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# Effects of Aerobic Exercise on Body Composition and Muscle Strength in Over-Weight to Obese Old Women with Intellectual Disability: A Pilot Study

Joav Merrick[*,1,2,3], Asad Bachar[1,2,3], Eli Carmeli[1,2,3] and Einat Kodesh[3]

[1]*National Institute of Child Health and Human Development, Division for Intellectual and Developmental Disabilities, Ministry of Social Affairs and Social Services, Jerusalem, Israel*

[2]*Neve Ram Residential Care Center, Rechasim, Israel*

[3]*Department of Physical Therapy, Faculty of Social Welfare and Health Sciences, Haifa University, Mt Carmel, Haifa, Israel*

**Abstract:** *Aim:* To examine the effect of treadmill walking on over-weight to obese females with unspecified mild ID (intellectual disability).

*Method:* Randomized assignment to an aerobic exercise group (G1, n = 6) and control group (G2, n = 3). The G1 performed mild to moderate intensity walking for 25-45 minutes per exercise session, 3-5 times per week up to a weekly walking of 150 minutes, for 32 consecutive weeks. The G2 maintained routine daily activities.

*Results:* The mean age of the study subjects was 57.2 ±7.5 year, BMI was significantly decreased at the conclusion of the intervention ($P = 0.005$). In the G1, the subcutaneous fat area was also significantly decreased ($P = 0.005$) but not in G2. No change was there in the visceral fat area of both groups. The quadriceps muscle maximal isometric muscle strength of the G1 and G2 did not change.

*Conclusion:* Long term mild to moderate intensity of aerobic physical exercise for over-weight to obese women with ID is a feasible and effective plan in reducing subcutaneous fat mass, while muscle strength remains unchanged.

**Keywords:** Body composition, fat, exercise, muscle strength, intellectual disability.

## INTRODUCTION

A sedentary life style and westernized diet pattern can cause obesity, which is a serious health threat [1]. Fat accumulation and especially visceral fat (i.e., abdominal fat that surrounds the vital organs on the trunk and stomach area of the body) is associated with cardiovascular diseases type II diabetes, metabolic syndrome, excess weight, weakness, falls and fatigue [2,3]. Adults with intellectual disabilities (ID) experience high rates of obesity. Despite this higher risk, there is little evidence on the effectiveness of weight-loss interventions for adults with ID and obesity. Previous studies in this population have reported a higher inactivity rate [4,5]. For the treatment of the obesity, physical exercise (PE) for longer than 30 minutes every day is recommended by the *US Department of Health and Human Services*, and specifically aerobic exercise with the moderate intensity of 40-70% of the maximal heart beat, for at least 150 minutes per week [6].

Numerous studies have examined the effect of aerobic exercise training on physical and mental health [7,8]. Thus, aerobic exercise can decrease visceral and subcutaneous fat more effectively than other exercise methods [9,10]. However, to our knowledge there are no studies that analyzed the effect of aerobic exercise on older adults with ID. Compared with counter parts without ID, older adults with ID are generally less physically active [11], and their lifestyle and health behaviors (e.g., social participation, diet, leisure hours) are often markedly different [12]. The combination of aging, obesity and cognitive disability imposes greater demands on the person and the caregivers in performing activities of daily living, and could increase health care costs associated with the multiple health impairments. Obese older adults are particularly susceptible to comorbidity and sarcopenia (the involuntary loss of skeletal muscle), and the combination of muscle loss and fat gain may act synergistically to increase risk for functional decline and physical disability [13,14].

We hypothesized that long term aerobic PE would produce significant weight loss and improvements in muscle strength compared with a non PE control group.

