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Effects of aerobic exercise on health-related indicators in individuals with intellectual disability with or without the Down syndrome

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Abstract

Purpose: This study examines the influence of aerobic exercise intervention on obesity, lipid profile and hemodynamic adaptations in individuals with intellectual disability with the Down Syndrome (DS) or without the Down Syndrome (NDS). **Methods:** Forty six institutionalized individuals (n=46), aged 36.02±8.50 yrs, were divided into three groups: DS (n=14), NDS (n=22) and control (n=10). Measurements on anthropometric characteristics (body mass, BMI, percent body fat, waist circumference), plasma blood lipids (TGs: triglycerides, TC: total cholesterol, HDL-C, LDL-C) and blood pressure (systolic, diastolic) were obtained before and after a 12-week aerobic training program. Mean arterial pressure and cardiac index were determined using specific equations. **Results:** Significant health-related adaptations were observed after a 12-week intervention on anthropometric characteristics in both training groups (DS and NDS; body mass: -1.76 and -2.5%; BMI: -1.76 and -2.63%; waist circumference: -4.07 and -3.3%, $p<.001$; and body fat: -0.85 and -2.62%, $p<.05$). Furthermore, HDL-C increased (+7.85 and 10.47%, $p<.001$) whereas LDL-C slightly decreased (-3.13 and -2.2%, $p>.05$). In addition, when a stepwise multiple regression was applied, using the cardiac index as a dependent variable, the 98% of the total variance was explained by diastolic blood pressure (DP: 55.7%), age (A: 22.2%), heart rate (HR: 6.1%) systolic blood pressure (SP: 5.4%) and body mass (BM: 8.6%), (y=2.405-0.037*DP-0.018*A+0.023*HR+0.019*SP-0.011*BM). **Conclusion:** The present study provides a practical model for the prediction of cardiac function and suggests that a 12-week regular aerobic exercise program improves body composition, lipid profile and hemodynamic response in people with intellectual disability with or without the Down syndrome.

Keywords: *Down syndrome; obesity; dyslipidemia; blood pressure; aerobic exercise.*

1. Introduction

Individuals with intellectual disability, with or without the Down syndrome, exhibit many health problems which impair daily living. Sedentary lifestyle, low access to exercise programs and lack of healthy eating habits (Draheim, Williams & McCubbin, 2002; Emerson, 2005) has been suggested as the main reasons for their poor health. These reduce their functional capacity making individuals with intellectual disability more susceptible to morbidity and mortality in all age groups (Hoge & Dattilo, 1995; Pitetti & Boneh, 1995; Patja et al., 2000). In addition to luck of physical fitness and low functional capacity, muscle weakness, cardiovascular abnormalities, type 2 diabetes, osteoporosis and high incident of obesity occur in these individuals (Rimmer et al., 2004; Fox & Rotatori, 1982; Kelly, Rimmer & Ness, 1986; Janicki et al., 2002; Traci et al., 2002). In particular, the prevalence of obesity which occurs at an early age is associated with the presence of multisystematic metabolic diseases later in life.

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Despite the fact that during the last decades there has been higher life expectancy among people with intellectual disability, there is no doubt that the excessive body fat and the inactive lifestyle raises the proportion of age-associated diseases, contributing substantially to cardiovascular and all cause mortality. Nevertheless, it is established that regular exercise, sports and physical fitness activities promote health and well being in all people (Baran et al., 2013).

Focusing on people with intellectual disability with and/or without the Down syndrome, there is growing evidence that the people with intellectual disability can safely participate in sports and activities and gain the benefits of exercise. Alongside, the guidelines of the American College of Sports Medicine (Fernhall, 2003) urges people with Down syndrome to participate in organized exercise programs (i.e. 20 to 60 min of aerobic training, 3 to 7 times per week at an intensity of 55% to 90% of HR_{peak}). Moreover, few studies have evaluated body composition, lipid profile and hemodynamic characteristics, as predictor factors of cardiovascular function in individuals with mental handicaps (Calders et al., 2011; Ordonez et al., 2014). Thus, we conducted a 12-week intervention program in order to examine the influence of regular aerobic exercise on obesity, lipid profile and hemodynamic adaptations in individuals with intellectual disability with the Down Syndrome (DS) or without the Down Syndrome (NDS).

2. Methodology

2.1Participants

The participants of the present study consisted of forty six institutionalized male (n=31) and female (n=15) adults with moderate intellectual impairment (IQ<51) according to Wechsler Adult Intelligence Scale (WAIS) with or without the Down syndrome (diagnosed by chromosome analysis). In particular, the participants were divided into three groups: i) NDS group (n=22, aged 36.0±8.1 yrs), ii) DS group (n=14, aged 38.2±9.5 yrs) and iii) Control group, n=10 consisted of NDS (n=5, aged 30.2±4.1 yrs) and DS (n=5, aged 36.0±10.2 yrs) individuals with similar anthropometric characteristics, which abstained from any kind of exercise training, and only involved in the pre- and post-training measurements. The criteria to participate in the study excluded regular consumers of tobacco and alcohol, patients with cardiovascular, metabolic and musculoskeletal diseases and individuals who participated regularly in organized training programs and physical activities. All participants lived in an institution for people with intellectual disability in Athens, Greece. The study was performed according to the principals of the Helsinki declaration. The license to conduct research within the institutions was obtained from the Ministry of Education and Religious Affairs and after the approval of the Research Ethics Committee of Democritus University of Thrace. An informed consent signed from the parents or the guardians of the participants.

2.2 Procedure

The exercise groups followed a supervised 12-week aerobic training intervention program. Measurements on anthropometric characteristics (body mass, BMI, percent body fat, waist circumference), blood lipids (TGs: triglycerides, TC: total cholesterol, HDL-C, LDL-C) and blood pressure (SP: systolic, DP: diastolic) were obtained before and after the aerobic training program. Prior to the training program all participants underwent a resting 12-lead electrocardiogram (ECG).

