Facultat de Psicologia, Ciències
de l'Educació i de l'Esport Blanquerna
Universitat Ramon Llull

TESIS DOCTORAL

Valoración funcional y niveles de actividad física en personas con discapacidad intelectual; efectos de un programa de actividad física aeróbico, de fuerza y equilibrio

Guillermo Ruben Oviedo

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y en el **Departamento de Ciencias de la Actividad Física y del Deporte**

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DEPARTMENT OF PHYSICAL ACTIVITY AND SPORT SCIENCES

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UNIVERSITAT RAMON LLULL

FUNCTIONAL EVALUATION AND PHYSICAL ACTIVITY LEVELS IN PEOPLE WITH INTELLECTUAL DISABILITY; EFFECT OF AN AEROBIC, STRENGTH AND BALANCE PHYSICAL ACTIVITY PROGRAM

INTERNATIONAL PhD

Thesis presented by:

Guillermo Ruben Oviedo

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Dr. Miriam Guerra Balic

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“La ciencia es una de las formas más elevadas del quehacer espiritual pues está ligada a la actividad creadora del intelecto, forma suprema de nuestra creación humana”.
René Gerónimo Favaloro (1923-2000)

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GLOSSARY OF ABBREVIATIONS AND ACRONYMS

6MWT	six-minute walk test
AAIDD	American Association on Intellectual and Developmental Disabilities
APD	antero-posterior displacement
ATS	American Thoracic Society
BMI	body mass index
BP	blood pressure
CG	control group
cm	centimeter
COP	center of pressure
CPAP	combined physical activity program
CRF	cardiorespiratory fitness
CVD	cardiovascular disease
CVR	cardiovascular risk factors
DBP	diastolic blood pressure
DEE	daily energy expenditure
DS	Down syndrome
EE	energy expenditure
$ERCO_2$	ventilatory equivalent ratio for carbon dioxide
ERO_2	ventilatory equivalent ratio for oxygen
FEAPS	Confederación Española de Organizaciones en favor de las Personas con Discapacidad Intelectual
$FeCO_2$	fraction of carbon dioxide in the expired air
FeO_2	fraction of oxygen in the expired air
FSRT	functional shoulder rotation test

g	gram
HR	heart rate
HR max	maximum heart rate
HR peak	peak heart rate
HRR	heart rate reserve
%HRmax	percent of maximal heart rate
ICC	intraclass correlation coefficient
ICF	International Classification of Functioning, Disability and Health
ID	intellectual disability
IG	intervention group
INE	Instituto Nacional de Estadística
Kg	kilogram
L	liters
LPA	light physical activity
m	meters
MET	Metabolic Equivalent of Task
MH	mental health
Min	minute
Mins	minutes
ml	milliliter
mmHg	millimeters of mercury
MLD	mediolateral displacement
MPA	moderate physical activity
MR	mental retardation
MS	metabolic syndrome

MVPA	moderate to vigorous physical activity
NHANES	National Health and Nutritional Examination Survey
PA	physical activity
PE	physical exercise
$PETCO_2$	end-tidal partial pressure of carbon dioxide
$PETO_2$	end-tidal partial pressure of oxygen
PMCC	primary medical care center
RA	radial area
RER	respiratory exchange ratio
SBP	systolic blood pressure
SLJT	standing long jump test
SLST	single leg stand test
SRT	sit and reach test
ST	sedentary time
SV	stroke volume
TTD	total travel distance
VJT	vertical jump test
VM	vector magnitude
VO_2	oxygen consumption
VO_2 max	maximal oxygen consumption
VO_2 peak	peak oxygen consumption
%VO_2max	percent of maximal oxygen uptake
VO_2R	maximal oxygen uptake reserve
VPA	vigorous physical activity
WC	waist circumference

WHO	World Health Organization

1. INTRODUCTION

1.1 Introduction

The present PhD thesis and the data analyzed, belong to the following research project: *“Effectiveness of physical activity on fitness, cognition and quality of life related to health in adults and older adults with Intellectual Disabilities”*

This project of 3 years long, which its principal investigator has been Dr. Miriam Guerra Balic, has been supported by the Ministerio de Economía y Competitividad de España (I+D+i Ref: DEP2012-35335). The project has been developed in collaboration with the Fundación Ramon Noguera (Girona), the Asociación Esport 3 and the Laboratorio de Ciencias Fisiológicas II of the Universidad de Barcelona.

In this project, where participants were persons with intellectual disabilities (ID) recruited from a workshop in Girona (Spain), the benefits of regular Physical Activity (PA) on health status of these individuals have been studied.

Gradually in our society, it has been scientifically demonstrated and stated that the inclusion of PA is one of the principal components in healthy life style, and it is beneficial for health (American College of Sports Medicine, 2011; U.S. Department of Health and Human Services, 2008; World Health Organization, 2010). Moreover, the WHO (2010) recognizes that physical inactivity is the fourth most important risk factor of mortality in the world (6% of deceases in a worldwide level). The physical inactivity is very much spread in many countries, and it considerably affects the general health in the world population, especially in non transmissible diseases prevalence and its risk factors.

It is estimated that in Spain there are almost 300,000 people with ID, as the general population, they have their needs, capacities and particular enjoyment. So, they would like to achieve several things in their lives but they would need several supports, too (FEAPS, n.d.).

Moreover, it is known that physical fitness and PA levels are related to daily functioning in these individuals.

Adults with ID, whether living at home or in a structured residential setting, must have social support of family or staff to take part in different PA programs and maintain a physically active lifestyle. Typically, PA programs are not readily available for people with ID. These people, that often refuse to participate or don't have enough support to do it, usually perform very low PA and if so, their intensities are very low, too (Hilgenkamp, van Wijck, Evenhuis, & Wijck, 2012; Mendonca, Pereira, & Fernhall, 2010; Messent, Cooke, & Long, 1999; Temple, Frey, & Stanish, 2006; Temple, 2007). It is necessary to take into account that the limitations to be physically active is a potential risk factor related to chronic diseases, and in the case of persons with ID, the probability to present these chronic diseases is still greater (Dixon-Ibarra & Horner-Johnson, 2014).

The present study is also based on the new conception about ID which considers it as "a disability characterized by significant limitations, both in intellectual functioning and in adaptive behavior, which covers many everyday social and practical skills", according to the American Association on Intellectual and Developmental Disabilities (2010). In this new vision of the ID, the mediation paper of the supports is a key in the promotion of healthy habits and PA performance, elements that will allow improving the health and quality of life in persons with ID.

That is why in our study we consider several evaluations as well as an intervention with an adapted PA program where we have worked with different components of fitness related to health.

During the study development, and thanks to the collaboration of the different participant centers and institutions, we had the necessary supports in order to obtain a comfortable environment that could make easier perform all the proposed activities, independently to the ID.

To evaluate the fitness level and the time used for PA at moderate and vigorous intensities, there were applied several tests at the beginning of the study before the PA program, which included aerobic, strength and balance components that were trained simultaneously. At the same time, there were objectively evaluated through the same previous fitness tests, the changes that could appear after the intervention and that could affect aspects related to sedentary lifestyle, PA levels and energy expenses in this subjects. After 14 week training, a new evaluation was performed using the same fitness tests to analyze the expected changes.

1.2 PhD Thesis structure

This thesis is divided in seven parts: **Introduction**, which explains and justifies the present study. **Literature review**, where different issues involved in the present thesis are presented. Here the definition of intellectual disability and estimates population with intellectual disabilities in Spain and Catalonia are explained. Risk factors that affect these people, physical activity levels, studies where different physical activity programs were implemented and their effects on physical fitness are presented. Finally, the different tests used to assess fitness in people with ID are analyzed. **Aims and hypothesis**, where objectives and hypothesis based on the literature review are presented. **Material and methods**, where equipment, protocols and procedures are described as well as the field and laboratory tests used. Next, the **results** of the different tests are presented. **Discussion** about main findings obtained from this work and its limitations. Finally, **conclusions** with the most relevant results from this thesis and future research directions are presented.

2. LITERATURE REVIEW

2.1. Intellectual Disability

2.2 Intellectual Disability in Spain and Catalonia

2.3. Intellectual Disability and health-related risk factors

2.4. Physical Activity

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2.1 Intellectual Disability

The American Association on Intellectual and Developmental Disabilities (AAIDD) since 2010 defines ID as follows: "Intellectual disability is a disability characterized by significant limitations in both intellectual functioning and maladaptive behavior, which covers many everyday social and practical skills. This disability originates before the age of 18". So, it means a limitation in the individual abilities for persons to learn how to function during daily life and that allows responding in several situations and different places or contexts. There are 5 essential premises to apply the definition of ID:

- Limitations in current functioning must be considered with the context of community environments typical of the individual's age peers and culture.
- Valid assessment considers cultural and linguistic diversity as well as differences in communication, sensory, motor, and behavioral factors.
- Within an individual, limitations often coexist with strengths.
- An important purpose of describing limitations is to develop a profile of needed supports.
- With appropriate personalized supports over a sustained period, the life functioning of the person with mental retardation generally will improve.

Even though the name or word has changed through time, in the last 50 years there has been no substantial changes of the three principal components of ID: limitations in the intellectual functioning, limitations in the adaptive behavior in front of the environment requests and early age of appearance (AAIDD, 2007; Schalock et al., 2007).

The term ID has been used as a synonymous of Mental Retardation (MR) and it refers to substantial limitations in current functioning. According to data collected from 147 countries, it is observed that several names exist related to ID: mental retardation (emphasis on neurological dysfunction and most common term in 76% of the countries), mental handicap/ learning disability (emphasis on difficulties in learning; in ~40% of the countries) and ID (emphasis on primary dysfunction; in ~57% of the countries). Other terms like learning/developmental disability and mental deficiency/subnormality are also used (Maulik & Harbour, 2010; Patja, 2001; Steadward, Wheeler, & Watkinson, 2003).

In the AAIDD manual of 2002 (Luckansson et al., 2002) a review is presented about the multidimensional model of the human functioning. Figure 1 shows the conceptual frame of human functioning and it has two main components: five dimensions (intellectual abilities, adaptive behavior, health, participation and context) and the special role that the supports have in human functioning.

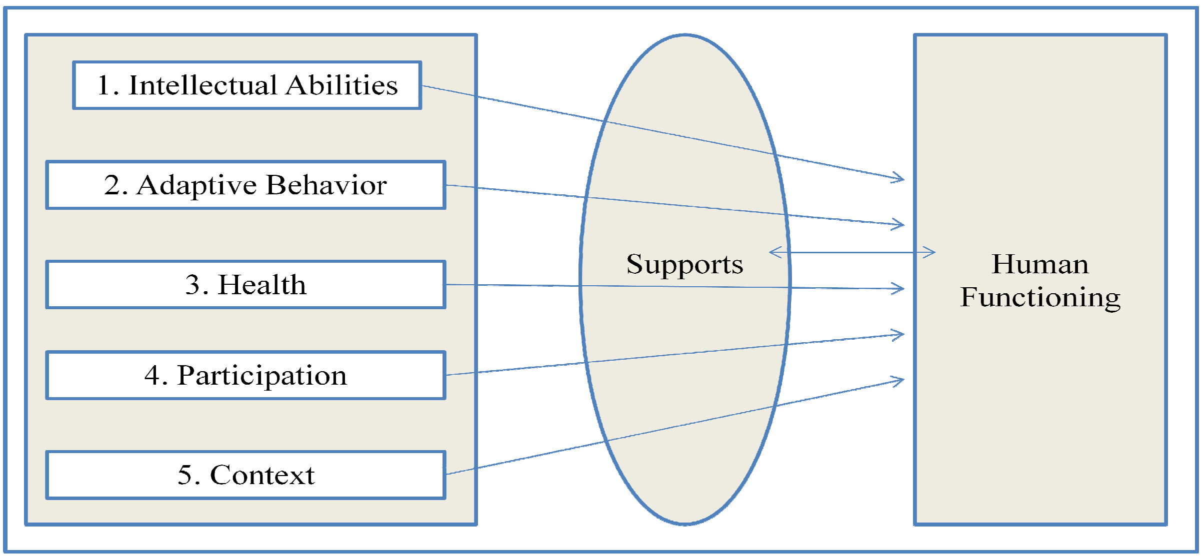

Figure 1. Conceptual frame of the human functioning (adapted from Luckansson et al, 2002). The ID manifestation, as it recognizes this view of human functioning, supposes a dynamic and reciprocal interpretation between intellectual ability, adaptive behavior, health, participation, context and individualize supports.

The conceptual frame of the human functioning shown in figure 1 is coherent with the model of the International Classification of Functioning, Disability and Health (ICF) (World Health Organization, 2002).

The ICF model (figure 2) describes functioning at three perspectives: body, personal and societal. The ICF organizes information in two parts. The first part deals with "*Functioning and Disability*" and the second part covers *"Contextual factors"*.

Components of *Functioning and Disability* are divided in: (1) "Body component" including Body functions and Anatomical structures. A problem in body function or structure is noted as an impairment; (2) "Activity" and "Participation" components, where Activity is defined as the execution of a task or action by an individual, and Participation is defined by involvement in a life situation. A difficulty at the personal level would be noted as an activity limitation, and at the societal level as a participation restriction. These components are related, by pairs, all between them (body and activity; body and participation; activity and participation) and in both senses.

The component of *Contextual factors* is an independent and integral component of the classification and is divided into (1) "Environmental factors' and (2) "Personal factors'. Environmental factors have an impact on all components of functioning and disability but Personal factors are not classified in the ICF.

The conceptualization provided in the ICF makes it impossible to understand disability without consideration and description of the environmental factors.