Despite the knowledge that regular exercise can improve many of age-related abnormalities, it remains unclear how much exercise is optimal to achieve this improvement and

*Address correspondence to this author at the Division for Intellectual and Developmental Disabilities, National Institute of Child Health and Human Development, Ministry of Social Affairs and Social Services, POBox 1260, IL-91012 Jerusalem, Israel; Tel: 972 506223832; Fax:972 532670827; E-mail: jmerrick@zahav.net.il

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whether aged ID women can reduce body fat and improve muscle strength to a degree similar to that is observed in healthy counterpart individuals. Previous studies [15,16] reported that the magnitude of the PE adaptation in aging is dependent on intensity and duration, and the lower the 'dose' the longer the intervention. Therefore, PE for aged people should last several months (> 6 months) to bring about physiological adaptation and these changes can be seen following slow, gradual increased and prolong training [17,18].

The aim of the study was to monitor the long term effects of PE on fat and muscle mass, and maximal isometric muscle strength.

## METHOD

Subjects were recruited for this longitudinal-sectional study from the same residential care or supported living center, and they were all exposed to the same life conditions and diet regime that existed at the facility.

Eligibility criteria to participate in the study were women with unspecified mild to moderate ID (diagnosed after birth before age of three years) and with over-weight to obese constitution. For the purpose of this study we classified the subjects into two categories on the basis of clinical cut off points of body mass index (BMI) for overweight and obese that is used by the general community. Overweight as BMI = 27-28.5 kg/m$^2$, and obese as BMI > 28.5 kg/m$^2$. Women older than 50 years, living in the residential care center for at least five years, being able to understand and follow simple orders, required no assistance for their daily activities, and not currently dieting or losing weight could join the study.

Exclusion criteria were women suffering from any specific IDD such as Down syndrome, a significant underlying disease likely to increase risk of intervention such as diabetes, cardiovascular disease, major psychiatric morbidity, active or painful degenerative joint disease at the lower extremities, cancer, fasting blood glucose >110 mg/dL, resting blood pressure >160/90 mmHg) and taking certain medications like systemic corticosteroids, antibiotics or chemotherapeutic drugs.

Potential subjects were screened by the study physical therapist and by the in house nutritionist to assess their physical, general health and motivation to successfully complete 32 weeks of 3-5 times a week physical exercise. Of 16 who were found eligible to participate in the study after screening, only nine women met the study inclusion and exclusion criteria, range age from 51.2 to 62.1 (57.2 ±7.5 years old) with a body mass index (BMI) greater than 27 kg/m$^2$. This study was approved by the Institutional Review Board and written consent was obtained from their legal guardians.

### Study Protocol

A single-blinded study design where personnel responsible for testing were blinded to the subjects' randomized assignment. This intervention represented a pilot study that was also designed to investigate the feasibility, acceptability, and efficacy of the long term physical exercise among older women with mild ID.

Subjects were randomly assigned to 32 weeks of PE (G1, n =6), and non PE group (G2, n =3). Measurements were made before starting (T1), three months later at a follow-up (T2) and at the end of the PE program (T3). The measurements included body mass index (BMI), subcutaneous and visceral fat and muscle mass determined by bioelectrical impedance analysis (BIA) (Tanita TBF-300A, Tanita Europe BV, Middlesex UK). Good to excellent *Pearson correlation coefficients* (> 0.69-0.96; Concordance with 95% Confidence interval) was reported between baseline DEXA and Tanita-BIA measures of body composition by gender [19]. Height was determined using a fixed wall-scale measuring device to the nearest 0.1 cm. Weight was determined within 0.1 kg for each subject using an electronic scale, calibrated before each measurement session. Pelvic circumference (in standing position with weight evenly distributed on both feet and legs slightly parted), between greater trochanter, and thigh circumference (in standing position, 20 cm above base of patella) were measured in duplicate manner using a flexible plastic tape. All assessments were conducted in the morning after a 12 hour fast. Weight and body fat were assessed wearing light clothing, bare foot and socks off.

