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Physical activity and cardiorespiratory fitness in adolescents with Down syndrome

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Abstract

Aims: **To determine if adolescents with and without Down syndrome (DS) accomplish the physical activity (PA) guidelines and to evaluate relationships between PA and cardiorespiratory variables.**

Methods: **42 adolescents (27 with DS) participated in this study. PA was measured using accelerometers. Walking-graded treadmill protocol with a breath-by-breath gas analyzer was employed to assess cardiorespiratory fitness.**

Results: **Adolescents with DS spent less time in sedentary PA, moderate PA (MPA), vigorous PA (VPA) and moderate to vigorous PA (MVPA) than those without DS. VO_{2peak} was correlated with total minutes spent in light PA, MPA, VPA and MVPA in the control group (from r = 0.55 to r = 0.61, $p < 0.05$) and with MPA and MVPA in the DS group (from r = 0.38 to r = 0.41, $p < 0.05$).**

Conclusion: **Nor DS neither control groups achieved at least 60 minutes of MPA daily. Engaging more time in MPA was associated with greater cardiorespiratory fitness in adolescents with DS.**

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Key words: *Accelerometry. Down syndrome. Physical activity. Cardiorespiratory fitness.*

ACTIVIDAD FÍSICA Y ESTADO DE FORMA CARDIOVASCULAR EN ADOLESCENTES CON SÍNDROME DE DOWN

Resumen

Objetivos: **Comprobar si los adolescentes con síndrome de Down (SD) cumplen las guías de actividad física (AF) y evaluar la relación entre AF y la condición cardiorrespiratoria.**

Métodos: **42 adolescentes (27 con SD) participaron en este estudio. La AF se midió usando acelerometría. La condición cardiorrespiratoria se evaluó mediante ergoespirometría en tapiz rodante con un protocolo progresivo continuo.**

Resultados: **Los adolescentes con SD pasaron menos tiempo en AF sedentaria, moderada (MAF), vigorosa (VAF) y moderada-vigorosa (MVAF) que los adolescentes sin SD. El VO_{2peak} mostró correlación con minutos totales en AF ligera, MAF, VAF y MVAF en el grupo control (desde r = 0,55 hasta r = 0,61, $p < 0,05$) y con MAF y VAF en el grupo de adolescentes con SD (desde r = 0,38 hasta r = 0,41, $p < 0,05$).**

Conclusión: **Ningún grupo alcanzó 60 minutos de MAF diaria. La capacidad cardiorrespiratoria en adolescentes con SD se asoció con una mayor participación en MAF.**

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Palabras clave: *Acelerometría. Síndrome de Down. Actividad física. Capacidad cardiorrespiratoria.*

Introduction

Physical inactivity and sedentarism are risk factors associated with the development of obesity and have also been linked to type 2 diabetes, stroke, cardiovascular diseases, and some cancers.[1,2] Children and adolescents with Down syndrome (DS) have been shown as less active[3] and with higher prevalence of overweight and obesity[4] than those without DS but the information regarding physical activity (PA) in adolescents with DS is few and inconclusive.[5]

Current recommendations on PA such as: *The Physical Activity Guidelines for Americans*[6] and the *UK Chief Medical Officers*[7] recommend that children and adolescents engage in at least 60 min of daily moderate PA (MPA) to achieve health-related benefits. Previous studies[8-10] in DS populations show no conclusive results in relation to the levels of PA, and

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no research has been focused on Spanish adolescents with DS. Furthermore, no specific PA guidelines for adolescents with DS which take into account the impairment of this population such as muscle hypotonicity, low cardiovascular fitness and decreased muscle strength[11] have been developed.

It is well known that cardiorespiratory fitness during adolescence has a strong association with present and future health and cardiovascular diseases.[12] Previous studies have shown that individuals with DS have lower levels of cardiovascular fitness compared with their peers without DS;[13] however, the relationship between cardiorespiratory factors and PA remains unknown in this determined population.

Therefore, the aims of this study were: (1) to determine if adolescents with DS accomplish the PA guidelines for health objectively assessed comparing their PA patterns with adolescents without disabilities; (2) to test the relationship between PA levels and cardiovascular fitness in adolescents with DS.

Methods

Participants

A total sample of 27 adolescents with DS (13 girls/ 14 boys; aged 10 to18 years) living at home, were recruited from different special schools and institutions within the region of Aragon in Spain. A control group composed of 15 adolescents (8 girls/7 boys) without any disability was also recruited from regular schools in the same region. Both parents and children were informed about the aims and procedures of the study, as well as the possible risks and benefits, and then, a letter of written informed consent was obtained from all the included subjects and their parents or guardians. The study was performed in accordance with the Helsinki Declaration 1961 (revised in Edinburgh, 2000) and was approved by the Research Ethics Committee of the Government of Aragon (CEICA, Spain).