2.3 Anthropometric measurements

Standing height, body mass and waist circumference were evaluated by the same investigator according to the international guidelines (US Department of Health and Human Services & National Center for Health Statistics, 1996; Lohman, Roche & Martello, 1988). Standing height was measured to the nearest 1.0 cm, using a stadiometer (Seca Gmba & Co, Road Rod 214 stadiometer, Hamburg, Germany). Body mass was measured to the nearest 0.1 kg using an electronic digital scale (model TBF-300A, Tanita Corporation, Tokyo, Japan), with the subjects wearing light clothing. BMI was calculated using the weight divided by the height squared (kg/m^2; National Institute of Health 1998). A flexible tape (Seca Gmba & Co, Hamburg, Germany) was used to measure waist circumference, midway between the lower rib margin and the iliac crest, to the nearest 1 mm.

Skinfold thickness was taken for all participants by the same investigator at the beginning of the study and after 12 weeks at the end of the training program. Skinfold thickness was measured twice to the nearest 0.2 mm at seven sites (chest, abdominal, thigh, triceps, subscapular, suprailiac, midaxillary) using the Harpenden calliper (British Indicators Ltd). When a difference between the two trials was more than 10%, a third measurement was taken. The mean of the trials gave the measurement for the particular skinfold and the percentage of body fat was calculated for male and female separately (Jackson & Pollock, 1978; Jackson, Pollock, & Ward, 1980).

2.4 Blood samples

Blood samples were collected into sterile tubes, by venipuncture (median cubital vein) from a specialized staff early in the morning (08:00-09:00), after a 12-hour overnight fast. All blood samples were immediately stored in vials containing EDTA, in refrigerated conditions (-20°C), and plasma was separated by centrifugation (at 3500 rpm for 10 min at 4°C). Total plasma cholesterol and triglycerides were determined by enzymatic colorimetric methods (Roche Modular P800, Roche Diagnostics, Indianapolis, IN). The HDL-C level was measured by the method of Warnick et al. (1982) and the levels of LDL-C were estimated according to Friedewald's equation (Friedewald, Levy & Fredrickson, 1972).

2.5 Blood pressure

Blood pressure was measured in the right arm to the nearest 1 mmHg with standard mercury sphygmomanometer while the subject was in a seated position. The first and fifth Korotkoff sounds were used for systolic and diastolic blood pressure respectively (US Department of Health and Human Services & National Center for Health Statistics, 1996). Three readings were obtained at intervals of at least 3 minutes, and the average of the last two readings was used in the analyses. Mean arterial pressure and cardiac index were determined using specific equations (Klabunde, 2011).

2.6 Aerobic intervention program (mode, intensity, duration)

Exercise sessions took place in the institution's gym at the same time of the day (09:00 to 13:00, with controlled temperature 24^{o}C and relative humidity 50%). The 12-week training program included a familiarized period of 2 weeks (progressively involved 5 to 30 min of aerobic activity on the treadmill, 3 days per week) for safety reasons. The main aerobic exercise protocol was conducted on an electric treadmill **(**Technogym Run Xt Pro 600, Gambettola-Italy**)** and included: 5 minutes warm-up, 50 minutes aerobic workout (walking) at an intensity of 60-80% of individual's HR_{peak}, and 5 minutes cool down. Peak HR was calculated by the age-predicted equation (220 – age). The training

heart rate zone was estimated according to Karvonen method using a range of 60 to 80% exercise intensity: Training heart rate= [0.60 or 0.80 x (HRpeak-HRrest)] + HRrest (Karvonen & Vuorimaa, 1988). Heart rate was monitored by the use of electronic device (Polar RS 800 CX). Motivational strategies included visual, (e.g., the enthusiastic attitude of the researcher), verbal (e.g., "*walk faster*", "*well done*", "*don't stop*", "*nice try*") and physical reinforcement (e.g., applause, pat on the back) in order to maintain exercise intensity, compatible with the personal age-predicted heart rate training zone.

3. Statistical Analysis

Descriptive statistics (means, standard deviations, %Δ) were calculated for all variables for each group (DS, NDS, Control group) and the time point measurement (Baseline, 12-week) to describe central tendencies and dispersion. Two-way analysis of variance (Group x Measure, 3 x 2) with repeated measures on the second factor was carried out to examine whether significant differences were presented among groups and time measures in each group separately. Furthermore, the Scheffe post-hoc test was applied whenever significant differences were found to locate the main effects. In addition, a multiple stepwise regression procedure was used to determine the amount of variance in cardiac index using age, body mass, resting heart rate and blood pressure as independent variables. The accepted level of significance was set at an alpha level of $p<.05$. In Figures, results are presented as means ± SE.

4. Results

The two-way ANOVA with repeated measures on the second factor (Group x Measure, 3 x 2) revealed a significant ($p=.002$) interaction effect between the factors of group (DS, NDS, Control group) and time point measurement (Baseline, 12-week) in overall anthropometric characteristics. Similarly, a significant interaction was observed in systolic [$F_{(2,43)}=5.48$, $p=.008$, $\eta^2=.203$] and diastolic blood pressure [$F_{(2,43)}=9.59$, $p=.000$, $\eta^2=.309$], in double product [$F_{(2,43)}=8.06$, $p=.001$, $\eta^2=.273$] and mean arterial pressure [$F_{(2,43)}=12.62$, $p=.000$, $\eta^2=.370$] as well as in the triglycerides [$F_{(2,43)}=18.61$, $p=.000$, $\eta^2=.464$] and HDL cholesterol [$F_{(2,43)}=6.28$, $p=.004$, $\eta^2=.226$]. Mean and standard deviation values at baseline and after the 12-week aerobic exercise training program were presented in Table 1 for each group separately.