Maximal knees extension strength was measured using handheld dynamometer. Quadriceps isometric muscle contraction was assessed on muscles of both legs in triplicate manner, two minutes apart from each trail. The mean score between the second and the third trial were calculated. Subject was sitting upright on a high chair thus lower limbs were placed on a stool, and upper limbs positioned crossed over the subjects' shoulder. The knee joint was kept fixed with the limb fixed to a brace at 45 degrees flexion; the manual isometric resistance for muscle contraction was given at the lower part of the tibia, just above the foot and lasted five seconds. The order given to the subject was 'press or push against my hand as much as you can for few seconds'. Handheld dynamometer Lafayette instrument (Lafayette, IN, Model 01163) weights of 300g and it obtains torque values through a series of basic calculations. It is sandwiched between the examiner's hand and the subject's limb, and provides a ''readout'' of force. For increased sensitivity the measurement range of this instrument is 0-300 pounds (136.1 kilograms) or 0-50 pounds (22.6 kilograms). Two values were used for statistical analyses: Torque or peak force (Kg) and peak time (seconds): The peak force is the peak pounds or kilograms applied during a test. The peak time value is the time during the test when the peak force occurred. The torque was measured in units of Newton meters (Nwm) (1 pound = 4.45 Newtons; 1 kilogram = 9.81 Newtons). The interrater reliability for handheld dynamometers was reported as good to excellent when used with a standard procedure [20].

### Physical Exercise

The physical exercise (PE) intervention consisted of aerobic exercises. Walking on a treadmill was the only mode of aerobic activity used. After the first two weeks of adaptation, subjects were encouraged in terms of convienient time and friendly atmosphere to meet a weekly walking goal of 150 minutes. Subjects were supervised by the physical therapist aid. Each walking session started with a brief warm-up and followed by a cool-down period. Subjects completed at least 25-minutes of walking during each session and never exceeded 45 minutes per session. The subjects were introduced to the intervention exercises in a structured way so that they began with lighter-intensity walking and gradually increased the speed. Following the initial of two weeks of adoption phase, each subject was instructed to begin walking at a faster rate yet with comfortable mode and safe intensity level. Subjects could use the handrails for balance. The Borg Perceived Exertion scale (a 15-point self-assessment tool that ranges from 6 to 20), was used to help subjects and examiner estimate and record the intensity level at which they were walking [21]. Subjects were encouraged to walk at an intensity level of 10-13 (activity perception "fairly light to somewhat hard"). The intensity of the walking speed was recorded at each session using metabolic equivalent of task (MET). Adherence to the PE participation and session completeness recorded during the course of the intervention. Throughout the PE program the care givers of the subjects were asked to report any adverse or positive physical or psychosocial effects of the intervention. The subjects in the control group were asked to maintain their usual dietary intake and physical activity patterns and not to engage in any intentional effort aimed at weight loss for 32 weeks.

### Statistical Analysis

Since the present study design was a pilot study we did not calculate sample size for power analysis. The means (95% confidence intervals [CI]) and standard deviations of variables were computed at baseline (T1) and at the end of the study (T3). The main outcomes of interest were change from T1 to T3 for (a) BMI, (b) fat and muscle mass, (c) knee extension isometric strength, and (d) total walking time, speed and distance. Descriptive analysis for continuous variables included means and standard deviation. Differences in the change from T1to T3 were tested using a student's *t*-test. All analyses were conducted using the SPSS version 12 software package. Differences were considered significant if p < values were lower than 0.05.

## RESULTS

Two subjects dropped out from the intervention, three and four weeks post initial intervention due to respiratory stress and lack of motivation, respectively. Therefore, statistical analyses were done on G1 n= 4, and G2 n= 3. None of the subjects reported musckoloskeletal pain during the study. Characteristics of the study subjects are shown in Table **1**.

### Changes in Weight and Body Composition

At the beginning of the intervention body weight and body composition were comparable between G1 and G2. Subjects randomized to the PE group lost during the intervention significantly weight (mean = 4.35 ±0.8 kg, $p$ = 0.005), whereas the subjects in the control group did not ($P$ = 0.32). Consequently, mean BMI of the G1 declined from 29.3±3.4 kg/m$^2$ at T1 to 27.8±3.8 kg/m$^2$ at T3.