Anthropometry

All participants were measured with a stadiometer without shoes and minimum clothing to the nearest 0.1 cm (SECA 225, SECA, Hamburg, Germany) and weighted to the nearest 0.1 kg (SECA 861, SECA, Hamburg, Germany). The body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2).

Physical activity assessment

PA was measured using the ActiTrainer uniaxial accelerometer (Actigraph, LLC, Pensacola, FL, USA). The monitor was set to record PA in a 15 epoch which was selected on the basis of literature related to the erratic and sudden bursts of activity common to youth.[14] Adolescents wore the accelerometer for seven consecutive days and was worn above the hip and fitted with an elastic waistband. Instructions were given to the participants and carers both verbally and in writing on how to wear the accelerometer during all waking hours except while bathing, showering and swimming. To be included in the study, participants had to wear the accelerometer for a minimum of 8 hours per day, for at least 6 days.[15] Minutes and percentage of valid time in sedentary, light (LPA), moderate (MPA), vigorous (VPA), and moderate to vigorous PA (MVPA) intensities were calculated from the raw data obtained from the accelerometer. The cut-offs proposed by Sirard et al.[16] were used to establish intensities. We also calculated time of bouts (bout = period of at least 5 min of consecutive MPA) and number of bouts.

Cardiovascular fitness assessment

Previous to maximal testing, an experienced cardiologist examined each participant, giving permission to participate in the study. Participants were familiarized with the laboratory and testing protocols prior to any data collection. Data collection started when participants were able to easily walk on the treadmill (Quasar Med 4.0, h/p/cosmos, Nussdorf-Traunstein, Germany) with the mask fitted. A walking-graded protocol was employed to assess cardiovascular fitness. Starting at a comfortable walking pace for each participant (2.4 or 3.2 $km.h^{-1}$), speed was increased by 0.8 $km.h^{-1}$ every 2 min until participants were not able to walk without running (4.8 or 5.6 $km.h^{-1}$). Then the grade was increased 4% every minute until exhaustion (until a maximum of 24%). A medical doctor, specialist in sports medicine, supervised the whole test, and also examined the participants prior exercising.

Respiratory gas-exchange data were measured "*breath-by-breath*" using an open circuit spirometry (Oxycon Pro, Jaeger/Viasys Healthcare, Hoechberg, Germany). Peak values of oxygen uptake (VO_{2peak}), are recorded as the highest average values obtained for any continuous 30 s period. The metabolic cart was calibrated with a known gas and volume prior to the first test each day as recommended by the manufacturer. Electrocardiogram (ECG) was used to record heart rate, utilizing a 12-lead system before, and during the whole test. The maximal value of heart rate (HR_{max}) was the highest value of heart rate recorded during the last stage of exercise.

Statistical analyses

All analyses were performed using the Statistical Package for the Social Sciences (SPSS 15.0 for

Table I
Descriptive data for participants

	Down syndrome			*Control*		
	All (n = 27)	*Female (n = 13)*	*Male (n = 14)*	*All (n = 15)*	*Female (n = 8)*	*Male (n = 7)*
Age (years)	16.2* ± 2.9	15.8 ± 3.2	16.5 ± 2.7	13.6 ± 3.0	13.3 ± 3.1	14.0 ± 3.1
Weight (kg)	48.8 ± 12.2	46.1 ± 12.5	51.2 ± 11.9	50.4 ± 15.1	47.3 ± 13.2	54.0 ± 17.4
Height (cm)	147.1* ± 11.3	141.3# ± 9.6	152.4 ± 10.4	156.0 ± 14.5	150.3 ± 10.8	162.6 ± 16.2
Body mass index (kg/m²)	22.2 ± 3.6	22.7 ± 4.1	21.8 ± 3.1	20.3 ± 3.6	20.7 ± 3.9	19.9 ± 3.5
VO_{2max} (mL/kg/min)	35.5* ± 6.4	33.6 ± 7.4	37.3 ± 4.9	43.1 ± 5.0	40.8# ± 5.8	45.8 ± 1.9
HR_{max}	170.9* ± 13.3	166.5 ± 16.4	175.1 ± 8.1	191.2 ± 7.8	190.1 ± 8.8	192.5 ± 7.0

*p ≤ 0.05 between groups.
#p ≤ 0.05 between sexes within the same group.

Windows; SPSS Inc, Chicago, IL) and significance was set at p ≤ 0.05.