4.1 Anthropometric characteristics

Body mass: Between the baseline and the 12-week of follow up measured values, body mass decreased -1.76 and -2.5% ($p<.001$) respectively in the DS and the NDS group (Table 1; Figure 1i), whereas it increased in the control group ($p>.05$). Both exercise groups presented significant differences as compared to control group after the 12-week intervention period (Figure 4i). In addition, the DS group had lower values and significant differences were observed between the DS and the NDS group [$F_{(2,45)}=5.51$, $p=.007$, $\eta^2=.204$] after training.

Body Mass Index (BMI): According to BMI, 32.6% of the participants characterized as overweight and 60.9% as obese (obesity type I: 37.0%, type II: 23.9%). No significant differences were observed in BMI values among groups (Table 1). However, BMI changed significantly after a 12-week aerobic exercise program (Figure 1ii) only for the training groups, while no changes was observed in the control group (Figure 4i).

Table 1. Mean, standard deviation and Δ% values at baseline and after a 12-week aerobic training program in anthropometric characteristics, cardiovascular function and lipids in each group separately.

Variables	Baseline	12 week	Δ%	*p*
Anthropometric characteristics				
Body mass (Kg)				
DS (n=14)	74.58±5.37	73.25±5.13	-1.76	.001
NDS (n=22)	89.58±14.29	87.29±13.68	-2.50	.001
Control (n=10)	80.48±16.39	80.80±16.09	+.46	NS
BMI (kg/m^2)				
DS (n=14)	31.40±4.51	30.84±4.39	-1.76	.001
NDS (n=22)	32.45±4.24	31.60±4.21	-2.63	.001
Control (n=10)	29.91±4.88	30.04±4.82	+.47	NS
Body Fat (%)				
DS (n=14)	30.02±9.55	29.82±9.75	-.85	NS
NDS (n=22)	36.42±7.55	35.38±7.11	-2.62	.05
Control (n=10)	32.70±10.92	32.88±11.02	+.56	NS
Waist circumference (cm)				
DS (n=14)	102.61±6.94	98.39±6.24	-4.07	.001
NDS (n=22)	104.64±12.09	101.07±11.26	-3.33	.001
Control (n=10)	97.73±12.20	99.62±12.39	+1.97	.05
Cardiovascular function				
Systolic pressure (mmHg)				
DS (n=14)	112.29±10.98	113.14±7.49	+1.16	NS
NDS (n=22)	124.23±15.29	117.59±10.40	-4.80	.001
Control (n=10)	108.00±13.88	108.90±10.36	+1.51	NS
Diastolic pressure (mmHg)				
DS (n=14)	71.43±8.76	73.21±5.57	+2.08	NS
NDS (n=22)	84.50±10.07	80.50±9.93	-4.50	.001
Control (n=10)	73.60±8.50	75.20±8.63	+1.93	NS
Mean arterial pressure (mmHg)				
DS (n=14)	85.04±7.81	86.57±5.13	+2.08	NS
NDS (n=22)	97.59±10.69	92.86±8.01	-4.50	.001
Control (n=10)	85.06±8.57	86.43±8.42	+1.93	NS
Cardiac Index (L/min/m^2)				
DS (n=14)	3.27±0.12	2.94±0.06	-8.32	.05
NDS (n=22)	3.20±0.12	2.99±0.11	-4.16	NS
Control (n=10)	3.36±0.13	3.19±0.10	-3.65	NS
Lipids				
Total Cholesterol (mg/dL)				
DS (n=14)	186.07±28.70	182.57±22.71	-1.41	NS
NDS (n=22)	211.32±32.39	208.81±26.35	-.64	NS
Control (n=10)	192.20±32.36	195.10±33.85	+1.48	NS
Triglycerides (mg/dL)				
DS (n=14)	88.38±31.46	85.15±18.96	-3.66	NS
NDS (n=22)	135.95±48.24	124.40±44.01	-8.39	.001
Control (n=10)	116.70±42.29	127.00±41.21	+11.82	.05
HDL-Cholesterol (mg/dL)				
DS (n=14)	46.86±5.85	50.35±5.48	+7.85	.001
NDS (n=22)	44.11±12.68	47.90±11.30	+10.47	.001
Control (n=10)	46.52±12.70	46.30±12.49	-.25	NS
LDL-Cholesterol (mg/dL)				
DS (n=14)	118.10±26.35	112.98±21.11	-3.13	NS
NDS (n=22)	140.09±31.15	135.54±25.53	-2.24	NS
Control (n=10)	122.48±30.04	123.00±29.78	+.73	NS

Note: DS: Down Syndrome, NDS: non-Down Syndrome, Control: Control group, NS: not significant

Body fat: Percentage of body fat in the DS group decreased from 30.02 to 29.82 (Δ%=-0.85, p>.05) and in the NDS group from 36.42 to 35.38 (Δ%=-2.62, p<.05; Figure 4i), whereas it remained unchanged in the control group (Table 1). In addition, no significant differences were observed among groups (Figure 1iii).

Waist circumference: After a 12-week aerobic training program, waist circumference decreased about -4.08 and -3.3% (p<.001) in the DS and the NDS group respectively (Figure 1iv), whereas it increased in the control group (+1.97, p<.05). Both exercise groups presented significant differences as compared to control group after a 12-week intervention program (Figure 4i).