A significant decline was recorded in mean pelvic measurement (95% CI; $p$= 0.005) (from 101.2 cm at T1 to 98.6 cm at T3). Subcutaneous fat percentage was significantly reduced (95% CI; $p$= 0.005) from 36.7±4 at T1 to 34.1±3 at T3. Visceral fat % was unchanged.

### Changes in Muscle Mass and Knee Extension Strength

Muscle mass as measured by thigh circumference and BIA (Tanita TBF-300A) was unchanged in either G1 or G2.

**Table 1. Characteristics of Study Subjects (M and ±SD)**

| | Exercises Group (G1) n= 4 | | Control Group (G2) n=3 | | p Value |
|---|---|---|---|---|---|
| | T1 | T3 | T1 | T3 | |
| Age (ys) | 57.2 ±7.5 | | 56.3 ±4.2 | | NS |
| BMI (kg/m$^2$) | 29.3±3.4 | *27.8±3.8 | 28.7±4.5 | 28.8±3.9 | 0.005 |
| Circumference (cm): | | | | | |
| Pelvic | 101.2±5.4 | *98.6±4.4 | 103.2±7.7 | 102±8.2 | 0.005 |
| Thigh | 52.8±3.5 | 53.1± 3 | 52.1±4 | 51.8±3.5 | NS |
| Fat (%): | | | | | |
| [a]Subcutaneous | 36.7±4 | *34.1±3 | 35.8 ±5 | 35.2±5 | 0.005 |
| [b]Visceral | 10.3 ±0.08 | 10.1± 0.07 | 9.9 ±0.06 | 10.1± 0.07 | NS |
| Muscle mass (%): | | | | | |
| Total body MM | 19.3±2 | 20.8 ±2 | 19.7 ±3 | 19.35±2 | NS |
| Knee extension [Torque] (Nwm): | | | | | |
| Peak force (Kg) | 17.3±0.8 | 17.7±1.1 | 17.1±1.0 | 17.0 ±0.9 | NS |
| Peak time (seconds) | 3.15±0.7 | 2.75±0.9 | 3.05± 0.8 | 3.10±0.8 | NS |

*p value based on total group comparison: T1 versus T3

[a]Normal values of Subcutaneous Fat % for women older than 50 years: 19-22 'good'; 23-31 'average'; 32-34 'moderate'; > 34 'bad' (Jackson AS, Pollock ML, Ward A. *Med Sci Sports Exerc*. 1980).

[b]Normal values of Visceral Fat % for women older than 50 years: 1-9 'normal'; 10-14 'high'; > 15 'very high' (Browning LM *et al*., *Obesity*, 2010).

Abbreviation: M- Mean ; SD- Standard deviation ; NS- not significant; BMI- Body Mass Index ; MM- muscle mass; Nwm- Newton meters.

Mean but insignificant improvement in total body muscle mass % from 19.3±2 at T1 to 20.8 ±2 at T3 was recorded in G1.

There were no significant differences between G1 and G2 regarding knee extension strength at T1. At T3 in G1 aerobic walking slightly and insignificantly improved muscle strength from baseline (T1). Mean but insignificant improvement in isometric contraction of quadriceps from the following values: torque or peak force 17.3 Kg at T1 to 17.7 Kg at T3; and peak time 03.15 at T1 to 02.75 at T3.

### Attendance and Walking Outcome Measurements

Four subjects (out of five) concluded 32 weeks of aerobic training. The attendance at exercise sessions was 80% (n=2) for three times a week, 10% for four times a week (n=1), and 10% for five times a week (n=1). Two of the subjects met the walking goal of the program and reported walking of 150 minutes per week, and the mean walking time (n=4) was 142±22 minutes per week. The mean walking session was 88 (out of maximum 144), the mean walking speed was 4.5 km/h, the mean walking distance per session was 2.6 km, the mean of total walking distance (km) over 32 wks was 228±35, and the mean walking intensity as measured by MET was 4.6. The walking outcome measurements are shown in Table **2**.