Mean and standard deviation were used to describe the characteristics of the participants and PA patterns among groups. All variables included in the study showed normal distribution, assessed by Kolmogorov-Smirnov tests. Differences between groups (with and without DS) separately by genders and between genders within each group were established for age, height, weight and BMI using Student s unpaired t-tests. Analyses of covariance (ANCOVA) were performed to evaluate differences between groups in the variables obtained from the accelerometer, using age as covariate. Partial correlations adjusted for age were applied to identify possible relationships between minutes of time spent in different PA intensities and cardiovascular parameters (VO_{2peak} and HR_{max}).

Results

Physical characteristics and cardiovascular fitness

Age, physical characteristics and cardiovascular parameters of the participants are summarized in table I. In general, participants with DS were older and smaller than those without DS (all p ≤ 0.05). No differences in weight and BMI were observed between groups or between genders within the same group. Within DS group, females were smaller than males; however, no differences were found between genders in the control group.

Differences in VO_{2peak} and HR_{max} were observed between groups. Within control group, females showed lower VO_{2peak} than males; no differences in HR_{max} were found between genders. In DS group, no differences in any cardiovascular parameters were found between genders.

Physical activity recommendations

Following the recommendations stated above[6,7] none of the two groups achieved the minimum of 60 minutes of MPA daily.

Physical activity

Significant differences between adolescents with and without DS regarding PA patterns were observed; those with DS engaged significantly less minutes in sedentary PA, MPA, VPA and MVPA than their counterparts without DS (all $p < 0.05$; fig. 1). However, adolescents with DS engaged more minutes in LPA (all $p \leq 0.05$; fig. 1). Moreover, less total counts, time and number of bouts, and steps were observed in the DS group compared with control group (all $p \leq 0.05$; data not shown).

Correlations PA-Cardiovascular fitness

In the control group, VO_{2peak} was correlated with minutes spent in LPA, MPA, VPA and MVPA (*r* =

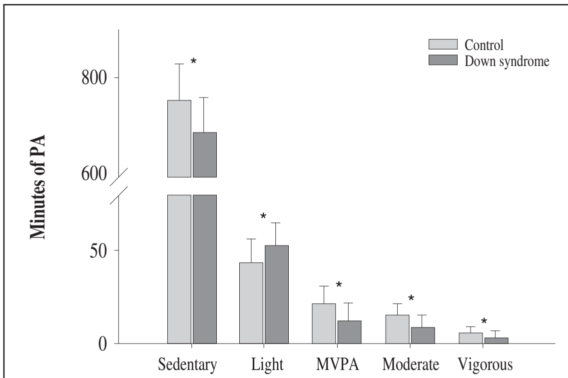

*Fig. 1.—Age-adjusted total minutes of PA for adolescents with and without DS; * p ≤ 0.05.*

0.55; 0.57; 0.61 and 0.61 respectively; all $p \leq 0.05$; data not shown). In the DS group, VO_{2peak} was correlated with minutes spent in MPA and MVPA ($r = 0.41$ and $r = 0.38$; both $p \leq 0.05$; data not shown); in addition, HR_{max} was correlated with minutes spent in MVPA ($r = 0.38$; $p \leq 0.05$; data not shown).

Discussion and conclusion

This study provides data on objectively measured PA and thereby provides valuable information about the PA levels and its relationship with cardiorespiratory fitness of adolescents with and without DS.

Different PA patterns were found between adolescents with and without DS in this study. Adolescents with DS presented higher levels of LPA and lower sedentary PA, MPA and VPA than adolescents without DS. To our knowledge, it is the first time that these results are found. Data in DS population are scarce and dissimilar.

Phillips et al.[8] showed that individuals with DS spend more sedentary time than those without DS. In contrast, similar levels of sedentary, LPA and MPA in children with and without DS were registered in the study performed by Whitt-Glover et al.[10] In our study, adolescents with DS engaged less minutes in MPA and MVPA than those without. A possible explanation could be the age difference, being our study focused on adolescents and the previous in children. This is in concordance with previous results where adolescents with DS aged 14 to 15 were more sedentary and spent less time in MVPA compared with children with DS.[9] Caution is needed when making comparison between studies as they differ in accelerometer models and cut-offs used. Neither of the previous studies used the same model of accelerometer or equal cut-off points. It would be, therefore interesting to establish specific cut-offs for population with DS.