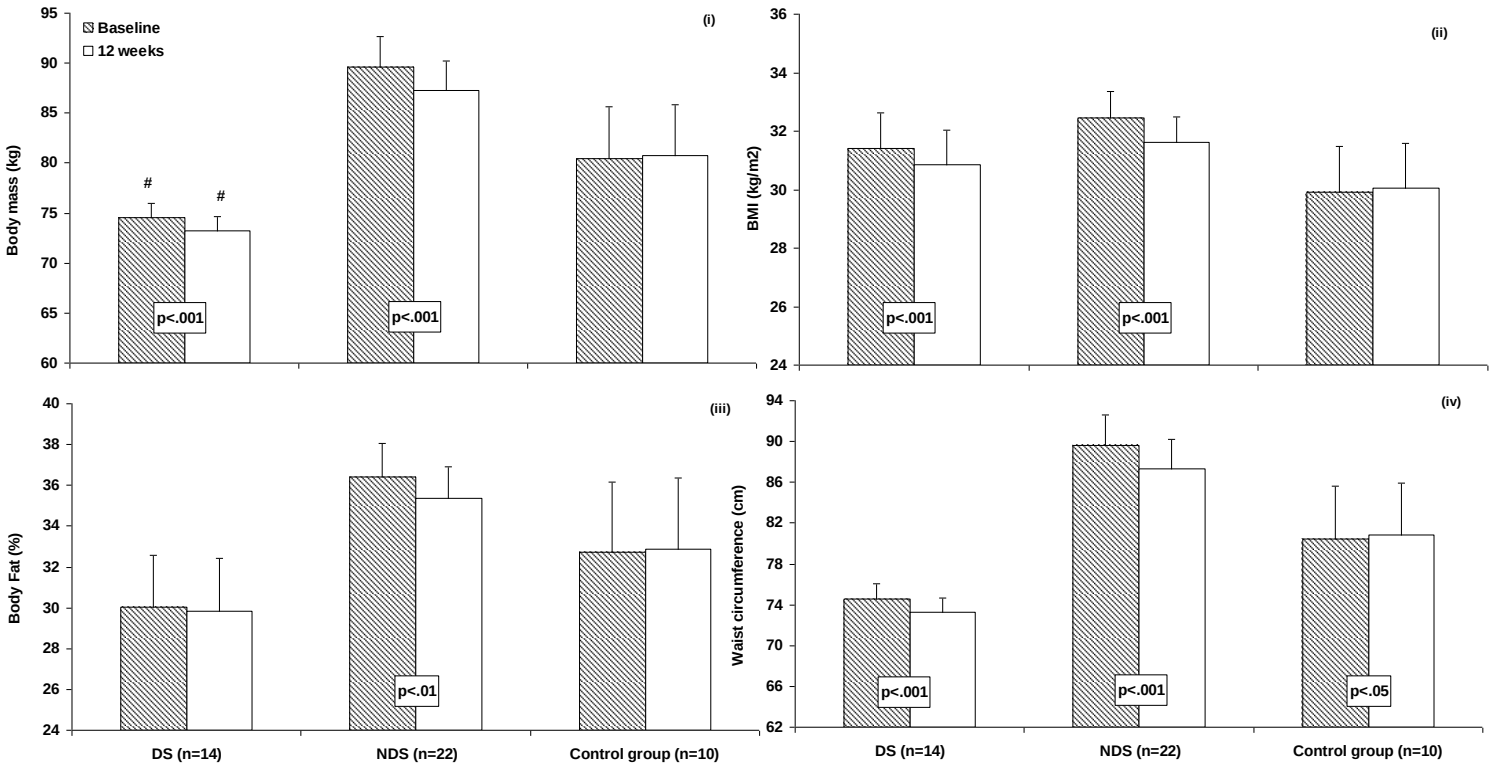


Figure 1. Mean±SE values of body mass (i), BMI index (ii), body fat (iii) and waist circumference (iv) at baseline and after a 12-week aerobic training program.
DS: Down Syndrome, NDS: non-Down Syndrome, SE: standard error
#: *p* <.05 significant differences from NDS group.

4.2 Cardiovascular function

Systolic and Diastolic Blood Pressure: No significant differences were observed between the baseline and the 12-week follow-up measured values in all groups (Figure 2). The NDS group decreased systolic blood pressure (-4.8%), while it increased in the control group (Figure 4ii). In addition, the NDS group reduced diastolic blood pressure after a 12-week aerobic exercise program (Figure 2ii). Moreover, significant differences were observed among groups [$F_{(2,43)}$=6.74, p=.003, η^2=.239] after the exercise

intervention program. In addition, the NDS group presented better values from the control ($p<.01$) and the DS group ($p<.05$; Figure 4ii).

Mean Arterial Pressure: Significant differences were observed among groups [$F_{(2,43)}=7.56$, $p=.002$, $\eta^2=.260$]. The DS group had lower values from the NDS group ($p<.01$) and the NDS group presented significant differences from the control group ($p<.05$). No significant differences were observed between baseline and a 12-week follow-up intervention program in all groups (Figure 4ii). However, the NDS group reduced diastolic blood pressure (-4.5%) in contrast with the DS and control group, which increased their values 2.08% and 1.93% respectively (Figure 4ii).

Cardiac Index: No significant differences were observed among groups [$F_{(2,43)}=.177$, $p=.838$, $\eta^2=.008$), (Figure 2iv). After a 12-week aerobic training program, cardiac index decreased in the DS group from 3.27 to 2.94 ($\Delta\%=-8.32$, $p<.05$). In addition, it decreased from 3.20 to 2.99 in the NDS group ($\Delta\%=-4.16$, $p>.05$), and in the control group from 3.36 to 3.19 ($\Delta\%=-3.65$, $p>.05$), (Figure 4ii).