**Table 2. Outcome Measurement Scores (M and ± SD) of Physical Exercises at the End of the Intervention (T3) (n=4)**

| | |
|---|---|
| **Walking (min/wk)** | 142 ±22 |
| **Walking session (no)** | 88/144 |
| **Walking speed (km/h)** | 4.5±0.6 |
| **Walking distance/session (km)** | 2.6±0.9 |
| **Total walking distance (km, 32 wks)** | 228±35 |
| **Walking intensity (MET)** | 4.6±0.5 |

M- Mean; SD- Standard deviation; MET - metabolic equivalent of task.

## DISCUSSION

The major finding of this study was that long term of aerobic physical exercise intervention produced significant weight loss in over-weight to obese women with ID. Subjects in the intervention group lost 4.35% of their initial body weight. Muscle strength was maintained in both the intervention and control groups. Moreover, despite the elongation of the intervention the mean attendance was good (> 76%), i.e., all subjects completed 32 weeks of aerobic exercise sessions, attending to at least three times a week.

There has only been limited research of older adults (> 50 mean age) with unspecified ID and PE. Short term (20 weeks) controlled trial had recently been published showing the effects of combined exercise training and endurance training on adults (mean age of 42) with ID [22]. This study revealed a tendency towards more beneficial effects of combined exercise training in female adults with intellectual disability. Females more than males suffer from over-weight and obesity, which is the reason for selecting only one gender [23].

A further study conducted by the same research group amongst adolescents with ID showed a positive effect on the indices of obesity, physical fitness and lipid profile [24].

To our knowledge, this study is the first to examine the effects of aerobic exercise intervention in over-weight to obese older women with ID. The findings of the present pilot study are encouraging regarding the potential of aerobic PE interventions to combat obesity in older women with ID. These findings are important due to our previous findings [25] and report that aged people with ID do not engage enough in physical activity and do not meet the minimum requirements of weekly physical activity of 150 minutes as recommended by the *US Department of Health and Human Services* [6]. PE interventions for ID individuals are urgently needed that can effectively reduce body weight and improve physical function levels in this high-risk population.

We did not observe significant effects on muscle strength, yet muscle strength was maintained among subjects in the both group. However, subjects in G1 maintained muscle strength despite losing a significant amount of body weight, contrary to G2 who did not reduce their body weight. This suggests that muscle quality (i.e., strength/muscle volume) may have improved. The influence of aerobic exercise on muscle strength was previously investigated and reported that low-intensity aerobic exercise do not necessarily induce muscle strength [26]. The concept of exercise intensity, duration and specificity is well known and shown that significant muscle strength gains is only possible after high-intensity aerobic training [27], or following resistance anaerobic training. However, previous clinical trials [28,29] found that low but prolonged aerobic exercise intervention, regardless of unchanged muscle strength, were effective in improving general health and physical function in obese, older adults. Consequently, following our study results, subjects in the control group were offered the opportunity to receive the same PE intervention.

## STRENGTHS OF STUDY

To our knowledge this pilot study is the first reporting the feasibility and beneficial effect of long term aerobic PE on body weight reduction in older women with unspecified ID. The intervention was carried out in a residential care center setting and thus represents a unique approach to implementing lifestyle-based interventions within such settings.

Finally, isometric muscle tests are the most common tests used in the clinics, as they are simple to perform and reproduce. The test conditions were well-defined and appropriate for comparing results within this unique population which difficulty in understanding and attention capabilities.