Following another guidelines,[17] Whitt-Glover found that most children with DS exceeded the guidelines of PA.[10] However, following the guidelines stated above (children and adolescents should perform at least 60 minutes of MPA daily);[6,7] in our study, none of the two groups achieved these recommendations (DS 9.2 min, control 15.4 min) nor the recommended 30-min of MPA either. Other studies found similar results.[8,9]

In this study VO_{2peak} showed moderate correlations with total minutes in LPA, MPA, VPA and MVPA in the control group. In the DS group, HR_{max} was only correlated with total minutes of MVPA. At the same time, moderate correlations between VO_{2peak}, MPA and MVPA were observed in the DS group and no correlations were found between VO_{2peak} and minutes spent in LPA or VPA. It could be due to the low time spent in vigorous intensity activities (with Sirard cut-offs) by adolescents with DS. It might be also thought that this cut-offs are not the most appropriate for children with DS as they have worse walking economy and a lower physical fitness.

Thereby, strategies aiming to increase MPA in adolescents with DS should be promoted as they may be at higher risk of developing diseases associated with physical inactivity such as osteoporosis or metabolic syndrome.[11] In addition, we could speculate that these strategies could improve cardiovascular fitness in adolescents with DS, being this fact relevant for reducing future cardiovascular diseases.

There are some potential limitations to this study that warrant consideration. Firstly, the cut-offs that were used to define the intensity of PA were generated to study preschool children without disabilities and may over- or under-estimate intensity of PA among adolescents with DS. Despite both groups was made up of adolescents, the age difference between groups was significant. Also the number of participants might be limiting the statistical power of the analyses.

In conclusion, nor DS neither control groups achieved the recommended 60 minutes of MPA daily. Different PA patterns were found between DS and control groups. Adolescents with DS engaged less time in sedentary PA, MPA, MVPA and VPA than their counterparts without DS but they achieved more minutes in LPA. Engaging more time in MPA and MVPA is associated with greater cardiorespiratory fitness in adolescents with DS.

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References

1. Gómez-Cabello A, Vicente-Rodriguez G, Pindado M, et al. [Increased risk of obesity and central obesity in sedentary postmenopausal women]. *Nutr Hosp* 2012; 27 (3): 865-70.
2. U.S. Department of Health and Human Services. Healthy people 2010: Physical activity and fitness. 2002.
3. Sharav T, Bowman T. Dietary practices, physical activity, and body-mass index in a selected population of Down syndrome children and their siblings. *Clin Pediatr (Phila)* 1992; 31 (6): 341-4.

4. Soler Marin A, Xandri Graupera JM. Nutritional status of intellectual disabled persons with Down syndrome. *Nutr Hosp* 2011; 26 (5): 1059-66.
5. Frey GC, Stanish HI, Temple VA. Physical activity of youth with intellectual disability: review and research agenda. *Adapt Phys Activ Q* 2008; 25 (2): 95-117.
6. US Department of Health and Human Services. 2008 Physical Activity Guidelines for Americans. Washington (DC), 2008.
7. Department of Health. Stay active, stay active: A report on physical activity from the four home countries Chief Medical Officers. London, 2011.
8. Phillips AC, Holland AJ. Assessment of objectively measured physical activity levels in individuals with intellectual disabilities with and without Down's syndrome. *PLoS One* 2011; 6 (12): e28618.
9. Esposito PE, Macdonald M, Hornyak JE et al. Physical activity patterns of youth with down syndrome. *Intellect Dev Disabil* 2012; 50 (2): 109-19.
10. Whitt-Glover MC, O'Neill KL, Stettler N. Physical activity patterns in children with and without Down syndrome. *Pediatr Rehabil* 2006; 9 (2): 158-64.
11. González-Aguero A, Vicente-Rodriguez G, Moreno LA et al. Health-related physical fitness in children and adolescents with Down syndrome and response to training. *Scand J Med Sci Sports* 2010; 20 (5): 716-24.
12. Ortega FB, Ruiz JR, Castillo MJ, et al. Physical fitness in childhood and adolescence: a powerful marker of health. *Int J Obes (Lond)* 2008; 32 (1): 1-11.
13. Baynard T, Pitetti KH, Guerra M et al. Age-related changes in aerobic capacity in individuals with mental retardation: a 20-yr review. *Med Sci Sports Exerc* 2008; 40 (11): 1984-9.
14. Pfeiffer KA, McIver KL, Dowda M et al. Validation and calibration of the Actical accelerometer in preschool children. *Med Sci Sports Exerc* 2006; 38 (1): 152-7.
15. Trost SG, Pate RR, Freedson PS et al. Using objective physical activity measures with youth: how many days of monitoring are needed? *Med Sci Sports Exerc* 2000; 32 (2): 426-31.
16. Sirard J, Trost S, Pfeiffer K, et al. Calibration and Evaluation of an Objective Measure of Physical Activity in Preschool Children. *J Phys Activity Health* 2005; 2 (3): 345-57.
17. Twisk JW. Physical activity guidelines for children and adolescents: a critical review. *Sports Med* 2001; 31 (8): 617-27.