

Muscle power, locomotor performance and flexibility in aging mentally-retarded adults with and without Down's syndrome

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Abstract

Longer life expectancy is resulting in increasing numbers of elderly adults with mental retardation (MR). The objective of the study was to compare lower limb isokinetic muscle power, locomotor performance and flexibility of aged adult mentally-retarded individuals with and without Down's syndrome (DS). Nine subjects with MR and DS (mean age 61), and sixteen subjects with MR and without DS (mean age 63), performed leg power testing on a Biodex dynamometer. Parameters measured were dynamic torque, dynamic torque % body weight, and average power % body weight. Functional performance tests including "Timed Get-Up and Go" and flexibility were also analyzed and compared. Results indicate that in knee extension and flexion isokinetic power the MR group without DS showed significantly higher scores than the MR group with DS. The functional performance of elderly adults with MR and DS was significantly impaired compared with MR adults without DS, although no differences were observed between the two groups in the flexibility tests. It was concluded that muscle leg power, and gross motor performance of elderly mentally-retarded individuals without Down's syndrome is better than in those with Down's syndrome.

Keywords: Muscle Power, Motor Performance, Mental Retardation, Down's Syndrome, Aging Gene Therapy, Tendon

Introduction

It is estimated that the incidence of mental retardation (MR) in Israel is about 3.5% of the general population. Out of a total population of 6.4 million, there are an estimated 200,000 mentally-retarded persons, which includes about 165,000 individuals with mild MR, and a further 35,000 with moderate to severe MR. Five to 6% of the mentally-retarded population are adults aged 55 years or more, and with increasing life expectancy the percentage of aged persons with mental retardation is steadily increasing¹. The reasons for increased life expectancy of this population in Israel have been attributed to improvements in medical technology and in the quality of health and social care. Increased life expectancy in the MR population enhances the incidence of

aging diseases^{2,3}.

The most common cause of MR in Israel is Down's syndrome (trisomy 21). Morphological and physiological differences exist between mentally-retarded individuals with and without Down's syndrome (DS). Physical characteristics associated with DS include: muscle hypotonicity, joint hypermobility, cardiac disorders, increased tendency for obesity and a higher frequency of cognitive impairments with aging⁴. The physiological differences place individuals with DS at a disadvantage in performing physical activities resulting in reduced independence and a tendency to immobility^{7,8}.

Relatively little is known regarding the relationship between muscle strength and functional abilities as measured by dynamic balance and flexibility in elderly mentally-retarded adults with or without DS, though some studies have reported strength characteristics in young persons with MR⁹⁻¹². The main aim of the present study was to evaluate the differences in isokinetic muscle leg power of elderly institutionalized MR individuals with and without Down's syndrome and also to investigate if differences exist in gross locomotor performance and soft tissue flexibility.

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		MR with DS		MR without DS	
		Males	Females	Males	Females
		(n=3)	(n=6)	(n=5)	(n=11)
Age (years):	Male	59.9 ± 2		61.5 ± 2	
	Female	62.1 ± 2		64.2 ± 2	
Height (cm):	Male	157.5 ± 12		163.8 ± 13*	
	Female	151.3 ± 14		159.1 ± 15*	
Weight (kg):	Male	78.7 ± 16		72.2 ± 17*	
	Female	72.8 ± 20		64.9 ± 21*	
BMI**:	Male	23.6 ± 5		21.3 ± 5*	
	Female	24.9 ± 6		22.1 ± 4*	
Cardiac disease (%)		33		16*	

Values are mean and standard deviation
MR (mental retardation), DS (Down's syndrome)
*p < 0.05
** BMI (body weight/height²) units are Kg/m²

Table 1. Descriptive characteristics of subjects.

Subjects and methods

Subjects

All participants in the study were residents in a foster home located in Rechasim, Israel, and were diagnosed as having mild MR requiring minimal supervision for daily activities. They had an intelligence quotient (IQ) range of 65-74 ± 5 as determined using the Stanford Binet Scale¹³. Their ages ranged from 57-65 years. Group A included nine elderly adults (6 females, 3 males) with mild MR, who were diagnosed at birth with Down's syndrome (trisomy 21) (mean age 61.5 ± 3.6). Group B included 11 females and 5 males (mean age 63.3 ± 2.8), who were diagnosed at birth with unspecified mental retardation. Table 1 shows the descriptive characteristics of the subjects. All participants were referred to the study by the in-house physician. Written informed consent was received from all subjects or their legal guardians prior to participation in the study. The study was approved by the Ethical Committee of "Akim", the national office for mentally-retarded individuals, and by the National Institute of Health and Human Development.