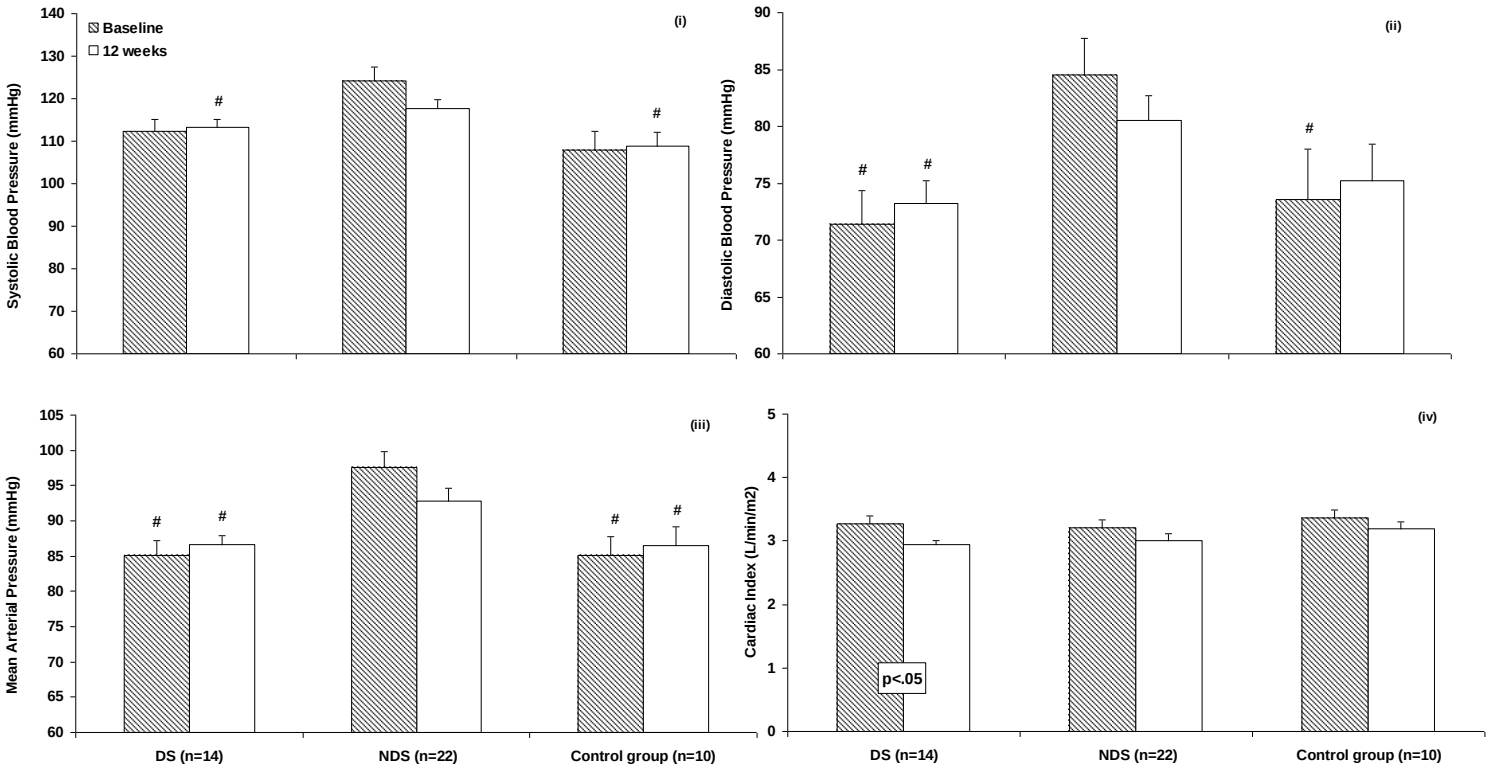


Figure 2. Mean±SE values of systolic (i), diastolic (ii) blood pressure, mean arterial pressure (iii) and cardiac index (iv) at baseline and after a 12-week aerobic training program.
DS: Down Syndrome, NDS: non-Down Syndrome, SE: standard error
#: *p* <.05 significant differences from NDS group.

4.3 ***Lipids***

Cholesterol: After a 12-week training intervention program, cholesterol decreased from 186.07 to 182.57 mg/dL (Δ%=-1.41%, p>.05) and 211.32 to 208.81 mg/dL (Δ%=-.64%, p>.05) in the DS and the NDS group respectively (Figure 3i), whereas it increased in the control group from 192.20 to 195.10 mg/dL (Δ%=+1.48, p>.05). However, no significant differences were observed among groups (Figure 4iii).

Triglycerides: Significant differences were observed between baseline and the 12-week follow-up values in all groups (Figure 3ii). The NDS group reduced triglyceride levels -8.39% (p<.01). A minor not significant reduction (p>.05) observed in the DS group. Moreover, triglyceride levels increased in the control group (Δ%=+11.82%, p<.05) (Figure 3ii). In addition, significant differences were observed at the post training period between the DS and the NDS group [$F_{(2,43)}$=4.99, p=.011, η^2=.192].

HDL-Cholesterol: After a 12-week exercise intervention program, the HDL-C increased from 46.86 to 50.35 mg/dL (Δ%=+7.85%, p<.001) in the DS group and from 44.11 to 47.90 mg/dL (Δ%=+10.47%, p<.001) in the NDS group (Figure 3iii), whereas it remained stable in the control group (Δ%=-.25, p>.05). In addition, both exercise training groups presented significant differences as compared to the control group after a 12-week aerobic training program (Figure 4iii).

LDL-Cholesterol: No significant differences were observed among groups [$F_{(2,43)}$=3.15, p=.053, η^2=.128]. After a 12-week intervention program, both exercise groups reduced LDL-cholesterol (NDS: -3.13%, & DS: -2.2%, p>.05) in contrast to the control group, which increased slightly their values (Figure 4ii).