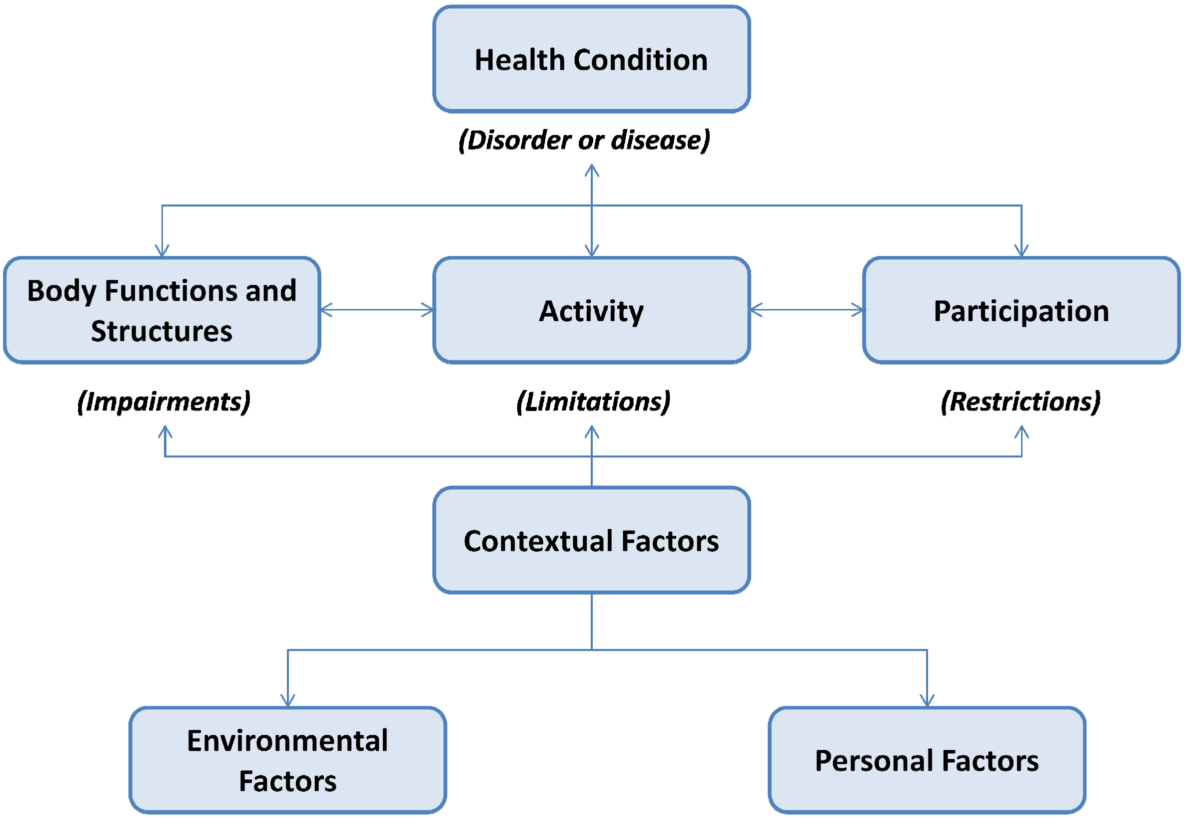

Figure 2. International Classification of Functioning, Disability and Health (World Health Organization, 2002)

The five dimensions already enumerated in the conceptual frame of the human functioning (figure 1), are shortly described as follows (Luckansson et al., 2002):

- Intellectual abilities: intelligence is considered a general mental capacity that includes rational thought, planning, problems solutions, abstract thought, complex ideas understanding, quick learning and learning through experience.
- Adaptive behavior: it is the set of conceptual abilities, social abilities and practice learnt by persons for daily life functioning. The limitations on the adaptive behavior affect both daily life and the ability to respond to vital changes and environment requirements.
- Health: it is understood health related to physical, psychological and social well being. The effects of physical health and mental health in the functioning of persons

with ID's can have a facilitating or inhibiting effect on human functioning altering the other four dimensions.

- Participation: it is the intervention of the persons in daily activities of different field of social life. It is related to with the individual's functioning in society. The participation refers to interactions and roles in the life areas of home, job, education, leisure, spirituality and cultural activities.
- Context: it describes the interrelated conditions where persons live their everyday life. From an ecological perspective (Bronfenbrenner, 1979), comprises three levels: (a) the immediate social environment, which includes the person, family and other closed persons (microsystem); (b) the neighborhood, community and organizations that facilitate educational, support or adaptation services (mesosystem); (c) the global profiles of the culture, the society, the enlarged populations, the country or the sociopolitical influences (macrosystem).

2.2 Intellectual Disability in Spain and Catalonia

The meta-analysis conducted by Maulik et al. (2011) informed that the estimate prevalence of intellectual disability was 10.37/1,000 persons, according to 52 different studies included that were conducted across different populations. The estimates varied according to income group of the country of origin, the age-group of the study population, and study design and report that the highest estimates were in low and middle income countries, and in child and adolescent populations.

The Spanish Confederation in favor of Persons with Intellectual Disabilities (La Confederación Española de Organizaciones en favor de las Personas con Discapacidad Intelectual, FEAPS) has assumed the AAIDD's definition of ID. The FEAPS shows that ID appear when a person with significant limitations interacts with his/her environment. So, it depends of the persons itself as much as the barriers or obstacles that the environment has. Depending of the environment more or less facilitator, the disability will appear on a different way.

The prevalence rate of ID in Spain is estimated on 5.03/1,000 inhabitants, which means that the total number of persons with ID in Spain is ~227,360 (FEAPS, 2009). The calculation of the number of persons with ID in Spain is done applying the estimated prevalence rate to the total number of Spanish population in January 1st, 2007, data registered by the National Institute of Statistics (Instituto Nacional de Estadística, INE). Spain is organized by Autonomous Communities, where Catalonia is the second most inhabited.

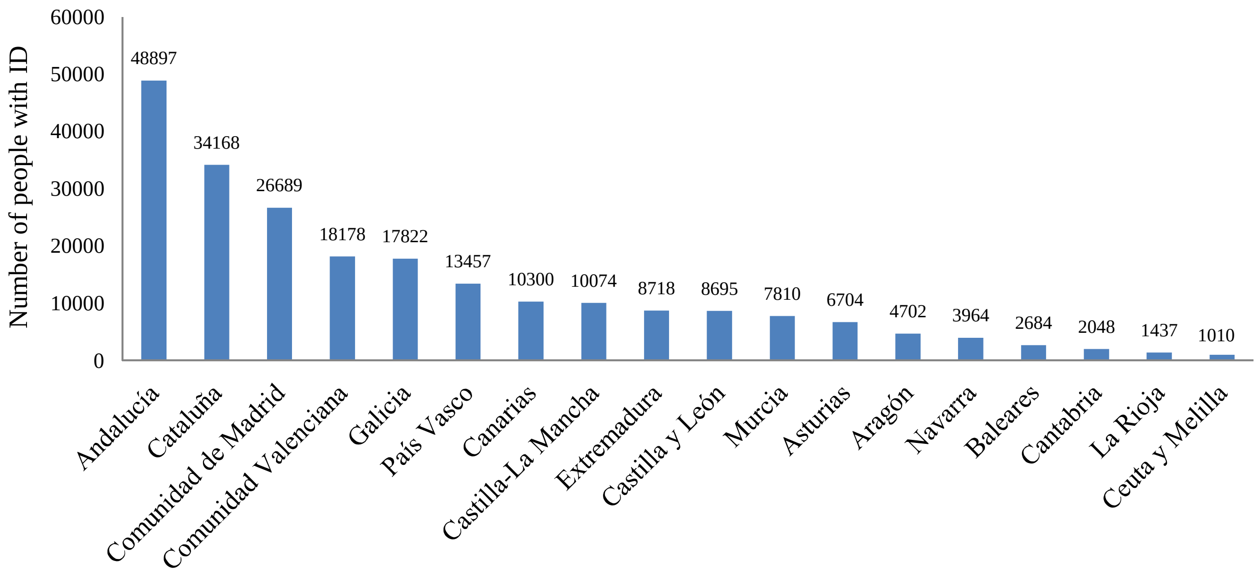

Figure 3. Distribution of people with ID by regions in Spain (FEAPS, 2008)

The demographic pattern of the population with ID shows that 52% are adults between 16 and 44 years old, 13% are older than 45 years of age (22% of which are older than 65 years old) and the younger than 15 years old represent a 34%. Always according to the estimated calculations, the 60% of persons with ID are men.

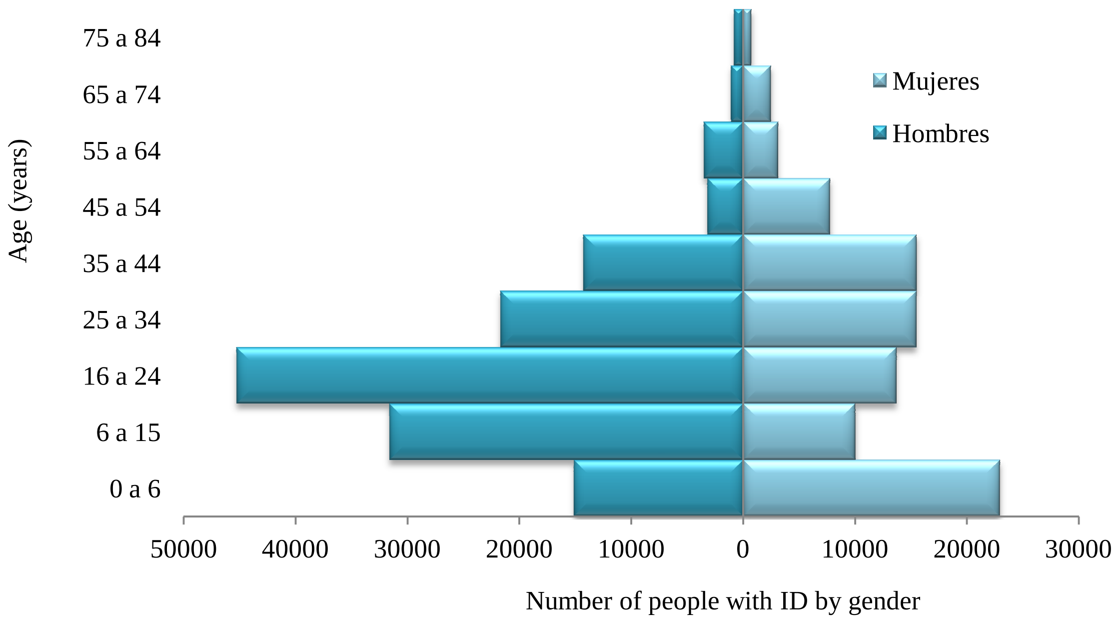

Figure 4. Demographic pattern of the populations with ID in Spain (FEAPS, 2008)

The same report informs that 87% of the persons with ID live with their families and 13.00% in several kinds of institutions (Table 1).

Table 1.
Distribution of population with ID by place of residence (FEAPS, 2008)

People with ID living with their families: 87%			**People with ID living in institutions: 13%**		
Dependence profiles	% distribution	Estimation of population living with their family	Dependence profiles	% distribution	Estimation of population institutionalized
Moderate	93%	49,394	Moderate	7%	3,951
Severe	86%	89,262	Severe	14%	14,281
High Dependence	85%	60,232	High Dependence	15%	10,240
Total		198,888	Total		28,472

In the report “Situation of the families with persons with Intellectual and Developmental Disabilities of Catalonia” (“Situació de les families amb persones amb discapacitat intel·lectual i del desenvolupament a Catalunya”) presented on December, 2009, (Dincat, Facultat de Psicologia i Ciències de l’Educació i de l'Esport Blanquerna. Universitat Ramon Llull, Universitat de Girona, & Fundació Jaume Bofill, 2010) there were 43,163 persons with DI, which correspond to 10.43% of the total persons with a legal recognition of their ID, where it was the third cause of disability after the physical disability and mental health. These amounts supposes the 5.34% of the total Catalan population. Between 1999 and 2009 the number of persons with ID has increased in 10,000 persons, approximately, which is a big growth, although it should be pointed that the relative increasing is less in persons with ID than in the rest of disabilities. But, the total numbers presented by FEAPS (2008) contrast with this last report, anyway it could be because FEAPS used previous general statistic data.

In relation with gender, 41.86% of the persons with ID are women, and 58.14% are men, meanwhile in relation with disability in general, 51% are women and 49% are men. It should be noted that in all disabilities (physical, visual, auditory and mental health) women are the ones that present higher rate than men, opposite to what happens with ID.

The population with ID of Catalonia are located principally in the metropolitan area of Barcelona, with a 62.20% of the total population, 11.50% are in Girona’s region and 10.90% in the Tarragona’s one. On the West Catalonia we can find the 6.10% of the population with ID, in Central Catalonia the 6.60%, in the Ebro’s region a 2.50% and finally in the Northern Pyrenees a 0.90% of this population.

2.3 Intellectual Disability and Health-related Risk Factors

The prevalence of Cardiovascular risk factors (CVR) as obesity, dislipaemia, diabetes mellitus, tobacco use and metabolic syndrome (MS) is clearly higher in persons with ID compared to general population (Draheim, 2006; Hasnain et al., 2009; McEvoy et al., 2005).

The CVR is due to the interaction of multiple etiological factors (Baptista, De Mendoza, Beaulieu, Bermúdez, & Martinez, 2004; Compton, Daumit, & Druss, 2006): genetic predisposition (Bellivier, 2005; Gough & O'Donovan, 2005), environmental factors and non healthy life style (bad habits, tobacco use and sedentary life style) (Compton et al., 2006; Grant, Hasin, Chou, Stinson, & Dawson, 2004) as well as the contribution on the metabolism alterations, every time more and more evident, of antipsychotic drugs (Khalil, 2012; Chadda, Ramshankar, Deb, & Sood, 2013; de Kuijper et al., 2013; Hägg, Lindblom, Mjörndal, & Adolfsson, 2006; McEvoy et al., 2005).

The prevalence of medication use and the prevalence of multiple medication use are very high in people with ID. The interactions between the multiple medications and physiological responses to PA participation or changes in dietary intake are not known. Many persons with ID also possess a unique endocrine profile that may influence their CVR (Draheim, 2006).

Some of the syndromes of people with ID are clearly linked to diabetes, such as Down syndrome (DS) and Prader–Willi syndrome, as well as conditions of overweight that frequently occur in people with ID (Anwar, Walker, & Frier, 1998; Butler et al., 2002; Henderson, Lynch, Wilkinson, & Hunter, 2007; Straetmans, van Schrojenstein Lantman-de Valk, Schellevis, & Dinant, 2007; Van Schrojenstein Lantman-De Valk, Metsemakers, Haveman, & Crebolder, 2000). Type 1 diabetes is estimated to be up to 35 times more common in people with ID (Anwar et al., 1998).

Similar to the general population, cardiovascular disease (CVD) is a problematic health concern with high morbidity and mortality rates for individuals with ID (Draheim, 2006; Patja, Mölsä, & Iivanainen, 2001; van den Akker, Maaskant, van der Meljdem, & van der Meijden, 2006). Furthermore, these disease rates have not declined among individuals with ID (Draheim, 2006; Janicki, Dalton, Henderson, & Davidson, 1999). While the risks of these conditions and greater health problems generally increase with age, people with an ID are at risk of developing them earlier owing to their higher levels of obesity (Foley, Lloyd, Vogl, & Temple, 2014; Rimmer, Yamaki, Lowry, Wang, & Vogel, 2010).

In addition to sedentary behavior and lack of education and health promotion programs, poor nutrition is likely to play a role in the development of obesity among adults with ID living in the community. The individuals tend to consume diets that are high in fat and low in fruit and vegetable intake (Draheim, Stanish, Williams, & McCubbin, 2007; Heller, McCubbin, Drum, & Peterson, 2011).

