., Matos, R., & Ferreira, J.P. (2021). Prescription and effects of strength training in individuals with intellectual disability—A systematic review. *Sports, 9*(9), 125. https://doi.org/10.3390/sports9090125

Jacinto, M., Oliveira, R., Martins, A.D., Brito, J.P., Matos, R., & Ferreira, J.P. (2023). Prescription and effects of cardiorespiratory training in individuals with intellectual disability: A systematic review. *Healthcare, 11*(14), Article 14. https://doi.org/10.3390/healthcare11142106

Jacinto, M., Vitorino, A.S., Palmeira, D., Antunes, R., Matos, R., Ferreira, J.P., & Bento, T. (2021). Perceived barriers of physical activity participation in individuals with intellectual disability—A systematic review. *Healthcare, 9*(11), Article 11. https://doi.org/10.3390/healthcare9111521

Janicki, M.P. (2011). Quality outcomes in group home dementia care for adults with intellectual disabilities. *Journal of Intellectual Disability Research: JIDR, 55*(8), 763–776. https://doi.org/10.1111/j.1365-2788.2011.01424.x

Kapsal, N.J., Dicke, T., Morin, A.J.S., Vasconcellos, D., Maïano, C., Lee, J., & Lonsdale, C. (2019). Effects of physical activity on the physical and psychosocial health of youth with intellectual disabilities: A systematic review and meta-analysis. *Journal of Physical Activity & Health, 16*(12), 1187–1195. https://doi.org/10.1123/jpah.2018-0675

Kroneman, M., Cardol, M., & Friele, R. (2012). (De)centralization of social support in six Western European countries. *Health Policy, 106*(1), 76–87. https://doi.org/10.1016/j.healthpol.2012.03.003

Lifshitz, H., Merrick, J., & Morad, M. (2008). Health status and ADL functioning of older persons with intellectual disability: Community residence versus residential care centers. *Research in Developmental Disabilities, 29*(4), 301–315. https://doi.org/10.1016/j.ridd.2007.06.005

Lindsay, S., Fuentes, K., Ragunathan, S., Lamaj, L., & Dyson, J. (2023). Ableism within health care professions: A systematic review of the experiences and impact of discrimination against health care providers with disabilities. *Disability and Rehabilitation, 45*(17), 2715–2731. https://doi.org/10.1080/09638288.2022.2107086

Mitra, S., Palmer, M., Kim, H., Mont, D., & Groce, N. (2017). Extra costs of living with a disability: A review and agenda for research. *Disability and Health Journal, 10*, 475–484. https://doi.org/10.1016/j.dhjo.2017.04.007

Paiva, A.F., Nolan, A., Thumser, C., & Santos, F.H. (2020). Screening of cognitive changes in adults with intellectual disabilities: A systematic review. *Brain Sciences, 10*(11), 848. https://doi.org/10.3390/brainsci10110848

Pérez-Cruzado, D., & Cuesta-Vargas, A.I. (2016). Changes on quality of life, self-efficacy and social support for activities and physical fitness in people with intellectual disabilities through multimodal intervention. *European Journal of Special Needs Education, 31*(4), 553–564. https://doi.org/10.1080/08856257.2016.1187876

Ptomey, L.T., Szabo, A.N., Willis, E.A., Gorczyca, A.M., Greene, J.L., Danon, J.C., & Donnelly, J.E. (2018). Changes in cognitive function after a 12-week exercise intervention in adults with Down syndrome. *Disability and Health Journal, 11*(3), 486–490. https://doi.org/10.1016/j.dhjo.2018.02.003

Rikli, R.E., & Jones, C.J. (1999). Development and validation of a functional fitness test for community-residing older adults. *Journal of Aging and Physical Activity, 7*(2), 129–161. https://doi.org/10.1123/japa.7.2.129

Ringenbach, S.D.R., Holzapfel, S.D., Mulvey, G.M., Jimenez, A., Benson, A., & Richter, M. (2016). The effects of assisted cycling therapy (ACT) and voluntary cycling on reaction time and measures of executive function in adolescents with Down syndrome. *Journal of Intellectual Disability Research: JIDR, 60*(11), 1073–1085. https://doi.org/10.1111/jir.12275

Robertson, R., Goss, F.L., Rutkowski, J., Lenz, B., Dixon, C., Timmer, J., Frazee, K., Dube, J., & Andreacci, J. (2003). Concurrent validation of the OMNI perceived exertion scale for resistance exercise. *Medicine and Science in Sports and Exercise, 35*(2), 333–341. https://doi.org/10.1249/01.MSS.0000048831.15016.2A

Schalock, R., Keith, K., Verdugo, M., & Gómez, L. (2010). Quality of life model development and use in the field of intellectual disability. In R. Kober (Ed.), *Enhancing the quality of life of people with intellectual disabilities* (Vol. 41, pp. 17–32). Springer. https://doi.org/10.1007/978-90-481-9650-0_2

Schalock, R., Luckasson, R., & Tassé, M. (2021). *Intellectual disability: Definition, diagnosis, classification, and systems of supports* (12th ed.). American Association on Intellectual and Developmental Disabilities.

Schalock, R., & Verdugo, M. (2002). *Handbook on quality of life for human service practitioners*. American Association on Mental Retardation.

Silva, R.A., Rogers, K., & Buckley, T.J. (2018). Advancing environmental epidemiology to assess the beneficial influence of the natural environment on human health and well-being. *Environmental Science & Technology, 52*(17), 9545–9555. https://doi.org/10.1021/acs.est.8b01781

Sim, I., Loh, A., & Hoe, S. (2017). Funding challenges of voluntary welfare organizations in Singapore's disability sector. *International Journal of Healthcare Management, 10*(2), 107–114. https://doi.org/10.1080/20479700.2016.1268327

Simões, C., Santos, S., & Biscaia, R. (2016). Validation of the Portuguese version of the Personal Outcomes Scale. *International Journal of Clinical and Health Psychology, 16*(2), 186–200. https://doi.org/10.1016/j.ijchp.2015.11.002

St. John, L., Borschneck, G., & Cairney, J. (2020). A systematic review and meta-analysis examining the effect of exercise on individuals with intellectual disability. *American Journal on Intellectual and Developmental Disabilities, 125*(4), 274–286. https://doi.org/10.1352/1944-7558-125.4.274

Thompson Coon, J., Boddy, K., Stein, K., Whear, R., Barton, J., & Depledge, M.H. (2011). Does participating in physical activity in outdoor natural environments have a greater effect on physical and mental wellbeing than physical activity indoors? A systematic review. *Environmental Science & Technology, 45*(5), 1761–1772. https://doi.org/10.1021/es102947t

Tse, M.M., Kwan, R.Y., & Lau, J.L. (2018). Ageing in individuals with intellectual disability: Issues and concerns in Hong Kong. *Hong Kong Medical Journal, 24*(1), 68–72. https://doi.org/10.12809/hkmj166302

World Health Organization. (1998). The World Health Organization quality of life assessment (WHOQOL): Development and general psychometric properties. *Social Science & Medicine, 46*(12), 1569–1585. https://doi.org/10.1016/S0277-9536(98)00009-4

World Health Organization. (2020). *Guidelines on physical activity and sedentary behaviour: At a glance*.

World Medical Association. (2013). World Medical Association Declaration of Helsinki: Ethical principles for medical research involving human subjects. *JAMA, 310*(20), 2191–2194. https://doi.org/10.1001/jama.2013.281053