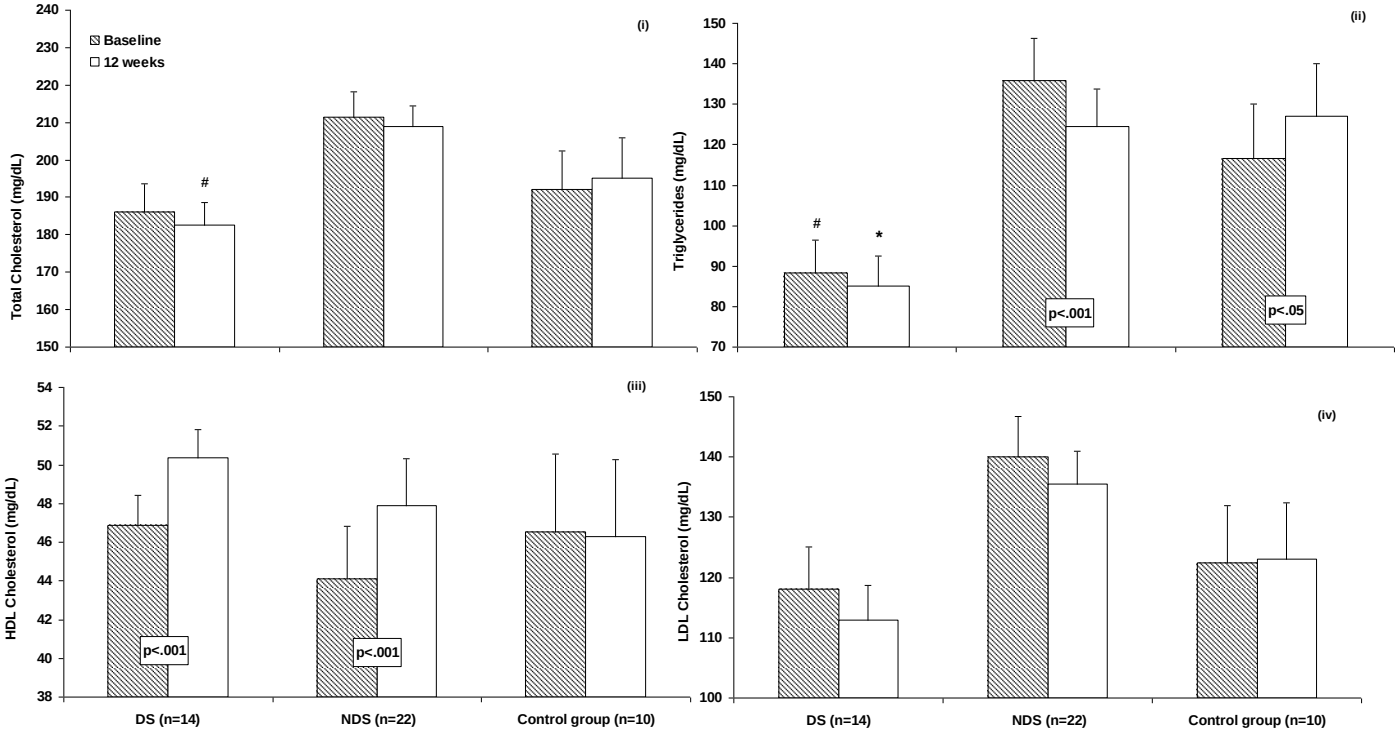


Figure 3. Mean±SE values of total cholesterol (i), triglycerides (ii), HDL cholesterol (iii) and LDL cholesterol (iv) at baseline and after a 12-week aerobic training program.
DS: Down Syndrome, NDS: non-Down Syndrome, SE: standard error
#: *p* <.05 significant differences from NDS group.

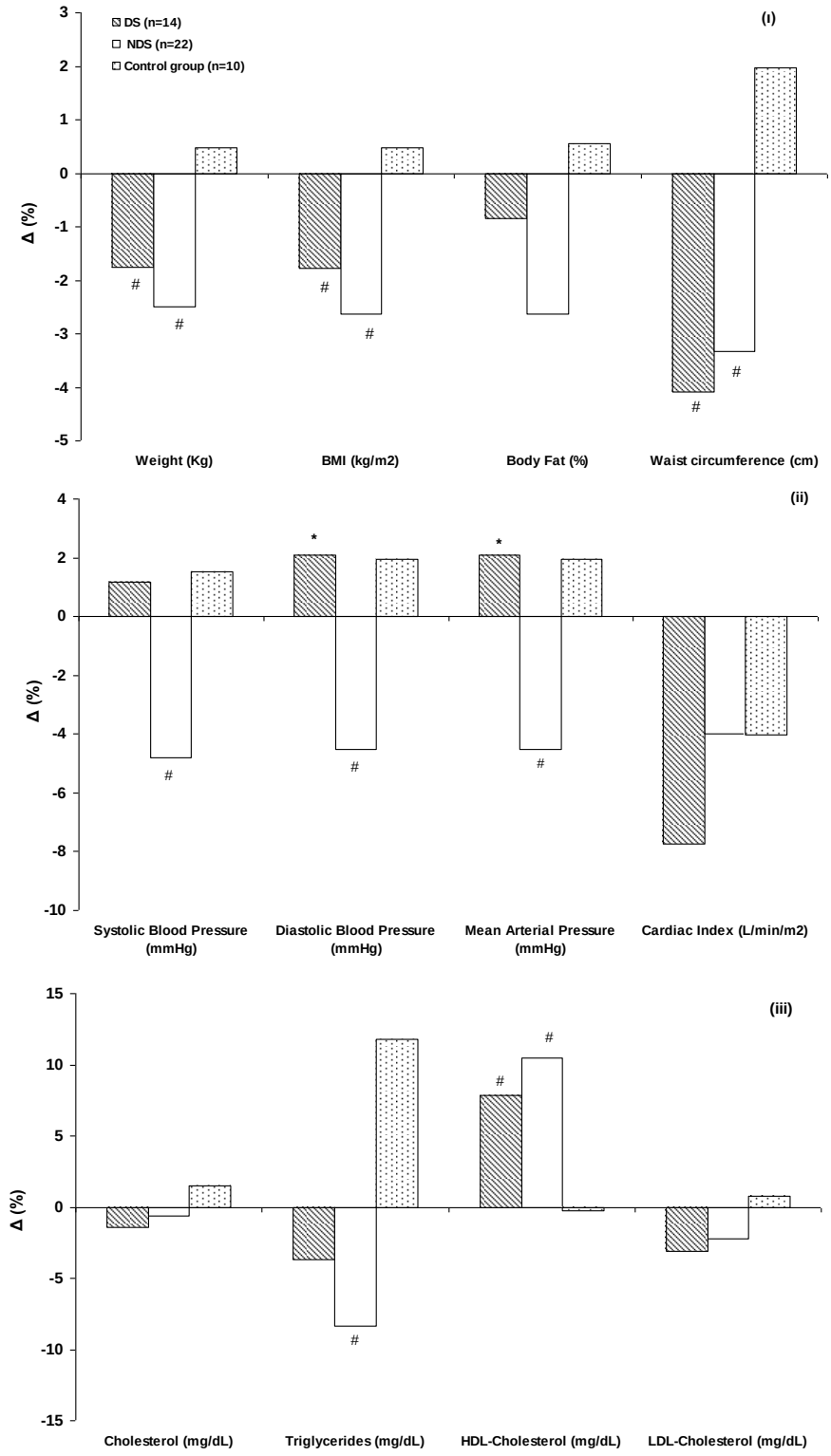


Figure 4. Δ% differences after a 12-week aerobic training program compared to baseline in anthropometric characteristics (i), cardiovascular function (ii) and lipid profile (iii).
DS: Down Syndrome, NDS: non-Down Syndrome.
#: p <.05 significant differences from control group.
*: p<.05 significant differences from NDS group.