Experimental procedures

Knee extension and flexion power were measured from both sides using a medical isokinetic system (Biodex dynamometer, Medical Systems, Shirley, NY, USA). All subjects initially performed 3 minutes warm-up walking at a comfortable speed. In order to become familiar with the

machine, subjects performed five practice repetitions for knee extension and flexion at a speed of 90°/sec. Finally, subjects performed three maximal voluntary contractions at a speed of 90°/sec (highest dynamic torque value, Newton-meters) for knee extensors (Quadriceps femoris) and flexors (hamstrings). During the testing, the lever arm was attached to the midline, and its axis of rotation aligned with the anatomic axis of knee rotation. All tests were performed in the sitting position. To stabilize the hip joints and the trunk, the subjects were seated in a chair with a solid back support and were strapped at the level of chest and pelvis. The hip joint was at an angle of 100° of flexion, and the knee joint was at an angle of 45° of flexion, supported by a bar underneath. Calibration of the machine was performed using standard weights placed on the lever arm. Data were collected for dynamic torque (Nm) (the greatest single value of three maximal efforts), dynamic torque percent body weight (Nm/kg), and average power (watts) (the expression of work per unit of time).

Flexibility: Soft tissue flexibility (i.e. skin, connective tissue and muscles) of the lower trunk and hamstring muscles was measured using procedures adapted from Hoeger¹⁴ and the functional reach test of Duncan et al.¹⁵ in modified long-sitting and forward-reach modes. The test requires that the subjects bend forward in a long-sitting position while keeping their legs straight. The best score (length, in cm) of 3 trials was recorded.

The "timed get-up and go" (TUAG) test was used to measure a mixture of four different locomotor tasks¹⁶. Participants were asked to rise from an armchair, walk 3

	MR with DS		MR without DS	
	Males (n=3)	Females (n=6)	Males (n=5)	Females (n=11)
Quadriceps:				
dynamic torque (Nm)	43.5±1	38.2±1	52.2±2*	49.4±2 [§]
dynamic torque % BW (Nm/kg)	48.8±1	47.2±1	60.2±2*	60.2±2 [§]
average power % BW (watts/kg)	40.2±1	34.8±1	47.2±1*	45.4±9 [§]
Hamstrings:				
dynamic torque (Nm)	26.8±4	18±4	41.7±6*	36±6 [§]
dynamic torque % BW (Nm/kg)	11.4±4	14±3	23.4±5*	19.9±5 [§]
average power % BW (watts/kg)	26.1±5	11±3	33.8±7*	27.8±7 [§]

* $p < 0.01$ between males, and $p < 0.01$ between females

Table 2. Angular velocity at 90°/s, the dynamic torque, dynamic torque % BW, and average power % BW of quadriceps and hamstrings of the MR with and without DS.

meters, turn around, return to the chair and sit down again. Times were measured using a manual stopwatch. The functional factors observed by the testers with this test include: path deviation, trunk sway, flexion of knees or back, abduction of arms, the use of a walking aid, sit-to-stand transfer, walk and turn. The target time period to complete this test for older adults with a good level of independence is between 8 and 10 seconds. The advantages of the test are: that it is simple, requires simple tools, and is quick to perform (less than 20 seconds including prior instructions), and can be performed by participants who use assisting devices such as a walker, cane or crutches. The procedure was experimentally tested and found to be a highly reliable tool to measure a complex chain of four consecutive movements¹⁷. Individuals with pre-existing conditions that could interfere with the results, such as blindness, amputation, or severe osteoarthritis, or could lead to co-morbidity (with non-age-related changes) were excluded from the study. Co-morbidity conditions included depression, and possible adverse drug reactions.

Statistical analysis

All data were analyzed with SPSS 7.2 for Windows 2000. Means and standard deviation were calculated for all variables. Age, height, weight, BMI, dynamic torque, dynamic torque % body weight (% BW), and average power % BW, were analyzed by one-way analysis of variance. One sample

independent t-tests were run to compare differences in medical data (taken from subject's medical records), leg power, functional test and flexibility between the groups. The critical value for statistical significance was assumed at an alpha level < 0.05 .