Among adults with ID, it was reported that those who were overweight or had abdominal obesity were 3 to 10 times more likely to have higher CVD risk factors, such as hypertension, hypertriglyceridemia, hyperinsulinemia, and low high-density lipoprotein cholesterol than those who are not overweight or who do not have abdominal obesity (Draheim, Williams, & McCubbin, 2002b; Draheim et al., 2007)

For a therapeutic approach to these kinds of disruptions and its interventions, it is fundamental a multidisciplinary work. Working together the Primary Medical Care center (PMCC) and the different institutions that work with people with Mental Health (MH) and/or ID is justified by the need to develop adequate activities for physical care and health promotion in this population (Cohen, Singh, & Hague, 2004; Naaldenberg, Kuijken, van Dooren, & Van Schrojenstein Lantman de Valk, 2013), in addition to improve their attention process.

Programs to promote PA and nutrition could be followed by an increase of PA performance and better nutritional habits, which would allow improving their fitness, health and quality of life. In the same way, it is relevant the early detection of risk factors and initial symptoms, to give priority to derivation to specialized services, and make easier a completion of the treatment and encourage therapeutic adherence.

2.4 Physical Activity

The term PA refers to “any body movement produced by the skeletal muscles that has as a result an energy consumption added to the basal metabolic rate”. To this concept framed in the biological field of knowledge, it has to be added the characteristics of the personal and socio-cultural experience (Devís, 2000), because without them many times it cannot be understood why people perform certain activities and not others (López-López, 2008).

This PA may have several aspects or purposes (Shepard, 1994):

- As a useful activity, which would include mainly job activities and domestic tasks.
- Leisure time activities, eminently ludic and recreational.
- Physical Education, understood as an activity with an educational character, which doesn’t exclude the previous ones that can be used to educate the person, too.

When we talk about Physical Exercise (PE) we refer to a subcategory of PA, and it means any body movement, structured and repetitive with the purpose of improving or maintaining the fitness level and/or also the motor capacities and abilities (motor learning). So, PE constitute a stimulus to develop and improve the psycho-physical qualities of people (López-López, 2008).

As a summary, in order that movement becomes a PE it needs the following characteristics:

- Willfulness: full conscience activities.
- Intentionality: activities with a clear intention. In physical education it will be educational, meanwhile in PA for health it would have to promote for itself.

- Systematization: activity with a specific order, intensity and difficulty, between other characteristics.

Exercise and exercise training frequently are used interchangeably and generally refer to PA performed during leisure time with the primary purpose of improving or maintaining physical fitness, physical performance, or health (Physical Activity Guidelines Advisory Committee, 2008).

PA can be classified as an aerobic or anaerobic activity depending on the principal metabolic pathways involved to produce energy for this particular activity, and it can be of several types, depending on the aerobic endurance, strength (resistance) or balance (Giannuzzi et al., 2003).

The intensity with which PA is performed represents the rhythm or effort level used. To classify intensity the Metabolic Equivalent of Task (MET) is very commonly used. The MET corresponds to the quantity of energy that the body consumes at rest, and 1 MET is defined as the oxygen consumption (VO_2) at rest, which is approximately equivalent to 3.5 $ml \cdot Kg^{-1} \cdot min^{-1}$. Based on the metabolic units, the intensity of PA can be classified on: low (< 3.00 METs), moderate (3.00 a 5.99 METs), vigorous (6.00 a 8.99 METs) and very vigorous (≥ 9.00 METs) (Ainsworth et al., 2000; Haskell et al., 2007).

Table 2 shows the approximate classification of exercise intensity using relative and absolute methods commonly used in practice. Not all of these methods of measurement for exercise intensity have been compared each other simultaneously; therefore, it cannot be assumed that one method of determining exercise intensity is necessarily equivalent to that derived using another method. It is prudent to keep in mind that the relationships among actual energy expenditure, HR reserve (HRR), VO_2 reserve (VO_2R), percent of maximal HR (%Hr max) and percent of VO_2 max (percent of maximal oxygen uptake) can vary considerably depending on exercise test protocol, exercise mode, exercise intensity, resting HR, fitness level, age, body composition, and others factors (American College of Sports Medicine, 2011; Cunha, Midgley, Monteiro, & Farinatti, 2010; Fernhall et al., 2001).

Table 2.
Classification of exercise intensity: relative and absolute exercise intensity for cardiorespiratory endurance and resistance exercise (American College of Sports Medicine, 2011)

	Cardiorespiratory Endurance Exercise											**Resistance Exercise**
	Relative Intensity				**Intensity (%VO_{2max}) Relative to Maximal Exercise Capacity in METs**			**Absolute Intensity**	**Absolute Intensity (MET) by Age**			**Relative Intensity**
Intensity	**%HRR or %VO_2R**	**%HR max**	**%VO_2 max**	**Perceived exertion (Rating on 6-20 RPE Scale)**	**20 METs %VO_{2max}**	**10 METs %VO_{2max}**	**5 METs %VO_{2max}**	**METs**	**Young (20-39 yr)**	**Middle-aged (40-64)**	**Older (≥65 yr)**	**% 1RM**
Very light	<30	<57	<37	<Very light (RPE <9)	<34	<37	<44	<2	<2.4	<2.0	<1.6	<30
Light	30-39	57-63	37-45	Very light-fairly light (REP 9-11)	34-42	37-45	44-51	2.0-2.9	2.4-4.7	2.0-3.9	1.6-3.1	30-49
Moderate	40-59	64-76	46-63	Fairly light to somewhat hard (RPE 12-13)	43-61	46-63	52-67	3.0-5.9	4.8-7.1	4.0-5.9	3.2-4.7	50-69
Vigorous	60-89	77-95	64-90	Somewhat hard to very hard (RPE 14-17)	62-90	64-90	68-91	6.0-8.7	7.2-10.1	6.0-8.4	4.8-6.7	70-84
Near-maximal to maximal	≥90	≥96	≥91	≥Very hard (RPE ≥ 18)	≥91	≥91	≥92	≥8.8	≥10.2	≥8.5	≥6.8	≥85

Abbreviations: Hrmax (maximal HR); %HR (percent of maximal HR); HRR (HR reserve); VO_{2max} (maximal oxygen uptake); %VO_{2max} (percent of maximal oxygen uptake); VO_2R (oxygen uptake reserve); RPE (ratings of perceived exertion); 1RM (one maximal repetition)

In Spain, Chodzko-Zajko et al. (2012) found that an 84% of the autonomous communities make some kind of recommendations for aerobic PA and a 37% for resistance training. But the ones that have documents that agree with the WHO's criteria are: aerobic PA (n = 11; 58%), adults (n = 10; 53%), older adults (n = 5; 26%), childhood and adolescents (n = 1; 5%); resistance training for adults(n = 6; 32%), older adults (n=3; 16%), childhood and adolescents (n=1; 5%); balance (n=5; 26%); bouts of continuous PA for at least 10 minutes (n=6; 32%); recommendation of 300 minutes of PA a week (n=10; 53%); PA intensities (n=2; 11%). The communities with higher aging indexes and higher percent of child/adolescents almost don't give recommendations of PA related to the WHO's guidelines (World Health Organization, 2010).

In the following tables 3 and 4 are shown the recommendations to perform PA done by different institutions and evidences about their influence on health status.

Table 3.
Recommendations from different institutions for the practice of PA in adults

Institution	Document	Year	Recommendation of PA for adults	Others recommendations
WHO	Global recommendations on PA for health	2010	≥150 minutes a week of moderate PA ≥75 minutes a week of vigorous PA	≥5 days a week Bouts ≥10 minutes
ACSM	Quantity and quality of exercise for developing and maintaining cardiorespiratory, musculoskeletal, and neuromotor fitness in apparently healthy adults: guidance for prescribing exercise	2011	≥30 minutes moderate PA ≥20-25 minutes of vigorous PA	≥5 days a week ≥3 days a week
Generalitat de Catalunya	Prescription Guidelines of Exercise for Health	2007	≥30 minutes of PA	2 – 5 days a week
Ministerio de Salud de la Presidencia de la Nación	Reference Manual of PA and Health in Argentina	2012	≥150 minutes a week of moderate PA ≥75 minutes a week of vigorous PA	≥5 days a week Bouts ≥10 minutes
Gobierno de Chile	Program of PA for Prevention and Control of Cardiovascular Risk Factors	2004	20 to 60 minutes of moderate-vigorous PA	3 to 5 days a week

Table 4.
Health Benefits Associated With Regular Physical Activity (US Department of Health and Human Services, 2008)

Children and Adolescents
Strong evidence • Improved cardiorespiratory and muscular fitness • Improved bone health • Improved cardiovascular and metabolic health biomarkers • Favorable body composition
Moderate evidence • Reduced symptoms of depression
Adults and Older Adults
Strong evidence • Lower risk of early death • Lower risk of coronary heart disease • Lower risk of stroke • Lower risk of high blood pressure • Lower risk of adverse blood lipid profile • Lower risk of type 2 diabetes • Lower risk of metabolic syndrome • Lower risk of colon cancer • Lower risk of breast cancer • Prevention of weight gain • Weight loss, particularly when combined with reduced calorie intake • Improved cardiorespiratory and muscular fitness • Prevention of falls • Reduced depression • Better cognitive function (for older adults)
Moderate to strong evidence • Better functional health (for older adults) • Reduced abdominal obesity
Moderate evidence • Lower risk of hip fracture • Lower risk of lung cancer • Lower risk of endometrial cancer • Weight maintenance after weight loss • Increased bone density • Improved sleep quality

2.5 Physical Fitness and Training

Fitness is the energy and vitality status that allows people to perform daily and regular tasks, just like enjoy active leisure time, confront unexpected events without excessive fatigue, and at the same time, face physical inactivity (sedentary life style), develop to maximal level the physical and intellectual capacities of each person, fully experiencing the happiness of living, through performing PA in a healthy way (Pancorbo Sandoval, 2004).

The Sport Committee of the European Council defined that “fitness related to health is composed by the following elements: cardiorespiratory endurance, strength, muscle resistance, flexibility, anthropometric dimensions (body composition), coordination-balance and a good psycho-emotional status” (Pancorbo Sandoval, 2004). A good physical fitness reduce the risk of health problems related to lack of exercise, and establish a fitness base for participation in a variety of activities.

Physical fitness can be divided into health-related and skill-related components of fitness. Health-related fitness includes those components of physical fitness that are most directly related to good health, decreased morbidity and mortality improving quality of life and well being (Departament de Salut i Secretaria General de l’Esport del Departament de la Vicepresidència de la Generalitat de Catalunya, 2007; Ministerio de Salud de la Nación Argentina, 2012; Rimmer, 2000).

Furthermore, the most important components of health-related physical fitness are: body composition, general cardiorespiratory endurance, muscular strength and endurance, body composition and flexibility. Different motors skills such as coordination, balance, gait and agility (neuromotor exercise training) are not the main goals for health-related fitness, but the lack of them may in fact be harmful in some cases. These activities should be part of a comprehensive exercise program (American College of Sports Medicine, 2011).

A program of regular exercise that includes cardiorespiratory, resistance, flexibility, and neuromotor exercise training beyond activities of daily living to improve and maintain physical fitness and health is essential for most adults. In addition to exercising regularly, there are health benefits in concurrently reducing total time engaged in sedentary pursuits and also by interspersing frequent, short bouts of standing and physical activity between periods of sedentary activity, even in physically active adults (American College of Sports Medicine, 2011).

Sport training is a planned and complex process to organize workloads with a progressively increase destined to stimulate the physiological process of super-compensation of the organism, facilitating the development of different physical qualities and capacities, in order to promote and consolidate the sport performance (Vicente, 1995).

2.6 Physical Activity and Intellectual Disability

The low levels of PA, muscle strength, balance and flexibility in people with and without ID may negatively affect the daily life activities and general functioning. Otherwise, a direct relationship between regular PA and exercise with numerous physical and mental health benefits and increases in cardiorespiratory functions in men and women is reported by different studies (American College of Sports Medicine, 2011; World Health Organization, 2010).

Several studies have demonstrated that adults with ID have significantly lower rates of PA than healthy adults (Draheim et al., 2002b; Frey, 2004; Messent, Cooke, & Long, 1998; Temple et al., 2006). These studies have also shown that the rates of PA in people with ID vary with the level of impairment (mild to profound), but regardless of their level of impairment, adults with ID have lower rates of PA activity compared with healthy adults. Moreover, more than two third of adults with ID do not reach the minimum volumes of PA that may guarantee health (Temple et al., 2006). Based on aging patterns in adults with ID, the importance of regular PA may be much higher in this population compared with the general population.

Robertson's et al. (2000) investigations have shown that adults with ID can benefit from exercise. In a cross sectional study of 500 individuals with ID, researchers concluded that PA would be the single most effective way to improve health. On other side, in a review article, Bartlo & Klein (2011) found a moderate to strong evidence that PA positively affected balance, muscle strength, and quality of life in individuals with ID.

Frey, Buchanan & Rosser Sandt (2005) stated that the probability that people with ID are integrated, productive and independent members is proportional to the capacity of maintain a good physical health, which is directly related to PA habits. One of the developmental settings for persons with ID is their job place, so it is very convenient to take into account the article of Fernhall (1993) who showed that the kind of work performed by the majority of people with ID requires low and moderate intensities of PA. And because of this reason, they need to be physically active in order to be able to maintain good levels of fitness which will allow them to obtain a satisfactory labor performance. As much as possible, adults with ID, whether living at home or in a structured residential setting, must have social support from their families or staff to take part in different PA programs and maintain a physically active lifestyle. But really, the options and access to PA and recreational programs based in the community are generally limited, which represents a barrier for persons with ID and could be one of the causes why they perform less PA (Draheim et al., 2002b; Messent et al., 1999; Temple, 2007). In the different centers where they are assisted, there are not many options to perform moderate or vigorous PA that allow them to reach the recommended levels to obtain health benefits, especially in people with low to moderate ID (Messent et al., 1998, 1999).

By what it has been mentioned previously, PA is one of the most cited practice related to the habits of health promotion in persons with ID, but until now these programs have not been enough developed.

From the study done by Frey et al. (2005) with the purpose to analyze the perception of PA in twelve adults with ID, they stand out some issues that explain the low PA in this population:

- Adults with ID express the same kind of barriers that persons without ID (job, money, time, etc.)

- Persons with ID express the need of guidelines and more structured orientations to participate in PA programs.
- It is detected that those who would have to instill and promote the health in persons with ID allow and strengthen sedentary behavior.
- The majority of participants in this study use their leisure time in sedentary activities and very few perform PA, other than Special Olympics programs.

The study by Frey et al. (2005) shows that adults with ID need specially designed PA education and training programs, as well as supports system providers should be educated regarding the importance of PA to health for these individuals.

Another study showed that a peer-guided model integrating social and instructional support for adolescents with ID and providing direction from fitness trainers was effective for engaging these youth in structured exercise and could favor exercise participation in community settings (Stanish & Temple, 2012).

Stanish & Frey (2008) in their publication explained that many suggestions have been put forth by researchers and practitioners to encourage people with ID to engage in physical activity. The following strategies are examples that could be considered when implementing programs for persons with ID:

- Include motivational strategies and positive reinforcement.
- Include low to moderate intensity activities such as walking.
- Ensure that the activity is fun and involves social interaction.
- Involve participants in activity selection and decision making.
- Select activities that are age-appropriate.