4.5 Cardiac Index

A multiple stepwise regression model was used to determine the best predictors of cardiac index (Table 2). Thus, using the cardiac index as dependent variable (y=2.405-0.037*DP-0.018*Age+0.023*HR+0.019*SP-0.011*BM), the 98% of the total variance was explained by diastolic blood pressure (DP: 55.7%), age (A: 22.2%), resting heart rate (HR: 6.1%), systolic blood pressure (SP: 5.4%) and body mass (BM: 8.6%).

Table 2. Results of the multiple regression procedure using total sample data from five variables as predictors of cardiac index.

Model	Multiple R	R Square	B	β	t	p
DP (mmHg)	.746	.557	-.037	-.789	-31.495	.000
Age (yrs)	.883	.779	-.018	-.361	-14.932	.000
HRrest (bpm)	.917	.840	.023	.477	17.604	.000
SP (mmHg)	.946	.894	.019	.443	15.404	.000
Body Mass (Kg)	.990	.980	-.011	-.363	-13.208	.000

y = 2.405 - 0.037 *DP - 0.018*A + 0.023*HR + 0.019*SP - 0.011*BM

DP: Diastolic Pressure, SP: Systolic Pressure, A: Age, HR: Resting Heart Rate, BM: Body Mass

5. Discussion

The results of the present study demonstrate that a regular short-term aerobic exercise program can affect health-related indicators in individuals with intellectual disability with or without the Down syndrome. Our 12-week intervention training program significantly improved body mass, BMI, waist circumference, triglycerides, HDL-C and blood pressure. These are among the main risk factors which contribute to the prevalence of metabolic and circulatory abnormalities. In addition, the use of a multiple regression model revealed that the easy acquired measurements of body mass, blood pressure, resting heart rate and age can accurately evaluate the cardiac function of individuals with intellectual disability.

5.1 Training effects on anthropometric characteristics

It is well-established that among people with disabilities, obesity can lead to serious public health problems, mainly because of the few opportunities to access physical exercise programs, due to the major barriers to enter and remain in such programs (Barr, & Shields, 2011; Rimmer, Heller, Wang, & Valerio, 2004; Seron, Silva, & Greguol, 2014). However, a meta-analysis by Hamilton et al. (2007) pointed out that little weight loss exercise intervention research has been conducted, involving adults with intellectual disabilities, as compared with the general population research. Most studies focus on behavioral intervention for weight loss (Harris, & Steven, 1984; Fox, Rosenberg, & Rotatori, 1985; Marshall, McConkey, & Moore, 2003; McCarran, & Andrasik, 1990) whereas few studies discuss the contribution of physical activity and regular exercise to successful weight management in adults with intellectual disabilities (Podgorski, Kessler, Cacia, Peterson, & Henderson, 2004; Rimmer et al., 2004). In a

comparable design with our study Rimmer et al., (2004) recruited fifty-two adult with Down syndrome and after a 12-week physical activity intervention observed a decrease in body mass (from 80.5±20.0 to 79.5±19.9 kg) while the control group yielded an increased (from 76.8±18.1 to 78.5±17.9 kg).

The results of our study presented a significant reduction of body mass, body mass index and waist circumference in both training groups, with or without the Down syndrome. However, body fat percentage statistically decreased only in the group without the Down syndrome, probably due to the initial higher values, while a minor reduction was observed in the group with the Down syndrome. Most likely, this reduction would be higher and reach a significant level if the participants continued to exercise for a longer period of time. Better results, would also be observed, if training intervention applied in combination with a personalized diet plan. Nevertheless, the inactive lifestyle seems to affect the health status of people with intellectual disability with or without the Down syndrome (Dodd & Shields, 2005). However, it should be noted with emphasis that cardiovascular health and aerobic capacity can be promoted even if there is no any reduction in body weight due to aerobic exercise training program (Pommering, Brose, Randolph, Murray & Purdy, 1994). On the other hand, we chose not to interfere and modify the eating habits of our participants. Additionally, it has to be mentioned that our participants did not take any medication, although, people with similar health problems usually receive a variety of medicines (especially, antipsychotics or lipid-lowering treatment), which inhibits the weight loss and the improvement of aerobic capacity, as well.