## STUDY LIMITATIONS

The results of the present study should be interpreted in the context of its limitations, and especially due to the small numbers of participants. Nevertheless, the drop out of two participants from the aerobic exercise group emphasize the complexity of such a regime for this population and their compliance to maintain the regime. We certainly believe that high-intensity intervention would be even less 'attractive' for them to comply. The first limitation we identified was that we did not directly measure body composition and therefore unable to determine the proportion of fat versus fat-free weight lost.

Secondly, when testing muscle under isometric conditions one must take under consideration that muscle force varies with muscle length, thus the length of the tested muscle on one hand, and the fixed position by the examiner on the other hand must be repeatedly maintained. In addition, even if the whole muscle is fixed at proximal and distal ends, the isometric-torque could be changed and diverse the results. Moreover, all tests based on voluntary activation of a muscle are prone to artifact, because of subject motivation and examiner encouragement.

## IMPLICATIONS AND FUTURE STUDIES

This pilot study demonstrated feasibility, acceptability, and efficacy of the long term effect of aerobic physical exercise on fat reduction among old women with mild ID. Future study should investigate the effect of such an intervention on males as well and on indicators such as the cardiovascular system, chronic morbidity, functional ability, falls, life satisfaction, and longevity. Furthermore, future study should test the effects of a comprehensive lifestyle-based weight loss intervention, such as certain diet, in an older adult population with and without impaired physical functioning.

## CONCLUSION

The findings of this study suggest that a mild to moderate aerobic exercise is feasible and can produce significant weight loss in over-weight to obese, older women with mild to moderate ID.

## CONFLICT OF INTEREST

The authors confirm that this article content has no conflict of interest.

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## REFERENCES

[1] Leyk D, Rohde U, Gorges W, *et al*. Physical performance, body weight and BMI of young adults in Germany 2000 - 2004: results of the physical-fitness-test study. Int J Sports Med 2006; 27(8): 642-7.

[2] Colditz GA, Willett WC, Rotnitzky A, Manson JE. Weight gain as a risk factor for clinical diabetes mellitus in women. Ann Intern Med 1995; 122(7): 481-6.

[3] Sohler N, Lubetkin E, Levy J, Soghomonian C, Rimmerman A. Factors associated with obesity and coronary heart disease in people with intellectual disabilities. Soc Work Health Care 2009; 48(1): 76-89.

[4] Li C, Balluz LS, Okoro CA, *et al*. Division of Behavioral Surveillance, Public Health Surveillance Program Office, Office of Surveillance, Epidemiology, and Laboratory Services. Surveillance of certain health behaviors and conditions among States and selected local areas --- behavioral risk factor surveillance system, United States, 2009. MMWR Surveill Summ 2011; 60(9): 1-250.

[5] Mikulovic J, Marcellini A, Compte R, *et al*. Prevalence of overweight in adolescents with intellectual deficiency. Differences in socio-educative context, physical activity and dietary habits. Appetite 2011; 56(2): 403-7.

[6] US Department of Health and Human Services: physical activity guidelines for Americans. 2008. Available from: http://www.health.gov/PAGuidelines/guidelines/summary.aspx [Accessed: Sept 2011].

[7] Heller T, McCubbin JA, Drum C, Peterson J. Physical activity and nutrition health promotion interventions: what is working for people with intellectual disabilities? Intellect Dev Disabil 2011; 49(1): 26-36.

[8] Wu CL, Lin JD, Hu J, *et al*. The effectiveness of healthy physical fitness programs on people with intellectual disabilities living in a disability institution: six-month short-term effect. Res Dev Disabil 2010; 31(3):713-7.

[9] Abe T, Kawakami Y, Sugita M, Fukunaga T. Relationship between training frequency and subcutaneous and visceral fat in women. Med Sci Sports Exerc 1997; 29(12): 1549-53.

[10] Slentz CA, Aiken LB, Houmard JA, *et al*. Inactivity, exercise, and visceral fat. STRRIDE: a randomized, controlled study of exercise intensity and amount. J Appl Physiol 2005; 99(4): 1613-8.