Results

The physical characteristics of the two groups are shown in Table 1.

There were significant differences in BMI between the two groups ($p < 0.05$). The DS group tended to be shorter in stature, and more obese than the MR group without DS. There were no significant differences in terms of medical profiles (coexisting medical conditions, including surgical procedures, and medications) between the MR groups as measured by one sample independent t-tests, however, the prevalence of cardiac diseases was higher in the MR group with DS in comparison with the MR group without DS.

At an angular velocity of 90°/s, dynamic torque, dynamic torque % BW, and average power % BW of quadriceps and hamstrings of the MR group without DS were significantly higher than the peak torque of the MR group with DS (Table 2). Moreover, the muscle power of knee flexion in males without DS was lower than in females.

Functional and flexibility tests showed insignificant differences between the groups (Figures 1 and 2). The MR group with DS and the MR group without DS were able to bend

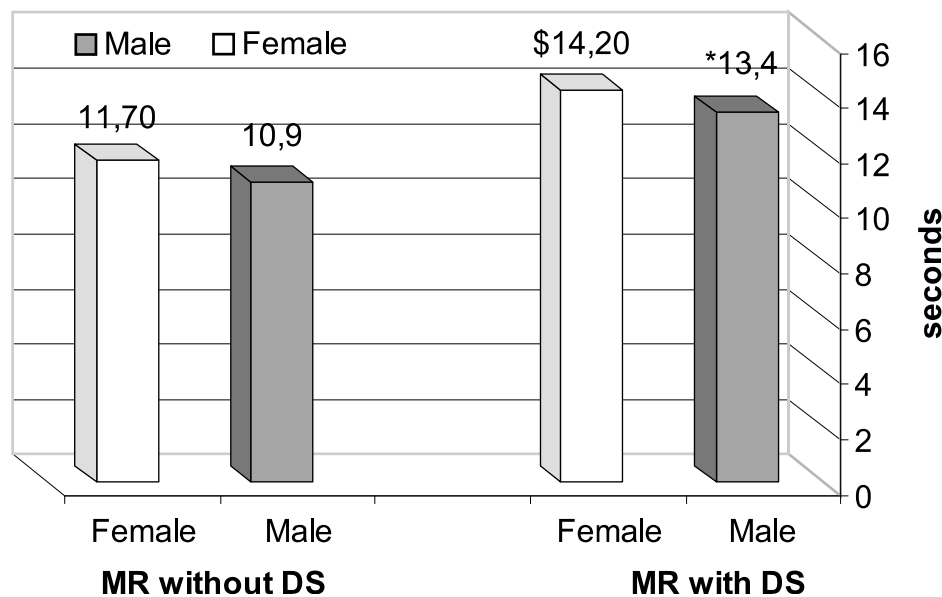


Figure 1. The values of timed get-up and go test. \$: significance between female groups, *: significance between male groups.

forward in long-sitting positions for 22.3 and 21.1cm respectively. The MR group with DS demonstrated significantly poorer performance in the TUAG test than the MR group without DS ($p < 0.05$).

Discussion

The main purpose of this study was to compare lower leg muscle power and functional ability in aging mentally-retarded adults with and without DS. The study examined cross-sectionally the test scores gained by the two groups. The results showed that isokinetic measurements obtained during one test session were lower than that for MR participants without DS ($p < 0.01$). There was a greater degree of overweight in the MR group with DS, and the ratio of weight and height of this group, as measured with BMI, was higher than that of the MR group without DS. In addition, motor performance as observed in the TUAG test of the MR with the DS group was inferior compared to the MR without the DS group. The above findings agree with the findings of a study undertaken on young mentally-retarded adults⁹.

Previous studies have reported isokinetic muscle power of lower limbs in adults with and without MR^{9,11}. However, there are no studies that have attempted to quantify muscle power characteristics of old mentally-retarded individuals with and without DS.

The authors did not anticipate the current findings since all the participants have a common lifestyle with regard to daily and recreational activities¹⁸. We are not aware of other studies that report a relationship between leg power and functional ability such as walking among MR individuals.