- Conduct programs in community-based environments where there is opportunity for inclusion (but consider participant preferences).
- Be prepared to modify activities to accommodate all abilities.
- Monitor progress and set activity goals.

Heller et al. (2004) have analyzed the attitude related to PE and psychosocial wellbeing in adults with DS. These studies have demonstrated that a program of health promotion based on PE and learning about healthy habits, give more positive attitude towards the exercise itself and, at the same time, improvements on social relations.

The U.S. Department of Health and Human Services (2008) have developed the next key Guidelines for Adults With Disabilities:

- Adults with disabilities, who are able to, should get at least 150 minutes a week of moderate-intensity, or 75 minutes a week of vigorous-intensity aerobic activity, or an equivalent combination of moderate and vigorous intensity aerobic activity. Aerobic activity should be performed in episodes of at least 10 minutes, and preferably, it should be spread throughout the week.
- Adults with disabilities, who are able to, should also do muscle-strengthening activities of moderate or high intensity that involve all major muscle groups on 2 or more days a week, as these activities provide additional health benefits.
- When adults with disabilities are not able to meet the guidelines, they should engage in regular PA according to their abilities and should avoid inactivity.
- Adults with disabilities should consult their health-care provider about the amounts and types of physical activity that are appropriate for their abilities.

2.7 Physical Activity Levels in persons with Intellectual Disabilities

Since many health guidelines published by several health authorities recommend regular PA, the interest to evaluate the PA levels and its nature in different populations has increased (American College of Sports Medicine, 2011; Departament de Salut i Secretaria General de l'Esport del Departament de la Vicepresidència de la Generalitat de Catalunya, 2007; Kohl et al., 2012).

As it was explained previously in section 2.4 the PA intensity can be classified in relation to the MET's, which in our study corresponds to: sedentary (1 to 1.5 METs), light (1.5 to < 3.00 METs), moderate (3 to 5.99 METs) and vigorous (≥ 6.00 METs). The need to better understand the relationship between the PA level and several health indicators, as well as to be able to explain the big increase of overweight and obesity in the general population, has taken investigators to improve the tools used to quantify the PA levels in different populations (Hendelman, Miller, Baggett, Debold, & Freedson, 2000; Temple, Anderson, Walkley, & Services, 2000; Temple & Walkley, 2003).

During the last years many instruments have been developed to measure objectively the PA level, as for example pedometers and accelerometers. The pedometers, through a pendulum system, measure the number of steps done during a certain period of time, but they are not designed to capture pattern, intensity, or type of PA (Bassett et al., 1996; Hendelman et al., 2000). The accelerometers are used to objectively monitoring PA, and lately their use in different populations have grown (Chen & Bassett, 2005; Rowlands, Eston, & Ingledew, 1999; Trost et al., 2002). At the same time, different cut-points have been developed in laboratory studies to translate the activity duration in specific intensity categories (Agiovlasitis et al., 2011; Agiovlasitis, Motl, Foley, & Fernhall, 2012; Freedson, Melanson, & Sirard, 1998; Santos-Lozano et al., 2013; Sasaki, John, & Freedson, 2011; Troiano et al., 2008). This allows us to overcome the possible disadvantages that pedometers present. So, at present accelerometers have become one of the most used method due to the information they provide about intensity, frequency and duration of the PA (Esliger & Tremblay, 2007; Troiano & Freedson, 2010).

Accelerometers register the change of the center of mass acceleration in the different axis or planes of movement, and they transform them in a quantifiable digital sign known as "counts". Depending of the number of axis where the information is registered, there are uniaxial accelerometers (one axis), biaxial (two axis) or triaxial (three axis). For the present study, the ActiGraph GT3X monitor device was used (ActiGraph, Pensacola, FL, USA). This is a lightweight (27 g), compact (3.8 × 3.7 × 1.8 cm) device and has a rechargeable lithium polymer battery (ActiGraph, 2011). It uses a solid-state tri-axial accelerometer to collect motion data on 3 axes: vertical (Y), horizontal right-left (X) and horizontal front-back axis (Z). The ActiGraph output also includes the vector magnitude which is the vector summed value of the three axis ($VM = \sqrt{(X^2 + Y^2 + Z^2)}$). The GT3X measures and records time-varying accelerations ranging in magnitude from ~0.05 to 2.5 Gs (ActiGraph, 2011). The accelerometer output is digitized by a 12-bit analog to digital convertor (ADC) at a rate of 30 Hz (ActiGraph, 2011). Once digitized, the signal passes through a digital filter that band-limits the accelerometer to the frequency range of 0.25–2.5 Hz (ActiGraph, 2011). Each sample is summed over an "epoch" and the output of the ActiGraph is given in "counts". The counts obtained in a given time period are linearly related to the intensity of the subject's PA during this period and the devices can collect these data continuously for several weeks (Berlin, Storti, & Brach, 2006). The device allows its programming in epochs de 1, 5, 10, 15, 20, 30 y 60 seconds, also including the possibility to record raw data, without the need of previously determine the sampling periods. The registration of the raw data offers the advantage of being able to modify later the epoch duration (ActiGraph, 2011).

Accelerometer validity has been determined for older adults, children, individuals who are obese, individuals with physical disabilities, and individuals with slow gait speeds (Berlin et al., 2006; Lopes, Magalhães, Bragada, & Vasques, 2009; Tudor-Locke, Brashear, Johnson, & Katzmarzyk, 2010; Vanhelst et al., 2012).

As for use in surveillance of PA of adults with ID it is uncertain whether questionnaire methods have sufficient reliability and the lack of specific ID recall demand (Matthews et al., 2011), the accelerometer could be a suggested instrument to use and there are studies that have effectively used these motion sensors with participants with ID to assess the PA levels (Dixon-Ibarra, Lee, & Dugala, 2013; Frey, 2004; Melville et al., 2011; Phillips & Holland, 2011; Temple et al., 2000; Temple & Walkley, 2003).

In the studies conducted by Temple et al. (2000; 2003) with individuals with mild to moderate ID demonstrated concurrent validity of energy expenditure (EE) from accelerometers with proxy reported. Later, two studies have been developed to validate specific accelerometer intensity cut-points for people with DS (Agiovlasitis et al., 2011, 2012).

Approximately 17.50% to 33% of adults with ID accruing the 30 minutes of moderate intensity of PA per day and between 20% to 45% accumulate the recommended 10,000 steps per day (Temple et al., 2006). Furthermore, others studies have found that time spent in sedentary behaviors is high (Finlayson et al., 2009; Frey, 2004; Temple & Walkley, 2003).

Temple et al. (2000) used direct observation and uniaxial accelerometers to record the PA behavior of six individuals with ID over 7 consecutive days. The data showed that one participant achieved 30 minutes of moderate intensity PA on 5 or more days per week, and other participant met the recommendations on each day he was not ill at home. Another study

(Temple & Walkley, 2003) found that the 32% of their participants achieve the recommended 30 minutes of moderate intensity PA per day.

In the study by Frey (2004) similar findings were reported based on a comparison of PA levels between adults with and without ID using uniaxial accelerometers, where the results showed an average time per day of moderate to vigorous PA of 19.7 minutes for people with ID, 31.6 minutes for sedentary people without ID and 55.9 minutes for active people without ID. Nevertheless, not significant differences were found between ID group and the sedentary groups without ID and the proportion of each group achieving 30 minutes of moderate intensity PA per day was 28%; 47% and 89% respectively.

The study by Dixon-Ibarra et al. (2013) indicates that older adults with ID were performing less PA than a younger group with ID and a group of older adults without ID. A 6% of older adults with ID and a 13% of younger adults with ID met the recommendations of 150 minutes of moderate or 75 minutes of vigorous PA in bouts greater than ten minutes across the week. Sedentary behavior ranged from 60% to 65% of the time, in all participants in this study.

Phillips & Holland (2011) in their study found that the total sample average 6,334 steps per day over the seven days and most of the waking day was spent being sedentary (608.1 mins/day) followed by light (120.7 mins/day) and then moderate PA (33.7 mins/day), with very little time engaged in vigorous PA (2.1 mins/day).

Others studies where pedometers or surveys (Finlayson et al., 2009; Temple, 2007) were used found that the 34.6% of adults with ID undertook any regular activity of at least moderate intensity and the average daily steps through a week ranged 8,100 steps.

A study (Stanish & Draheim, 2005) where pedometers were used and the NHANES

III Physical Activity Survey was administered found that the mean weekly step count for adults with ID was ~58,000 steps and only 21.40% of the participants recorded 10,000 steps/day. Moreover, 17.50% of the participants reported engaging in five bouts of moderate to vigorous PA (MVPA) per week totaling 30 minutes per bout. The percent that coincided between participants meeting the recommended 10,000 steps/day and those meeting the recommended 30 min of MVPA five days per week was 68.90%.

The study by Hilgenkamp et al. (2012) found that from the 257 participants, only 16.70% complied with the guideline of 10,000 steps/day, 36.20% took 7,500 steps/day or more, and 39% was sedentary (<5,000 steps/day). As the measured sample was the more functionally able part of the total sample it could be possible that these results are likely to be a considerable overestimation of the actual PA levels in this population. This study shows that PA levels are extremely low in adults with ID aged 50 years and over.

In the analyzed literature, is noticeable that the levels of PA in adults with ID are low and PA decreases with age. Other interesting point that would have been taken into account when a PA program is implemented is the ID level, because PA decreases with the ID level due the fact that individuals with higher ability have, in general, fewer restrictions, less need for staff supervision, and more independence to be physically active.

The low PA levels and the situation of dependence of people with ID, whose activities and lifestyle are under the influence of others, suggest that well-designed, accessible, preventive health promotion strategies and interventions should be designed to raise the levels of PA in this specific population.

2.8 Physical Fitness in Persons with Intellectual Disabilities

Adults with ID, as shown by several studies, have decreased cardiovascular fitness, lower rates of PA and higher incidence of obesity compared to persons without ID (Baynard et al., 2008; Draheim et al., 2002b; Fernhall & Pitetti, 2001; Frey, 2004; Skowroński, Horvat, Nocera, Roswal, & Croce, 2009; Temple et al., 2006). This impaired fitness is associated with several factors such as a sedentary lifestyle, possible lack of motivation and task understanding, unhealthy diet, decreased muscle strength, hypo-tonicity, aerobic capacity, fat-free mass, an increased prevalence of cardiovascular diseases and lower insulin sensitivity (de Winter et al., 2009; Flore et al., 2008; Pitetti & Boneh, 1995; Skowroński et al., 2009)

Different studies have shown that exercise programming intended to improve physical fitness may positively affect general health (Carmeli, Kessel, Coleman, & Ayalon, 2002; Heller et al., 2011; Robertson et al., 2000), anxiety and quality of life (Bartlo & Klein, 2011; Carmeli, Zinger-Vaknin, Morad, & Merrick, 2005; Carraro & Gobbi, 2012; Guidetti, Franciosi, Gallotta, Emerenziani, & Baldari, 2010; Heller et al., 2011).

Some systematic reviews have evaluated the evidence associated with physical fitness or PA and health or psychosocial benefits of activity programs in individuals with ID with or without DS (Andriolo, El Dib, Ramos, Atallah, & da Silva, 2010; Bartlo & Klein, 2011; Dodd & Shields, 2005; Gonzalez-Aguero et al., 2010; Heller et al., 2011; Oppewal, Hilgenkamp, van Wijck, & Evenhuis, 2013; Pitetti, Baynard, & Agiovlasitis, 2013). Some of the analyzed studies in which only people with ID with DS were included (Andriolo et al., 2010; Dodd & Shields, 2005; Gonzalez-Aguero et al., 2010; Pitetti et al., 2013) underline that health in this specific population could be greatly benefited from PA and adequate exercise prescription.

It is well described that people with DS have anatomical and physiological anomalies associated with DS like hypo-tonicity and congenital heart disorders that may further limit the cardiorespiratory capacity, and their participation in physical activities (American College of Sports Medicine, 2009b). People with DS have demonstrated to have lower perk heart rate and peak oxygen consumption than other individuals with ID (Baynard et al., 2008; Baynard, Pitetti, Guerra, & Fernhall, 2004; Guerra, Llorens, & Fernhall, 2003). Some of these characteristics such as musculoskeletal disorders (hypo-tonicity, hyper-mobility of the joints or ligaments laxity, joint instability and osteoporosis), light to moderate obesity, an underdeveloped respiratory and cardiovascular system and short stature (short legs and arms in relation to torso) are related to exercise (Pitetti, Rimmer, & Fernhall, 1993). These characteristics together, may place them to have greater risk of injury and emphasize the needed of adapted PA programs. It was shown that strength and aerobic fitness could be improved in these people (Casajus, Pueyo, Vicente-Rodríguez, & González-Agüero, 2012; Mendonca, Pereira, & Fernhall, 2011)

Several studies have highlighted the need for physical activity programs and research for individuals with intellectual disability, in which they noted the importance for researchers and clinicians to promote a healthier aging for future populations of elderly persons with lifelong disabilities and to prevent and reduce different health problems in these population (Davidson, Heller, Janicki, & Hyer, 2004; Rimmer, Chen, McCubbin, Drum, & Peterson, 2010; Walsh, 2005).

Poor health-related fitness profiles of adults with ID are pointing out serious health and social implications because high levels of cardiorespiratory fitness are important for children and adolescents as cardiorespiratory fitness (CRF) declines with age; low levels of CRF are a major risk factor for metabolic and CVD; childhood obesity is associated with several risk factors for adulthood heart disease and other chronic diseases including hyperlipidemia, hyperinsulinemia, hypertension and early atherosclerosis. At the same time, it has been demonstrated that to maintain muscle strength of the lower extremities in persons with ID is an important factor that contributes to peak oxygen consumption (VO_2 peak), functional performance and bone mineral density (Cowley et al., 2010; Pitetti & Boneh, 1995; Pitetti & Fernhall, 1997; Pitetti & Yarmer, 2002)

Well structured PA programs not only could benefit the relations between fitness and health in persons with ID, but they benefit greatly from the persons and places they see and meet while performing fitness. Physical training has also been reported to have effects on general well-being and self-image in people with ID (Carmeli et al., 2005; Heller et al., 2004). It is certified that any type of PA could promote health benefits. Moreover, if an individual is capable of exercising within a certain range of his or her own maximum HR (HR max) and increase the exercise time duration, the benefits will be greater (Podgorski, Kessler, Cacia, Peterson, & Henderson, 2004; Rimmer, 2000; World Health Organization, 2010).