5.2 Training alterations in systolic and diastolic blood pressure

The association between obesity and elevated blood pressure has been demonstrated by recent studies (Dorresteijn, Visseren & Spiering, 2012; Timpson et al., 2009). Each 5% weight gain is associated with 20-30% increased odds of hypertension (Droyvold, Midthjell, Nilsen & Holmen, 2005) while weight reduction results in blood pressure decrease (Neter, Stam, Kok, Grobbee & Geleijnse, 2003). Based on a meta-analysis, conducted by the American College of Sports Medicine (ACSM, 2010), it was observed that regular physical activity and exercise decreases systolic blood pressure by 6 mmHg and diastolic pressure by 5 mmHg. In our study, there was a similar reduction in blood pressure (systolic and diastolic) for the NDS group while the DS group presented a slighter increase. This interaction perhaps occurs due to the variability of the individual values of blood pressure as well as to their increased body mass index and obesity prior to our training intervention program. In addition, the NDS group was characterized by higher initial blood pressure values which were normalized after our 12-week aerobic training program. Indeed, after a closer look at the individual blood pressure data, we observed that the participants with initial lower diastolic pressure (<70 mm Hg) presented an increase, whereas the hypertensive participants (>140 mm Hg) showed a decrease. Thus, our exercise training program acted in the individuals of intellectual disability as a proper regulator towards the physiological blood pressure. Furthermore, the beneficial effects of regular exercise in hypertension are not limited only to the reduction of blood pressure. Exercise training may help the hypotensive individuals with the Down syndrome to up-regulate their blood pressure. Nevertheless, it is well known that regular aerobic exercise causes a reduction of the sympathetic tone with beneficial effects on heart rate, cardiac function and other metabolic abnormalities (Choudhury & Lip, 2005; Fagard, 2011; Thompson, 2003) such as high levels of triglycerides and low levels of HDL cholesterol which designates individuals at a high risk for developing cardiovascular disease (Mancia et al., 2013).

5.3 Training adaptations in lipids and lipoproteins

Our participants revealed significant increase in the high density lipoprotein (HDL) cholesterol levels in both exercise training groups after the 12-week intervention program despite the fact that this particular lipoprotein requires a long period of time and a significant life style modification in order to reach an optimal level. This positive alteration in HDL cholesterol, which protects cardiovascular function, was only observed in the individuals who followed our exercise training intervention (not in the control group). In addition, a decrease in total cholesterol and the low density lipoprotein (LDL) cholesterol levels, the harmful risk factors, were observed only in exercise groups, despite the fact that these individuals started with relatively low initial values. Another important observation of our study is the positive effect of aerobic exercise on triglyceride levels in both training groups. In contrast, the persons of the control group, with or without the Down syndrome, had a significant increase, in this risk factor, mainly because of the lack of exercise in combination with their eating habits.

In fact, the non-controlling eating may be considered as a limitation of our study, since all the individuals participated without any modification of their eating habits. Nevertheless, when we planned the design our study we decided to examine the real effects of exercise training in our participants of intellectual disability (with or without the Down syndrome) without any interference in their daily eating. However, research findings indicate that many adults with intellectual disabilities do not meet the criteria for a balanced diet and consistent nutritional impairment (Bertoli, 2006; Hamilton et al., 2007; Robertson et al., 2000). Nevertheless, it is believed that eating habits, sedentary lifestyle and decreased levels of physical fitness of people with the Down syndrome increase their risk of health problems (Dodd & Shields, 2005).

5.4 Health-related strategies and cardiac function

It is necessary to create health-promotion strategies and give the opportunity to individuals with intellectual disability, with or without the Down syndrome, to participate in various exercise programs and increase their physical activity in a convenient setting. People with intellectual disability need close supervision and constant reinforcement (Millar, Fernhall & Burkett, 1993) in order to exercise in a safe and effective way at the required intensity and duration. Indeed, supervision and motivation is considered to be an integral part of cardiovascular exercise programs (Hutzler & Korsensky, 2010). The present study conducted in the environment of the institution and the only requirement was a trained physical educator specialized to work with people with intellectual disability. To stress the point further, even the working personnel in an institution can properly run a program using the facilities of the institution (stairs, treadmills or other apparatus) and the ACSM guidelines after following a seminar for exercise training to persons with or without the Down syndrome.

Furthermore, it is important to create practical tools in order to evaluate the functional ability of these individuals. Such a tool may be the indirect estimation of cardiac function (Klabunde, 2011) using practical measurements such as age, body mass, heart rate and blood pressure. Thus, taking into consideration the measurements of our participants we run a stepwise regression analysis searching for a formula to predict cardiac function in individuals with intellectual disability. Looking forward to health promotion in this population we feed our post-training data to the stepwise multiple regression models. The model we have adopted yielded the highest prediction for cardiac function (98% of the total variance) using only practical measures such as body mass, blood pressure, resting heart rate and age (Table 2). This model does not require complex laboratory equipment, it is easy to apply for field measurements, and it can be used as a useful, safe and effective tool for the assessment of cardiac function before

and after an exercise regime. We have to acknowledge, however, that the high prediction equation obtained from the stepwise regression model using the sample of the present study requires a larger sample size which is not easy to acquire with a special population such as the people with intellectual disability.

5.5 Limitations of the study

A small number of people with intellectual disability participated in the present study. Therefore, our results cannot be generalized for the entire population of persons with mental impairment. In addition, the limited sample of participants, also limits the validity of the model, when it is applied outside the range of our sample. Furthermore, aerobic workout is related with the conscious effort of the participants. However, it is always possible for people with intellectual disability to exert less effort than they actually can. In order to diminish this risk we used the validated exercise protocol and the accepted criteria introduced by the ACSM guidelines. Additionally, multiple motivational strategies were utilized in the intervention exercise program including visual, verbal and physical reinforcement in order to achieve the intended outcome.

6. Conclusion

The findings of the present study indicate that regular aerobic exercise optimizes blood lipid profile and hemodynamic parameters and at the same time contributes notably to the reduction of obesity rates without any modification in eating habits. In our study, no negative effects were observed due to the exercise protocol (muscle and joint injuries, undesirable chronotropic response, abnormal increase of blood pressure and heart rate or a sense of excessive fatigue). Our participants gladly followed the training program without any complaints concerning the difficulty of the exercise protocol. This study suggests that regular aerobic exercise contributes considerably to health promotion by reducing obesity rates, optimizing hemodynamic characteristics and circulated blood lipid concentrations, and thus improving cardiovascular health and function in people with intellectual disability with or without the co-existence of the Down syndrome. High morbidity and mortality rates which characterize people with intellectual disability may be reduced by increasing physical activity. Walking on an electric treadmill is a pleasant, familiar exercise for every person, regardless of mental status, age or aerobic fitness. Regular aerobic activity that conforms to the ACSM guidelines for individuals with intellectual impairment can significantly improve various health parameters and safely promote functional capacity and quality of life.

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