Although the differences are not extrinsically apparent in terms of daily basic lifestyle, specific strength evaluation procedures can be used for better assessment and prediction of functional capacity¹⁹. The differences may be explained by the significant differences in body weight, and reduced muscle tone.

Most of the medical histories reveal non-significant differences between the two groups with the exception of cardiac disorders, which were considerably more prevalent among individuals with DS as previously reported^{2,20}. The higher prevalence of cardiac disease in the MR group with DS may suggest a possible mechanism to explain the decrease in their muscular power output compared with the MR group without DS.

Functional flexibility as seen in trunk flexion and hamstring muscle stretching were similar in both groups with both study groups showing similar degrees of soft tissue mobility and lumbar flexibility. Loss of flexibility is one of the earliest noticeable changes occurring in elderly adults²¹. The fact that MR with DS demonstrated similar degrees of flexibility to that of MR individuals without DS is somewhat surprising and merits special attention. Individuals with Down's syndrome often possess poor skeletal muscle tone with soft tissue elasticity. This might have been expected to provide a relative advantage with respect to flexibility as they aged, however, this was not the case. Since we did not evaluate muscle tone in the present study, we can only assume that a "lazy" lifestyle probably played a major role in determining flexibility levels at age 60 among MR individuals with Down's syndrome.

The "timed get-up and go" (TUAG) is used to assess a person's ability to perform a common task that is probably

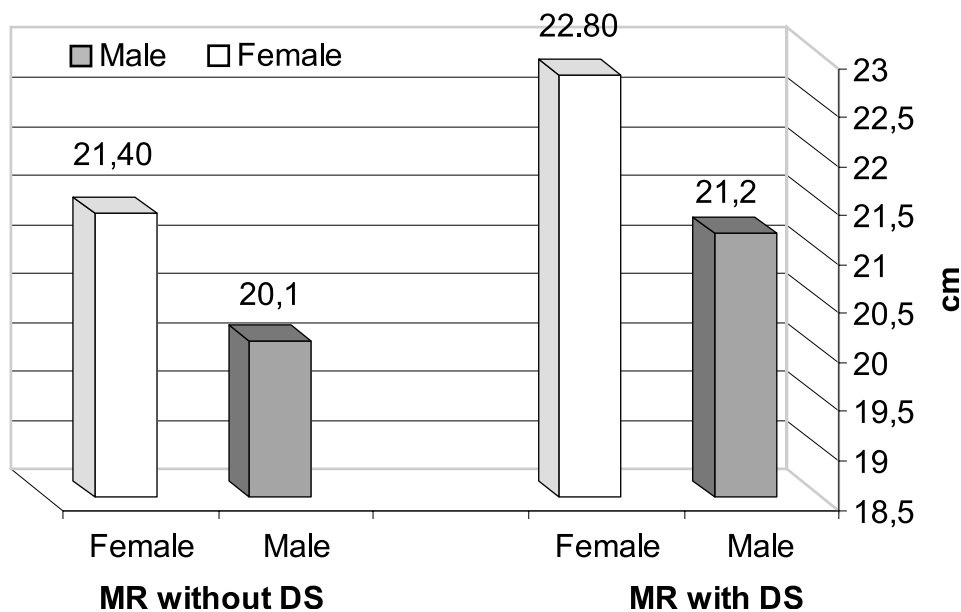


Figure 2. The values of the flexibility test.

performed several times throughout the day by elderly adults. The MR with DS scored lower in this functional test, which may reflect on their general state of health or sedentary lifestyle. Few studies have indicated that this test can supply additional information about the participant's functional ability and rehabilitation requirements²²⁻²⁴. Poor performance (slower than 30 seconds) may be used to justify therapy intervention as a preventive measure. The MR group with DS needed significantly more time to complete the test than the other group, but still finished the test within the normal timeframe. The relatively small number of participants in the study makes it difficult to characterize the results as a general phenomenon, however, the results of this pilot study do indicate a unique motor performance pattern among MR individuals with DS and indicate the value of a larger and more extensive study to confirm these observations. The present study provides added support for the viewpoint that adults with MR undergo functional changes as they age.

We conclude that aged mentally-retarded adults with Down's Syndrome do present inferior functional abilities than age-matched mentally-retarded individuals without DS. The mechanisms, although still not understood, may be associated with physically inactive and mainly sedentary lifestyles, with reduction in basic muscle tone.

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