2.8.1 *Cardiorespiratory Fitness*

A person's total capacity for physical performance is determined by his/her capacity for aerobic and anaerobic performance. His/her aerobic or CRF is the ability of the circulatory and respiratory systems to supply oxygen for working muscles during sustained PA (López Chicharro & Izquierdo Redín, 2006; Physical Activity Guidelines Advisory Committee, 2008). Sedentary life style and a low CRF are known to be a major independent risk factor for CVDs and all-cause mortality (U.S. Department of Health and Human Services, 2008; World Health Organization, 2007, 2010). CVDs are the number one cause of disability and premature morbidity and mortality throughout the world (World Health

Organization, 2007, 2010).

The standard measure to express CRF is the maximal VO_2 (VO_2 max), which is defined as the maximum amount of oxygen that the body is able to absorb, transport and consume per unit of time and is achieved during a maximal cardiorespiratory exercise test, in which a sufficiently large muscle mass is used (López Chicharro & Izquierdo Redín, 2006). It is the product of the maximal cardiac output and arterial-venous oxygen difference.

The variability among different subjects is wide and depends on various factors such as: the genetic endowment, age, body composition, sex and training levels or fitness conditioning.

Possible mechanisms limiting of VO_2 max could be both centrals and peripherals. Within the centrals are cardiac output (American College of Sports Medicine, 2010), which is the product of heart rate (HR) and stroke volume (SV). Peripherals factors are the mitochondrial mass and capillary density (López Chicharro & Izquierdo Redín, 2006).

The highest achieved oxygen uptake during a maximal cardiorespiratory exercise test can be considered as VO_2 max when a plateau in oxygen uptake with an increase in work rate is reached. However, when a plateau is not reached, there are secondary criteria to check whether VO_2 max is reached (at least two of these criteria): (1) a respiratory exchange ratio (RER) >1.1, (2) a plateau in HR with an increase in work rate or within 10 beats of the estimated HR max, (3) no change (increase lower than 150 $ml \cdot min^{-1}$) in oxygen uptake with an increase in workload, and (4) high levels of lactic acid in the minutes following exercise (López Chicharro & Izquierdo Redín, 2006; Reaño & Ricart, 2001; Wilmore & Costill, 2004). VO_2 peak is the highest achieved oxygen uptake during a test and it makes reference to the value obtained during a maximal test that has not met the criteria to be considered VO_2

max. In sedentary people, old people or individuals with ID, test results are often called VO_2 peak, which means that they have reached volitional exhaustion (the point at which the participant feels he/she can no longer continue).

Individuals with ID have low levels of CRF (Baynard et al., 2008; Fernhall & Pitetti, 2001; Mendonca et al., 2010), starting with low levels at a young age with further decline with increasing age. Furthermore, their PA levels are low (Dixon-ibarra, Lee, & Dugala, 2013; Hilgenkamp, Reis, van Wijck, & Evenhuis, 2012; Peterson, Janz, & Lowe, 2008; Phillips & Holland, 2011; Temple et al., 2006). The combination of these characteristics puts them at a high risk for CVDs.

Several endurance training studies with people with ID have reported large positive effects on cardiovascular endurance (Calders et al., 2011; Chanias, Reid, & Hoover, 1998; Fernhall, 1993; Millar, Fernhall, & Burkett, 1993; Varela, Sardinha, & Pitetti, 2001). The study by Rimmer et al. (2004) examined values of VO_2 peak, peak heart rate (HR peak), time to exhaustion, and maximal workload on a cycle-ergometer stress test. The individuals in the intervention group significantly improved their physical fitness levels compared with control groups. Overall, the intervention participants improved their VO_2 peak rates by 12%, whereas the control groups' VO_2 peak rates decreased by 6%. Varela et al. (2001) found that intervention participants increased their work performance on treadmill and rowing ergometer tests but did not improve VO_2 peak rates. The study by Cluphf, O'Connor & Vanin (2001) did not specifically evaluate general fitness measurements but did find significant improvements (4% decrease) in HR after a walking test in intervention participants.

All these studies are showing strong evidence that physical fitness, including cardiorespiratory endurance, can be developed through training regimens in persons with ID.

2.8.2 *Body composition*

Body composition is a common and important element in fitness evaluation. It has been well demonstrated than an excess body fat is bad for health. Body composition refers to the relative proportions of fat, muscle, bone and residual body mass of the total weight of a person. The pattern of fat distribution is important and body composition gives more detailed data of individuals' tissues than weight alone. Another simple index of weight-for-height that is commonly used to classify underweight, overweight and obesity in adults is the Body Mass Index (BMI). It is defined as the weight in kilograms divided by the square of the height in meters ($kg \cdot m^{-2}$) and is commonly used as a health indicator. BMI has been identified as a key health indicator and determinant of health for people with ID (Sohler et al., 2009; Van Schrojenstein Lantman-de Valk, Linehan, Kerr, & Noonan-Walsh, 2007). Body composition can be estimated using both laboratory or field techniques (American College of Sports Medicine, 2010; Esparza Ros, 1993; WHO, 2000).

Individuals with ID are more likely to be both obese and extremely obese that their peers without ID. Research shows adults, women, residents of group homes and individuals with DS remain at particularly high risk for a condition that increases the chance of cardiovascular, pulmonary, metabolic and neoplastic diseases. Youth with ID who are overweight or obese also present an elevated number of obesity-related secondary conditions such as asthma, high blood pressure, high blood cholesterol, diabetes, depression, fatigue compared with peers of a healthy weight (Bertoli et al., 2006; Draheim et al., 2007; Emerson, 2005; Melville, Cooper, McGrother, Thorp, & Collacott, 2005; Pitetti, Yarmer, & Fernhall, 2001; Rimmer et al., 2010; Rimmer & Yamaki, 2006; Yamaki, 2005).

In the United States, between 1997–2000, the rate of obesity (body mass index$\geq$30.0 $kg \cdot m^{-2}$) was 35% in persons with ID versus 21% in the general population (Yamaki, 2005).

Body fatness, physical inactivity and over-nutrition play an important role in cardiovascular disease risk.

Individuals with DS have a different body shape and body proportion than individuals in general population or other individuals with ID. Moreover, women with DS are more likely to be overweight or obese than other individuals with ID (Kelly & Rimmer, 1987; Melville et al., 2005; Usera, Foley, & Yun, 2005).

Different studies have evaluated the effects of exercise on body composition in population with ID. Some of these studies found no significant effects of exercise on the reduction of body composition (Calders et al., 2011; Casey, Boyd, Mackenzie, & Rasmussen, 2012; Casey, Rasmussen, Mackenzie, & Glenn, 2010; Guidetti et al., 2010; Mendonca et al., 2011), whereas others studies have reported significant decrease in body composition and/or BMI (Boer et al., 2014; Elmahgoub et al., 2009; Elmahgoub et al., 2011; Ordoñez, Rosety, & Rosety-Rodriguez, 2006; Savucu, 2010).

Individuals with ID who participated in more frequent bouts of PA or who consumed lower dietary fat intakes lowered their risk for hyperinsulinemia and abdominal obesity by one third compared to those who participated in less frequent PA or who consumed higher fat intakes (Draheim, Williams, & McCubbin, 2002).

It would appear that more stringent nutritional guidelines and opportunities to participate in carefully prescribed moderate to vigorous PA and different options to combine programs of exercise and nutrition diet should be made available for people with ID.

2.8.3 *Strength*

In general, muscle strength can be defined as the ability of the muscles to deform a body or modify its acceleration: to begin or stop the movement of a body, to increase or decrease its velocity or to make it change its direction. It can be refer to the maximal one-effort force or strength endurance, where muscles apply force repeatedly for certain period of time (Bompa, 1995; López Chicharro & Izquierdo Redín, 2006).

The strength capacity arrives to its peak value at the age of 20-30 years old; it remains stable until approximately 50 years old when it begins to decrease. Between 30 and 80 years old the decrease of muscle strength is calculated to be 30-40%, and static and concentric strength reduction is greater than peak eccentric one. Several studies confirm that the capacity to produce fast strength decreases more than the peak strength, especially in advanced ages. This strength reduction is due to the muscle mass loss (because of atrophy or decrease number of muscle fibers) and because of the disturbances in the metabolism of contractile proteins. There are also alterations at neuronal level, specifically in the intramuscular and intermuscular coordination, in the capacity of using the reflex activity and the sensitive and motor information process in the highest levels of the Central Nervous System. The loss of motor units, even in healthy and active individuals, seems to be responsible of the strength reduction. Until the 60 years of age, the number of functioning motor units has few alterations, but it is since 70 years old when these units may be reduced to less than the half. Some authors estimate that the cause could be that the motor units formed by fast fibers are the most affected by the degenerative process, so the slower motor units would be an important part of the muscle activity in aging, determined by the decrease of muscle protein (Pezarat & Silva 1999, cited in Martín Rodríguez, 2006).

The health benefits of enhancing muscular fitness have become well established in the past (Williams et al., 2007). Higher levels of muscular strength are associated with significantly better cardio-metabolic risk factor profiles, lower risk of all-cause mortality fewer CVD events, lower risk of developing functional limitations, and nonfatal disease (FitzGerald et al., 2004; Gale, Martyn, Cooper, & Sayer, 2007; Jurca et al., 2004, 2005; Manini et al., 2006; Newman et al., 2006). Resistance training may prove to be effective to prevent and treat the ‘‘metabolic syndrome’’. Importantly, exercise that promotes muscle strength and mass also effectively increases bone mass (bone mineral density and content) and bone strength of the specific bones stressed, and may serve as a valuable measure to prevent, slow or may reverse, the loss of bone mass in people with osteoporosis (Kohrt, Bloomfield, Little, Nelson, & Yingling, 2004; Maïmoun & Sultan, 2011; Suominen, 2006).

A resistance training program emphasizing dynamic exercises involving concentric (shortening) and eccentric (lengthening) muscle actions that recruit multiple muscle groups (multijoint exercises) is recommended, including exercises targeting the major muscle groups of the chest, shoulders, back, hips, legs, trunk, and arms. Single-joint exercises that isolate functionally important muscle groups such as the abdominals, lumbar extensors (lower back), calf muscles, hamstrings, quadriceps, biceps, etc., should also be included. To prevent muscular imbalances, training opposing muscle groups (antagonists), such as the quadriceps and hamstrings, as well as the abdominals and lumbar extensors, is important (American College of Sports Medicine, 2009a, 2009b, 2010, 2011).

A different number of studies have shown that sedentary adults and athletes with ID demonstrate lower strength measures compared to individuals without ID (Croce, Pitetti, Horvat, & Miller, 1996; Horvat, Croce, Pitetti, & Fernhall, 1999; Horvat, Pitetti, & Croce, 1997; Mendonca et al., 2011; Van de Vliet et al., 2006).

There is also evidence that individuals with ID may have disturbed central and peripheral processing components as indicated by the longer reaction and motor times (Davis, Sparrow, & Ward, 1991; LeClair, Pollock, & Elliott, 1993); and the associations of intelligence and/or general mental ability with peripheral (Tan, 1996) and brain (Reed, Vernon, & Johnson, 2004) nerve conduction velocities and with neural transmission (McRorie & Cooper, 2003; Mcrorie & Cooper, 2004). At the same time, individuals with ID demonstrate damage in the integrity of white matter tracts that are responsible for the processing and control of sensory and motor information controlling arousal and motor function that may affect motor-neuronal recruitment and movement control during sustained effort (Yu et al., 2008).

Pitetti & Yarmer (2002) reported that for all age groups, males and females without ID were significantly stronger than their same-gender peers with ID for all isometric strength measurements. For individuals with ID, particularly decreasing leg and back strength is a serious health and social concern. Muscle strength, especially lower body muscle strength, for persons with ID is fundamental for overall health, for improving vocational productivity and for gaining independence in activities of daily living (Fernhall, 1993; Pitetti & Yarmer, 2002).

Relationship between upper body strength and aerobic capacity and a significant positive relationship between maximal aerobic capacity and isokinetic leg strength were demonstrated (Pitetti & Boneh, 1995; Pitetti, Fernandez, Pizarro, & Stubbs, 1988; Pitetti & Fernhall, 1997). Nevertheless, the studies by Cowley et al. (2011) and Nasuti et al. (2013) have not found relations between leg strength and maximal aerobic capacity.

Other studies focused on strength training found significant increases in muscle strength (handgrip strength, leg strength) and balance among individuals with ID (Calders et al., 2011; Carmeli et al., 2005; Guidetti et al., 2010; Mendonca et al., 2011; Shields, Taylor, & Dodd, 2008; Suomi, 1998; Tsimaras & Fotiadou, 2004). These studies varied in their training methods, but all assessed muscle strength of at least two different muscle groups.

Overall, the studies reported strength increases from baseline, ranging from 10% to 29%, although one study demonstrated an improvement of women's knee flexion improvement of 50% (Carmeli et al., 2002). Shields, Taylor & Dodd (2008) reported within-group improvements in muscle strength for the intervention group but no significant differences in muscle strength between intervention and control groups.

Improvements in strength were also noted within the intervention group in the study by Podgorski et al. (2004), but this study did not have a control group for comparison. Cowley et al. (2011) found that progressive resistance training is an effective intervention for persons with DS to improve leg strength and stair-climbing ability.

A randomized controlled trial investigated the effects of a student-led progressive resistance training program in adolescents and young adults with DS and noted that the intervention group increased their upper and lower limb strength at week 11 compared to the control group, but only their lower limb muscle strength at week 24 (Shields et al., 2013).

These studies are showing that systematic and well-designed training can elicit increases in muscle strength and endurance in adolescents and adults with ID and to be able to improve and normalize the muscle strength level; people with ID must take part of progressive resistance exercise programs.

2.8.4 *Flexibility*

Flexibility is the ability of body segments to move through typical ranges of motion achievable without injury at a joint or group of joints. This ability is developed until when adulthood is reached (20-25 years) and decreases with age, with an evident reduction since 55-60 years old (Alarcón, 2011; Sáez-Pastor, 2005).

Maintaining flexibility is lifelong need and it is important to locomotor system, balance and coordination. Flexibility gives physical support to the everyday living activities and decreases the incidence of accidents. Poor flexibility may cause muscle-skeletal problems, especially around the shoulder, lumbar and hip regions (American College of Sports Medicine, 1998, 2011).

Stretching exercises increase tendon flexibility through two major effects on the muscle tendon unit, mechanoreceptor mediated reflex inhibition and viscous-elastic strain. Increased tension in the muscle-tendon unit is detected by proprioceptors in the tendon and muscle, which inhibit further agonist muscle contraction and induces relaxation in the antagonist unit. Theoretically, this reflex inhibition prevents excessive strain injury and may account for short-term increases in flexibility immediately after stretching (American College of Sports Medicine, 1998).

The same as with strength, the loss of flexibility is specific to each joint and each movement, and the less damaged those which are done with different movements of upper limb. So, besides the degenerative alterations of joints and muscle mass typical of aging, the reduction of PA seems to be one of the first causes of flexibility loss (Brown & Holloszy, 1991).