[11] Carmeli E, Barchad S, Lenger R, Coleman R. Muscle power, locomotor performance and flexibility in aging mentally-retarded adults with and without Down's syndrome. J Musculoskelet Neuronal Interact 2002; 2(5): 457-62.

[12] Lotan M, Henderson CM, Merrick J Physical activity for adolescents with intellectual disability. Minerva Pediatr 2006; 58(3): 219-26.

[13] Blaum CS, Xue QL, Michelon E, *et al*. The association between obesity and the frailty syndrome in older women: the Women's Health and Aging Studies. J Am Geriatr Soc 2005; 53: 927-34.

[14] Carmeli E, Imam B, Merrick J. The relationship of pre-sarcopenia (low muscle mass) and sarcopenia (loss of muscle strength) with functional decline in individuals with intellectual disability. Arch Gerontol Geriatr 2012; 55(1): 181-5.

[15] Okazaki K, Iwasaki K, Prasad A, *et al*. Dose-response relationship of endurance training for autonomic circulatory control in healthy seniors. J Appl Physiol 2005 ; 99(3): 1041-9.

[16] Carmeli E, Reznick AZ The physiology and biochemistry of skeletal muscle atrophy as a function of age. Proc Soc Exp Biol Med 1994; 206(2): 103-13.

[17] Rhea MR, Alvar BA, Burkett LN, Ball SD. A meta-analysis to determine the dose response for strength development. Med Sci Sports Exerc 2003; 35(3): 456-64.

[18] Seynnes O, Fiatarone Singh MA, Hue O, Pras P, Legros P, Bernard PL. Physiological and functional responses to low-moderate versus high-intensity progressive resistance training in frail elders. J Gerontol A Biol Sci Med Sci 2004; 59(5): 503-9.

[19] Beeson WL, Batech M, Schultz E, *et al*. Comparison of body composition by bioelectrical impedance analysis and dual-energy X-ray absorptiometry in Hispanic diabetics. Int J Body Compos Res 2010; 8(2): 45-50.

[20] Bohannon RW. Test-retest reliability of hand-held dynamometry during a single session of strength assessment. Phys Ther 1986; 66: 206-9.

[21] Borg GAV. Physical Performance and Perceived Exertion. Lund, Sweden: Gleerup 1962

[22] Calders P, Elmaghoub S, de Mettelinge TR, *et al*. Effect of combined exercise training on physical and metabolic fitness in adults with intellectual disability: a controlled trial. Clin Rehabil 2011; 25(12): 1097-108.

[23] Ogden CL, Carroll MD, Curtin LR, McDowell MA, Tabak CJ, Flegal KM. Prevalence of overweight and obesity in the United States, 1999-2004. JAMA 2006; 295(13): 1549-55.

[24] Elmahgoub SM, Lambers S, Stegen S, Van Laethem C, Cambier D, Calders P. The influence of combined exercise training on indices of obesity, physical fitness and lipid profile in overweight and obese adolescents with mental retardation. Eur J Pediatr 2009; 168(11): 1327-33.

[25] Carmeli E, Merrick J, Imam B, Levy R. Are older adults with intellectual disability physically active enough? [To be published in Int J Gerontol] 2013.

[26] Duchateau J, Hainaut K. Isometric or dynamic training: differential effects on mechanical properties of a human muscle. J Appl Physiol 1984; 56(2): 296-301.

[27] Fitts RH, Widrick JJ. Muscle mechanics: adaptations with exercise-training. Exerc Sport Sci Rev 1996; 24: 427-73.

[28] Akbartabartoori M, Lean ME, Hankey CR. The associations between current recommendation for physical activity and cardiovascular risks associated with obesity. Eur J Clin Nutr 2008; 62(1): 1-9.

[29] Mora S, Lee IM, Buring JE, Ridker PM. Association of physical activity and body mass index with novel and traditional cardiovascular biomarkers in women. JAMA 2006; 295(12): 1412-9.

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