Associated age related skeletal changes such as degenerative joint disease and osteophyte formation may further limit motion in the joints. This loss of flexibility can significantly impair an individual's ability to accomplish daily activities and perform exercise (American College of Sports Medicine, 1998).

Low levels of flexibility have been associated to injuries, especially in the spine, and to the walking troubles and daily tasks performance in an independent way (Wood, Reyes-

Alvarez, Maraj, Metoyer, & Welsh, 1999). Nonetheless, others studies have not found a consistent link between regular flexibility exercise and reduction of exercise-related injury, prevention of low back pain or important reductions in delayed-onset muscle soreness (Almeida, Williams, Shaffer, & Brodine, 1999; Fields, Sykes, Walker, & Jackson, 2010; Herbert, de Noronha, & Kamper, 2011; McHugh & Cosgrave, 2010; Thacker, Gilchrist, Stroup, & Kimsey, 2004)

Some studies emphasize the great importance of flexibility in adults and seniors, that benefits the functional mobility and, in consequence, the quality of life. It is important to remember that flexibility is one of the physical capacities that begins to decrease earlier and quicker in adults and elderly (American College of Sports Medicine, 1998, 2011; Chesworth & Vandervoort, 1989; Nelson et al., 2007).

Different studies have suggested that stretching exercises may enhance muscle performance. Worrell (1994) demonstrated increased peak torque generation in hamstring muscle with flexibility training. In another study (Wilson, Elliott, & Wood, 1992) authors have reported improved rebound bench-press performance after flexibility training which was attributed to a reduction in the series elastic component stiffness of the upper extremities. These findings are contradicted somewhat by studies on running economy that have demonstrated an inverse correlation with hip flexibility (Beaudoin & Whatley Blum, 2005; Craib et al., 1996; Trehearn & Buresh, 2009). But Mojock et al. (2011) have suggested that the performance decrements previously associated with stretching may not occur in trained women.

Studies developed until now allow to state that PA contributes to increase the flexibility levels, and because of its importance, they recommend to always trained this capacity and never stop working it (American College of Sports Medicine, 2009c, 2011).

Individuals with disabilities, who are often inactive, lose flexibility and it often complicates the ability to move. Although some individuals, like persons with Down syndrome, may have more muscle flexibility than the others (American College of Sports Medicine, 2009b).

In a 13 years follow-up study (Graham & Reid, 2000) they did not find changes in women's and men's flexibility with ID. On the contrary of what it has been thought, in this study the values obtained were slightly better, but not significantly after 13 years. In the same line, Carmeli et al. (2002) found no changes in flexibility.

Other works with persons with ID did find improvements on flexibility (Giagazoglou et al., 2013) after different kinds of training programs. Meanwhile, a meta-analysis performed by Chanias et al. (1998) found that exercise interventions have small effects for flexibility.

Cuesta-Vargas et al. (2011) found that women with ID showed better results for flexibility than men. Interestingly, when athletes con ID were compared with athletes without ID, Van de Vliet et al. (2006) found best flexibility values in athletes with ID.

A series of exercise targeting the major muscle-tendon units of the shoulder girdle, chest, neck, trunk, lower back, hips, posterior and anterior legs, and ankles are recommended. For most individuals, this routine can be completed within 10 minutes (American College of Sports Medicine, 2011).

2.8.5 *Balance and coordination*

Balance is important for everyone; it is needed in order to sit, stand and move independently, and to walk or run without falling so it is important to have good balance to stay mobile and prevent falls. Balance is also crucial to PA which, in itself, is a well-known, important determinant of a healthy lifestyle and well-being. Some studies have reported that people with ID may have reduced balance ability compared with people who have not intellectual disability (Hale, Miller, Barach, Skinner, & Gray, 2009; Lahtinen, Rintala, & Malin, 2007).

In the same line, adults with ID do experience a higher rate of injuries and falls when compared with the general population (Finlayson, Morrison, Jackson, Mantry, & Cooper, 2010); a further indication that the effects of deficits in the function of balance are major in ID people (Hale, Bray, & Littmann, 2007; Sherrard, Tonge, & Ozanne-Smith, 2001). The extended lifespan of adults with intellectual disability will likely increase their risk and rate of falls in their later years (Hsieh, Rimmer, & Heller, 2012). As reported by Cox et al. (2010) in the general population, increasing age presents a risk to people in their 70s or older, whereas in their study there were notable increases in falls for people with ID in their 40s and 50s. Furthermore, Chiba et al. (2009) reported a 2.5 times higher fall risk in those over 50 years of age compared to those younger than 50 years of age. The results of another study showed that females have poorer balance capacities than males and that balance capacities decrease with increasing age (Oppewal, Hilgenkamp, van Wijck, & Evenhuis, 2013).

Delays in motor development, to varying degrees, negatively impact individuals' motor and physical capabilities and these motor problems, balance, and difficulties in the integration of perceptual information into motor action are common in persons with ID (Cleaver, Hunter, & Ouellette-Kuntz, 2009). These problems may result in inadequate solutions to daily tasks, increase in falls and injury risks (Carmeli, Bar-Yossef, Ariav, Levy, & Liebermann, 2008; Cox et al., 2010).

Although falls are influenced by multiple variables, lack of balance and motor coordination are latent factors in individuals with ID. Falls are a predominant cause of serious injury for individuals with ID and constitute a special topic for adults with ID, as 24% of those that have suffered a fall required medical care and over 50% of injuries in this population are caused by falls (Grant, Pickett, Lam, & Connor, 2001; Hsieh, Heller, & Miller, 2001; Hsieh et al., 2012). At the same time, falls risk are reported to be significantly correlated with ID levels (Hsieh et al., 2012).

Four of the analyzed studies evaluated balance. Different methods of balance assessment were used in the studies, but all methods were supported by prior studies of reliability and validity. Studies by Carmeli et al. (2004, 2005) and Carmeli, Kessel, et al. (2002) used one or both the Timed Up and Go Test (Podsiadlo & Richardson, 1991) and the Functional Reach Test (Duncan, Weiner, Chandler, & Studenski, 1990). The study by Carmeli et al. (2004) also used the physical performance test. The study by Tsimaras & Fotiadou (2004) used a balance deck to assess balance. For the four studies analyzed, balance improvements were between 9% and 25% for intervention groups compared with control groups. Cluphf et al. (2001) did not specifically measure balance but measured walking ability and showed a 6% improvement in walking times in the intervention group.

Fortunately, a growing concern on research about balance and falls management in people with ID was found in the analyzed literature. At the same time, it gave us a general idea that adults with ID, can improve their balance ability with systematic and well-designed training programs (Carmeli, Kessel, Merrick, & Bar-Chad, 2004; Giagazoglou et al., 2013; Tsimaras & Fotiadou, 2004).

2.9 Physical Training effects in persons with Intellectual Disabilities

There is moderate to strong evidence that PA positively affects health-related physical fitness parameters, like balance, muscle strength and quality of life in individuals with ID (Bartlo & Klein, 2011; Chanias et al., 1998; Heller et al., 2011), which provides credence for PA recommendations in this population.

Aerobic training should be considered an integral part of a PA programs for adults with ID. Walking has been considered an easy mode of exercise due to low cognitive training needs and cost effectiveness. Different reviews have found that exercise programs have an important effect on cardiovascular endurance in people with ID (Bartlo & Klein, 2011; Chanias et al., 1998; Shin & Park, 2012). At the same time, resistance training in the studies analyzed in these reviews exhibited a positive impact on strength, balance, and in some cases functioning (Carmeli et al., 2002; Podgorski et al., 2004; Tsimaras & Fotiadou, 2004). Heller et al. (2011) suggested that PA programs not only improved fitness, but also promoted less maladaptive behaviors and improved adaptive behaviors, better attitudes toward exercise, and improved life satisfaction.

The review by Dodd & Shields (2005) and the study by Mendonca & Pereira (2009) indicated that cardiovascular PA programs for people with DS were effective in increasing VO_2 peak, peak minute ventilation, maximum workload achieved, and time to exhaustion. In the same line, combined cardiovascular and strength exercise training programs have shown significant improvements in VO_2 peak, muscular strength and muscular endurance (Calders et al., 2011; Elmahgoub et al., 2009; Mendonca et al., 2011; Rimmer et al., 2004).

Chanias et al. (1998) reported that the effect of PA programs on flexibility was small but significant. Guidetti et al. (2010) that used specific training programs for track and field athletes and basketball players did not found changes in the SRT.

Shin & Parker (2012) and Bartlo & Klein (2011) suggest in their studies that exercise programs including muscular endurance and strength can significantly affect performance of their participants. Some analyzed studies reported significant balance improvements in the participants after programs where balance and/or resistance training were the main components (Carmeli et al., 2004, 2005; Carmeli, Kessel, et al., 2002; Tsimaras & Fotiadou, 2004).

In the same line, combined exercise programs report increases in strength (Calders et al., 2011; Elmahgoub et al., 2009; Elmahgoub et al., 2011; Guidetti et al., 2010; Mendonca et al., 2011)

Chanias et al. (1998) have observed that health-related physical fitness does not have a significant effect on body composition and Shin & Park (2012) in their meta-analyses found that the effect size of biometric outcomes and body composition data was small and insignificant. In intervention studies, different authors have failed to demonstrate significant weight loss despite improvements in fitness (Casajus et al., 2012; Casey et al., 2012; Casey et al., 2010; Pitetti & Tan, 1991; Pommering et al., 1994). Conversely, studies by Mendonca & Pereira (2009), Ordoñez et al. (2006) (aerobic exercise program) and by Elmahgoub et al. (2009; 2011) (combined exercise program) have reported a significant decrease in fat mass and increase in fat free mass. In the same direction, others studies that have implemented a combined exercise program have reported a significant decrease in BMI or body weight (Guidetti et al., 2010; Mendonca et al., 2011; Rimmer et al., 2004)

Regarding the moderating effect of the duration of exercise, less than 10 weeks was most effective in affecting exercise outcomes (Shin & Park, 2012), meanwhile Dodd &

Shields (2005) informed that 12 to 16 weeks could be a good duration to obtain significant changes. Previous meta-analysis have indicated that exercise programs with a duration of more than 9 weeks may have significantly larger effects than shorter programs on cardiovascular and muscular endurance (Chanias et al., 1998).

Shin & Park (2012) informed that short-duration exercise had a better effect than long-duration exercise, and the effect of exercising 4 times a week was better than the effect of exercising 3 times a week, whereas Dodd & Shields (2005) showed that sessions should be held 3 times a week. The most effective duration of exercise was between 30 to 60 minutes (Dodd & Shields, 2005; Shin & Park, 2012), and exercise was more effective for older people than for younger people with ID. Regarding intensities, Dodd & Shields (2005) suggest that exercise sessions should be performed between 50% to 75% of the VO_2 peak.

Combined cardiovascular and strength exercise training programs have shown significant improvements in VO_2 peak, muscular strength, endurance and a slight reduction in body weight and fat mass (Calders et al., 2011; Elmahgoub et al., 2009; Mendonca et al., 2011; Rimmer et al., 2004). Specifically, Calders et al. (2011) demonstrated greater improvement in strength measures, functional measures, systolic blood pressure and total cholesterol using a combined aerobic-resistance training protocol (12 week) over an endurance –only training group, while both the combined and endurance-only training groups (n=15 each group) experienced similar increases in aerobic capacity.

Collectively, these studies suggest that exercise training, and perhaps combined resistance-aerobic training, are beneficial in individuals with ID.

As far as it is known, even though flexibility and balance have been evaluated after several PA programs including aerobic a strength training, they have not been associated to any other PA program developed with persons with ID.

Most of the PA programs implemented are short lived or report challenges about their implementation because of the lack of local partnerships with mainstream sport and care providers, transportations issues, negative perceptions of the PA program with staff, availability of staff to accompany participants and lack of financial support (Naaldenberg et al., 2013). PA programs implemented as research should be sustainable and to take into account these challenges before they could be implemented, so after the research period has ended the local institution could continue with them.

2.10 Physical Fitness Evaluation in persons with Intellectual Disabilities

Measurement of physical fitness is a common and appropriate practice in preventive and rehabilitative exercise programs. The purposes of health-related fitness testing in such programs include the following (American College of Sports Medicine, 2010):

- Educating participants about their present health-related fitness status relative to health-related standards and age- and sex-matched norms.
- Providing data that are helpful in development of exercise prescriptions to address all fitness components.
- Collecting baseline and follow-up data that allow evaluation of progress by exercise program participants.
- Motivating participants by establishing reasonable and attainable fitness goals.
- Stratifying cardiovascular risk.

2.10.1 *Cardiorespiratory Tests*

a) Laboratory tests:

Aerobic laboratory tests obtaining metabolic data have been used in population with ID, but due to several difficulties already shown previously, not all of them are reliable and valid. Moreover, it is always necessary to work familiarization sessions before testing in order to get accurate data.

The use of maximal treadmill test with open circuit spirometry allows for the direct and accurate assessment of VO_2 and anaerobic threshold in this population. This test have been showed to be a reliable and a feasible test (Fernhall, Millar, Tymeson, & Burkett, 1990; Fernhall & Tymeson, 1987).

a) Field tests:

There are numerous field test used in the general population to indirectly evaluate cardiorespiratory capacity. In population with ID many of them have been used, too, and if it was necessary, they have been adapted to this population.

- The 600-yard walk/run test was found to be a valid and reliable for adolescents with mild to moderate ID (r = .98) (Fernhall et al., 1998).

- The 1.5 mile run test appears to be a valid test as an indicator of cardiovascular fitness for adults with ID. It correlated significantly with VO_2 peak (r = .88) (Fernhall & Tymeson, 1988)

- Test de Leger y Lambert or 20 meters shuttle run was studied by Fernhall et al. (2000) and found an ICC = .94 on the 20 meters shuttle run for children and adolescents with ID, meanwhile Mac Donncha et al. (1999) also revealed an ICC = .94 for adolescents with ID. Conversely, Guerra et al. (2003) in adolescents with DS and Gillespie (2009) in children with ID have found lowers intraclass coefficients than previous studies in this test (ICC = .54 and ICC = .53 respectively).

- Modified 16 meters shuttle run was found to be a valid and reliable test by Fernhall et al. (1998) in children with ID. It correlated significantly with VO_2 peak (r = .72).

- The modified step test, which is a modified version of the test created by Jetté et al. (1976), was found to have a high test-retest reliability in people with ID (ICC = .98; Graham & Reid, 2000).

- The 10 meters incremental shuttle walking test, used by Hilgenkamp et al. (2012), was found to have a very good test-retest reliability in adults with ID (same-day ICC = .90;

two-week interval ICC = .71).

2.10.2 *Body Composition Tests*

Anthropometric methods for body composition assessment are (Esparza Ros, 1993):

1. Direct laboratory methods: the values obtained with these techniques are quite accurate, but are invasive techniques, so its use is practically unviable; they would give us direct values without the necessity of posteriors transformation equations (Sirvent Belando & Garrido Chamorro, 2009). These two methods are:

- Body dissection, very difficult and with technical problems.

- Tissue biopsy, but its viability is greatly limited due to technical requirement of penetration in human tissues.

2. a) Indirect laboratory tests:

- Hydrodensitometry (Underwater) weighing: this technique of measuring body composition is based on Archimedes' principle, which states that when a body is immersed in water, it is buoyed by a counterforce equal to the weight of the water displaced. This loss of weight in water allows calculation of body volume. This is the technique used as a criterion for the calculation of body composition (American College of Sports Medicine, 2010). Hydrodensitometry weighing has a high reliability (r = .98 to .99) as reported by Rimmer, Kelly & Rosetsweig (1987), which validated the formula of Durnin & Womersley (1974) as the best in men to calculate body fat % through skinfolds (r = .84). While the most suitable equation for women was the formula of Jackson, Pollock & Ward (1980) (r = .92).

- Dual-energy X-ray absorptiometry (DEXA): these scanners remain relatively straightforward to operate with no need for participant involvement, an important consideration when working with individuals with ID, and have reported accurate measurements in diverse populations (Pritchard et al., 1993). The study performed by Temple et al. (2010) found a high correlation between DEXA and BMI as indicators of adiposity in people with ID. González Agüero et al. (2011) have not found differences in body fat % measured with DEXA and plethysmography in children and adolescents with DS.

- Plethysmography: In this test body volume also can be measured by air rather than water displacement. One commercial system uses a dual-chamber plethysmograph that measures body volume by changes in pressure in a closed chamber. This technology shows promise and generally reduces the anxiety associated with the technique of hydrodensitometry. It has been shown as a valid and reliable method in the general population (American College of Sports Medicine, 2010).

- Bioelectrical impedance analysis (BIA): the accuracy of BIA is similar to skinfolds, as long as a stringent protocol is followed and the equations programmed into the analyzer are valid and accurate for the populations being tested (American College of Sports Medicine, 2010). Rieken et al. (2011) reported that BIA is more accurate at assessing nutritional status in this population than is the measurement of skinfold thickness.

- Near-infrared intercadence requires additional research to substantiate the validity and accuracy for body composition assessment.

2. b) Indirect field tests for the study of body composition:

It is based on anthropometric measures that include height, weight, waist and hip circumferences, and skinfolds. Although skinfold measurement are more difficult than other anthropometric procedures, they provide a better estimation of body fatness than those based only on height, weight, and circumferences.

- The BMI, or Quetelet index, which shows the degree of overweight and obesity, is used to assess weight related to height and it is calculated by dividing body weight in kilograms by height in meters squared ($kg \cdot m^{-2}$).

These are simple measures that provide a convenient and inexpensive alternative to estimate body composition, and thus be frequently used in clinical studies and fitness condition.

- Skinfold Measurements: body composition determined from skinfold measurements correlates well ($r = .70$ to .90) with body composition determined by hydrodensitometry. The principle behind this technique is that the amount of subcutaneous fat is proportional to the total amount of body fat. It is assumed that close to one third of the total fat is located subcutaneously. The exact proportion of subcutaneous-to-total fat varies with sex, age, and ethnicity. Therefore, regression equations used to convert sum of skinfolds to percent body fat must consider these variables for greatest accuracy (American College of Sports Medicine, 2010). Usera et al. (2005) reported a correlation of $r = 0.54$ between skinfold method and plethysmography, but recommended to develop new equations for DS people.

2.10.3 *Strength Tests*

a) Laboratory strength test:

- Isokinetic strength for arm and leg musculature: these tests are reliable and efficient methods of estimating the strength of muscles involved in elbow and knee flexion and extension of individuals with ID (Pitetti, 1990). Good and very good test-retest reliability were found in different studies ($ICC > 0.72$; Pitetti et al. (1992) and $ICC > .82$; Suomi (1998)).

b) Field strength tests:

- 1-RM tests: these tests have been showed to be reliable and feasible tests in population with ID by Rimmer & Kelly (1991) (ICC ≥ .95).

- Leg and lumbar dynamometry: Bofill (2008) did not found in population with DS differences between 3 different leg dynamometry tests performed in three different days. More research will be needed to establish reliability and validity for these tests.

- Hand grip dynamometry: Bofill (2008) did not found differences between 3 different Hand grip tests in people with ID. Hilgenkamp et al. (2012) found a very good test-retest reliability for this test (same-day interval ICC = .94; two-week interval ICC = .90). In the same line, Graham & Reid (2000) reported a very good test-retest reliability for the Hand grip test (ICC = .98).

- Sit-ups test: Graham & Reid (2000) reported a very good test-retest reliability (ICC = .93).

- Push-ups: Graham & Reid (2000) reported a good test-retest reliability (ICC = .80).

- The 30 seconds chair stand test (30s CS) (Rikli & Jones, 2001). This test used to assess muscle endurance have been found to have a good reliability and validity in the general older population (Gill & McBurney, 2008). Test–retest reliability in older adults with ID was moderate (same-day interval ICC = .72; two-week interval ICC = .65) (Hilgenkamp et al., 2012).

- Standing long jump test: this test is part of the Eurofit Special, but no reliability values have been reported.

2.10.4 *Flexibility Tests*

a) Laboratory flexibility test:

- Goniometry: is the technique of measurement of the angles created by the intersection of the longitudinal axes of the bones at the joints levels. Its objectives are to assess the position of a joint in space and evaluate the range of motion of a joint in each of the three planes of space. To evaluate these angles there are manual, digital and electronic goniometers.

b) Field flexibility tests:

- Sit and reach test: Giagazoglou et al. (2013) have used the sit and reach test with people with ID. A very good reliability for this test in people with ID was found by Mac Donncha et al. (1999).

- The Extended version of the Modified Back-Saver Sit-and-Reach Test: this test have showed a very good test-retest reliability in older adults with ID (same-day interval ICC > .94; two-week interval ICC ≥ .63) (Hilgenkamp et al., 2012).

- Functional shoulder rotation test (FSRT): reliability was assessed by Boström et al. (1991) in patients with rheumatoid arthritis. Not reliability test-retest was found for people with ID.

2.10.5 *Balance and Coordination Tests*

a) Laboratory balance and coordination test:

- Balance deck: Tsimaras et al. (2004) used a balance deck to assess balance in people with ID, but no values for reliability were reported.

- Pressure platform: Giagazoglou et al. (2013) used a pressure platform to assess static balance in people with ID. Tests durations were 30 seconds and participants performed one-leg stance with opened ayes and double-leg stance with eyes opened and closed. No values for reliability were reported.

- Force platform: a force platform was used by Blomqvist et al. (2012) to assess static balance in people with ID. Tests durations were 30 seconds and participants performed one-leg stance (ICC = .89).

b) Field balance and coordination test:

- Functional reach test: this test was used by Carmeli et al. (2004) in people with ID. No reliability values for this population are reported.

- Modified forward reach test: test-retest reliability was assessed by Blomqvist et al. (2012) and found a good reliability (ICC = .80).

- One leg stand test: Blomqvist et al. (2012) reported a very good test-retest reliability for this test (ICC = .88) in young adults with ID. The maximum time was set to 30 seconds.

- Walking speed test (Walking at a Comfortable Speed and Walking at a Fast Speed; Bohannon, 1997): was found to have a very good test-retest reliability in older adults with ID (Same-day ICC = .96 and two-week interval ICC ≤ .90) (Hilgenkamp et al., 2012).

- Dynamic one-leg stance test: in this test fair-to-good reliability was found for young adults with ID (Blomqvist et al., 2012).

- Timed up and go test (9 meters): was used to measure the dynamic balance and gait speed by Carmeli et al. (2005). Blomqvist et al. (2012) reported a very good test-retest reliability (ICC = .92) in people with ID.

- Timed up and go test (3 meters; Mathias, Nayak, & Isaacs, 1986): was used by Carmeli et al. (2002) but no values for test-retest reliability are reported.

- The Berg balance scale: consists of 14 balance tasks with varying difficulty. Validity and reliability in the general older population have been demonstrated previously with very good test–retest reliability (ICC > .90; Steffen & Seney, 2008) and in the older population with ID (ICC = .96; de Jonge, Tonino, & Hobbelen, 2010).

3. AIMS AND HYPOTHESES

3.1 Aims and hypotheses

The main purpose of the study was to show the physical and physiological effects of a CPAP including balance training, in adults with ID. For this purpose, it was necessary to use several tests and equipment in this population and check its reliability and validity.

The secondary aims of the present study were:

1. To measure the reliability of the vertical jump test (VJT) to assess leg power with a contact platform and its correlation with the standing long jump test (SLJT) used in the Eurofit special.
2. To propose a combined PA program (CPAP) adapted to adults with ID.
3. To determine the effects and functional changes in the participants after a 14-weeks CPAP including aerobic, strength and balance training was implemented.
4. To determine PA levels between participants included in the CPAP and PA levels of those participants not included in the CPAP through accelerometry.

These aims were based on three initial work hypotheses:

1. With a modified VJT it will be possible to assess leg power in adults with ID.
2. A CPAP will improve the health-related fitness in people with ID: CRF, body composition, isometric strength and balance.
3. PA levels in this population will increase with a CPAP intervention.

4. MATERIAL AND METHODS

4.1 Participants

4.2 Study Design

4.3 Ethical concerns

4.4 Testing Procedures

4.5 Exercise Protocol

4.6 Statistical Analysis

4.1 Participants

A total of 92 adults (51 male/41 female) between 20 to 60 years old, with mild to moderate ID were recruited from an Occupational Day Center for people with ID (Girona, Spain). Most frequent activities in this center involved light physical work for 6-7 hours per week. Exclusion criteria included contraindications to exercise, severe to profound ID and medication that may have an important effect to their physical response to exercise.

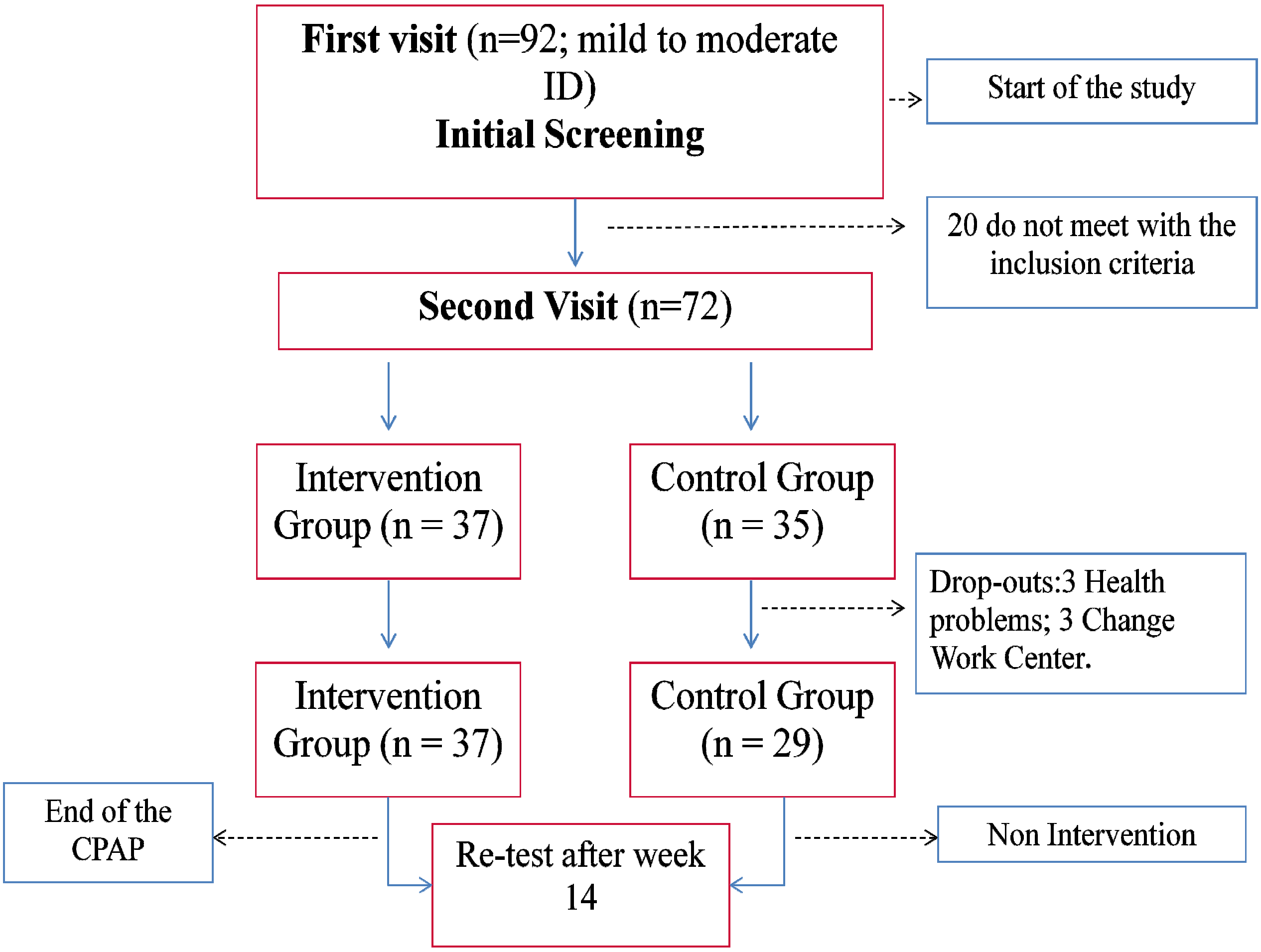

Figure 5. Flow diagram depicting the study process

4.2 Study Design

After the initial screening (Appendix II), 20 were not enrolled because severe to profound ID or exercise contraindications or use of medicines that may have an important effect to their physical response to exercise; which left a total of 72 adults with ID that met the study criteria to participate in the study. They were assigned to the intervention and/or control groups. In the present study we used an attention-control clinical trial design.

The intervention group (IG) with 37 participants, followed a CPAP that included a combination of aerobic, strength and balance training over 14 weeks, at 1 hour per session, 3 times a week. All the participants presented intellectual disability, but 25 participants were unable to retrieve cause of ID etiology. The other 12 were diagnosed as Down syndrome (n = 9), West syndrome (n =1), Cornelia Lange syndrome (n = 1) and Microcephaly (n = 1). Conduct disorder (n =14); epilepsy (n = 2) and autism (n = 2) were associated with ID.

During the first and third week of the study, 6 participants from the control group (CG) dropped out for reasons related to change in work place and health problems, which left the CG with 29 individuals. This group did not participate in any exercise training and were asked to continue with their daily regular activities. In order to control for the fact that the intervention group may have improved their performance simply due to exposure to the researchers and the socialization effect of working in a group, the CG activities were supplemented with weekly visits by the research staff to ensure their daily activities were not changing. Each visit lasted approximately 2.5 to 3 hours. In the CG 21 participants were unable to retrieve cause of ID etiology, meanwhile the others 8 participants were diagnosed as Down syndrome (n = 5), Lennox syndrome (n =1) and cerebral palsy (n = 2). Conduct disorder (n =9); epilepsy (n = 2) and autism (n = 1) were associated with ID.

4.3 Ethical concerns

The present study is ethically respectful to the principles of (Amaro et al, 1996; Gillon, 1994): non maleficence, beneficence, autonomy, justice and confidentiality. It also have followed the guidelines of the Helsinki Declaration, as revised in 1975, of the World Medical Association, which regulates the obligatory nature of the informed consent in clinical investigations, as it is a PA study but with the application of sports medical tests. The study was submitted to the Institutional Review Board of the University Ramon Llull which gave its agreement to perform it.

That is why all participants and their parents and/or legal guardians signed an informed consent to participate. All subjects and their parents were informed about the purpose of this study, its risks and procedures. Through a meeting, the project was explained and all doubts were clarified. After signing the informed consent a health screening questionnaire was completed by each participant’s parent(s) and/or guardian (Appendix II).

4.4 Testing Procedures

All volunteers participated in familiarization sessions prior to testing at the lab facilities. The number of familiarization sessions ranged from 2 to 3.

The tests were performed in two sessions. During the first one, all participants underwent a medical screening prior to testing in order to evaluate possible contraindications (Appendix II). This was followed by body composition measurements (Appendix III). During visit two, participants completed a treadmill test of peak aerobic capacity, strength, balance and flexibility tests (Appendix III). These same tests were repeated at the end of the training period.

4.4.1 *Anthropometric measurements*

Height was measured to the nearest 0.1 cm using a stadiometer (Seca 225, Seca, Hamburg, Germany). Weight was measured to the nearest 0.1 kg on a digital scale (Seca 861, Hamburg, Germany) with the subject wearing lightweight clothing and no shoes. BMI was calculated from weight and height. With a tape measure, waist circumference (WC) was measured three times at the level of the umbilicus.

Skin folds measurements were taken on the right side of the body three times by the same researcher using a Holtain skin fold caliper (Holtain Ltd., Wales, UK) and following the International Society for the Advancement of Kinanthropometry guidelines (Norton et al., 1996). Chest, abdomen and thigh thickness for men and triceps, suprailiac, and thigh thickness for women were obtained. To calculate body density, the Jackson and Pollock equation (1978) (Jackson & Pollock, 1978) was used for men and the Jackson, Pollock and Ward equation (1980) (Jackson et al., 1980) was used for women. Body fat percentage (%) was calculated using Siri’s equation (1961) (Siri, 1961). Bone mass % was calculated using Rocha’s equation, residual mass % was calculated using Wurch’s equation and fat-free mass % was determined thereafter (Esparza Ros, 1993).

4.4.2 *Peak Aerobic Capacity*

All tests were conducted during the morning at a room temperature of 22-24 ºC and relative physical humidity between 55-65%. Before the test, participants were asked to walk at a comfortable pace over 10 meters in a corridor and the velocity was calculated manually three times. The mean velocity of the three tests was used to obtain each participant’s velocity, which was used during the treadmill test. The participants walked on a treadmill (Quasar model, HP Cosmos sports & medical gmbh, Nussdorf-Traunstein, Germany) at their individual pre-determined velocity for 2-3 min, after which grade increased by 0.5% every 30 seconds, up to exhaustion. Peak effort was ascertained by a plateau in heart rate (HR) for all participants.

During the test, at rest and peak values of the following parameters were obtained:

- Respiratory rate (RR, $r \cdot min^{-1}$): also known as the respiration rate or breathing frequency, is the rate (frequency) of ventilation, that is, the number of breaths (inhalation-exhalation cycles) taken within a set amount of time (typically 60 seconds). A normal respiratory rate is termed eupnea, an increased respiratory rate is termed tachypnea and a lower than normal respiratory rate is termed bradypnea. Its normal values are ~ 12 $r \cdot min^{-1}$ (López Chicharro & Izquierdo Redín, 2006; Reaño & Ricart, 2001).
- Ventilation (VE, $L \cdot min^{-1}$): the basic functions of the pulmonary ventilation are the O_2 y CO_2 exchange with the environment, regulating the pH of blood and oral communication. The level of ventilation is regulated from the respiratory center as a function of the metabolic needs, the gaseous state, the balance of acid-base balance of the blood and the mechanical conditions of lung-thorax. The purpose of ventilation is to transport O_2 to the alveolar space so the exchange at the pulmonary capillary space will be done and CO_2 produced at a metabolic level will be evacuated. In a maximal exercise test, its values indicate the magnitude of the response of the lung function, showing the amount of air exchanged per minute. Is values at rest are ~6 $L \cdot min^{-1}$ (López Chicharro & Izquierdo Redín, 2006; Reaño & Ricart, 2001).
- Tidal volume ($L \cdot min^{-1}$): Tidal volume is the volume of air flowing between an inspiration and normal expiration without additional effort. The normal value is approximately 500 ml o 7 $ml \cdot kg^{-1}$.
- Relative oxygen consumption (VO_2, $mL \cdot kg \cdot min^{-1}$): oxygen uptake respect to body weight in milliliters of oxygen consumed per minute per kilogram of body weight.
- Absolute oxygen consumption (VO_2, $L \cdot min^{-1}$): liters of O_2 consumed per minute and its value at rest is ~0.22 $L \cdot min^{-1}$ (López Chicharro & Izquierdo Redín, 2006; Reaño & Ricart, 2001; Wilmore & Costill, 2004).

- Respiratory exchange ratio (RER): is the relation between the produced volume of CO_2 (VCO_2) and the consumed volume of O_2 ($VCO_2 \cdot VO_2^{-1}$). Its value at rest is ~0.8 (López Chicharro & Izquierdo Redín, 2006; Reaño & Ricart, 2001; Wilmore & Costill, 2004).
- Carbon dioxide production (VCO_2, $L \cdot min^{-1}$STPD): is the amount of CO_2 produced by the organism. Its value at rest is ~0.20 $L \cdot min^{-1}$.
- Fraction of O_2 in the expired air(FeO_2%) and Fraction of CO_2 in the expired air ($FeCO_2$%)
- Ventilatory equivalent ratio for O_2 (ERO_2, L): is the ratio between ventilation in liters per minute and oxygen consumption in liters per minute. It is a parameter that indicates the amount of air in liters that must be vented so that the body can use a liter of oxygen. It therefore expresses the degree of effectiveness of the pulmonary ventilation.
- Ventilatory equivalent ratio for CO_2 ($ERCO_2$, L): is the ratio between ventilation in liters per minute and the amount of CO_2 exhaled in liters per minute. Expresses the relationship between the ventilated air and breathe out CO_2.
- End-tidal partial pressure for the O_2 and CO_2: represents the partial pressure of O_2 ($PETO_2$ mmHg) and CO_2 ($PETCO_2$ mmHg) at the end of an exhaled breath.

All these variables were measured breath-by-breath with an automatic gas analysis system (Metasys TR-plus, Brainware SA, La Valette, France) equipped with a pneumotachometer and making use of a two-way mask (Hans Rudolph, Kansas, USA). Gas and volume calibrations were performed before each test, according to the manufacturer's guidelines. Peak values were recorded as the highest value during the last 30 seconds of exercise.

Twelve lead electrocardiogram and HR were monitored continuously during the test (CardioScan v.4.0, DM Software, Stateline, Nevada, USA), whereas blood pressure (BP) was measured with an automatic sphygmomanometer at rest and at the end of the treadmill test (Monitor Omicrom FT, RGB Medical Devices, Madrid, Spain).

When the exercise starts, HR increases directly in proportion to the increase in the intensity of the exercise up to a point close to exhaustion. Some authors suggest that the linear relationship holds up submaximal HRs around 170 beats·min^{-1} and from this point, the HR tends to increase slowly and approaching asymptotically at a maximum value (López Chicharro & Izquierdo Redín, 2006). Achieving the theoretical maximum HR is a criterion for maximality of the stress test. There are many equations to calculate maximum HR based on age. The most commonly used is 220-age in years of the subject. However, it should be keep in mind that this equation is only an approximation and that individual values can vary considerably (Wilmore & Costill, 2004). Specialized regression equations for estimating maximal HR are supported to be superior to the commonly used equation of 220-age for the estimation of maximal HR because influences associated with aging, possible gender differences, health problems and disabilities (Fernhall et al., 2001; Gellish et al., 2007; Gulati et al., 2010; Hawkins & Wiswell, 2003; Tanaka, Monahan, & Seals, 2001).

Blood pressure (BP) is the pressure exerted by the blood against the walls of the vessels, and the term usually refers to the pressure of the blood in the arteries (Wilmore & Costill, 2004). The BP reflects the changes in the cardiac output, HR, peripheral vascular resistance and blood volume. Its assessment is, while simple, very important because it gives valid information about the functioning of the heart as a pump and the resistance of the vascular tree.

The systolic blood pressure (SBP) represents the highest pressure in the artery and corresponds to the ventricular systole. The diastolic blood pressure (DBP) represents the lowest value and corresponds to the ventricular diastole. The SBP and DBP have different responses during exercise depending on the type of contractions performed (especially we can differentiate dynamic and static exercises). The SBP tends to rise during exercise, whereas DBP changes slightly with aerobic exercise and increase with static exercises (López Chicharro & Izquierdo Redín, 2006; Wilmore & Costill, 2004).

4.4.3 *Physical activity levels measurements*

Physical activity levels of the participants in relation to sedentary, light, moderate, vigorous and moderate to vigorous was obtained using the GT3X Actigraph accelerometer (ActiGraph™, Fort Walton Beach, FL, USA; Firmware 4.4.0).

Participants were provided instruction for wearing the accelerometers including placement, wear time and when to return the devices (8 days later). Instructions were given to the participant and carers both verbally on how to wear the accelerometer during all waking hours except while bathing, showering, swimming, and playing contact sports.

The accelerometers were distributed to the participants during the center visits and were picked up 8 days later. The accelerometer was fitted to an elastic waist band and attached to the participant's right hip.

Accelerometer data were downloaded with the ActiLife5 software and imported into a Microsoft Excel template.

Accelerometers were programmed to measure activity in 5 second epochs. Outcome variables were total physical activity (counts/min), steps per day (steps/day), and time spent (mins/day) in sedentary (ST), light (LPA), moderate (MPA), vigorous (VPA), and MVPA intensities. Daily EE (DEE) was calculated using the work-energy theorem (ActiGraph, 2011).

The intensity cut points were replicated from the National Health and Nutritional Examination Survey (NHANES) for adults over 18 years of age (Troiano et al., 2008). These intensity thresholds are: 0 to 99 counts for sedentary (≥ 1.5 METs); 100 to 2,019 counts for light intensity (< 1.5 to < 3 METs), 2,020 to 5,998 counts for moderate intensity (≥ 3 to < 6 METs), and > 5,998 counts for vigorous intensity (≥ 6 METs). Time in moderate to vigorous intensity activity was determined by summing the minutes over the moderate intensity threshold.

Non-wear time was defined by a string of 60 consecutive minutes of zero counts with an allowance for 1–2 minutes of counts between 1 and 100. The zero bout ends when the program encounters a count larger than 100 or three consecutive epochs with counts between 1 and 100.

The number of days necessary to assess habitual PA and estimate weekly PA behavior determined through the literature were four days (Berlin et al., 2006; Hart, Swartz, Cashin, & Strath, 2011). Thus, participants who wore devices for at least four days, with one weekend day, were included in analysis. If participants did not meet these assumptions, they were asked to use the accelerometer during the missing days. For inclusion in the analysis each participant needed a minimum wear time of 10 hours per day (Troiano et al., 2008).

4.4.4 *Functional Test*

6-minute walk test

The six-minute walk test (6MWT) is commonly used to measure the physical performance in adults (Enright & Sherrill, 1998; Enright, 2003), as well as in children with and without diseases (Geiger et al., 2007; Morinder, Mattsson, Sollander, Marcus, & Larsson, 2009).

It assesses the distance that a person can walk in 6 minutes and offers a feasible, objective, and relatively inexpensive way to test functional exercise capacity (ATS Committee on Proficiency Standards for Clinical Pulmonary FunctionLaboratories, 2002).

It is often chosen because it is easier to administer, better tolerated and better reflects activities of daily living than other walk tests (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002; Takken et al., 2009).

The American Thoracic Society (ATS) (American Thoracic Society & American College of Chest Physicians, 2003; ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002) has published standardized guidelines for 6MWT in adults and children.

Early studies looked at the reproducibility of the 6MWT for individuals with cardiovascular disease (Guyatt et al., 1985), and now many studies indicate that the 6MWT also represents a reliable measure for evaluating exercise capacity among different populations including individuals with stroke (Eng, Dawson, & Chu, 2004) and cerebral palsy (Andersson, Asztalos, & Mattsson, 2006) as well as among adults (Harada, Chiu, & Stewart, 1999) and children (Geiger et al., 2007) with and without disabilities (Casey, Wang, & Osterling, 2012; Elmahgoub, Van de Velde, Peersman, Cambier, & Calders, 2012; Guerra et al., 2013; Nasuti, Stuart-Hill, & Temple, 2013; Vis et al., 2009).

The 6MWT was performed at a self-paced velocity in a 30-meter long unobstructed corridor. Participants were asked to cover as much distance as possible within 6 minutes by walking. Participants walked alone without someone walking alongside or physically supporting them and could stop at any time but were encouraged to restart as soon as possible. Throughout the test, participants were continuously verbally encouraged using standard phrases. Covered distance after 6 minutes was measured to the nearest 0.50 meter.

The timed up and go test

The timed up and go test (TUGT) was used to assess motor coordination (dynamic balance and gait speed). The advantages of the test are that it is simple, requires simple tools, and is quick to perform and can be performed by participants who use assisting devices such as a walker, cane or crutches. The target time period to complete this test for older adults with a good level of independence is between 26 and 30 seconds. The procedure was experimentally tested and found to be a highly reliable and valid tool to measure balance and motor functions (Blomqvist et al., 2012; Carmeli et al., 2002; Wall, Bell, Campbell, & Davis, 2000).

The test consists on rising from an armless chair with a seat height of ~46 cm without using the arms, walking 9 meters and going back to the chair sitting again. The time to perform this test was obtained. Three practice and three trials were performed. The best trial was recorded.

4.4.5 *Strength measurements*

Handgrip strength was measured to determine muscle strength . The participant squeezed an isometric handgrip dynamometer (Takei - Physical Fitness TKK 5001, Kogyo co., Ltd., Tokyo, Japan). Participants were in a standing position, arms at their side at 30°

flexion alongside the body. Participants were instructed to squeeze the dynamometer as strong as possible, squeezing only once for each measurement. Three trials were performed with each hand and a pause of 1 minute between each trial was made to avoid the effects of muscle fatigue. Left and right hand were alternated. The best score was recorded to the nearest 0.5 kilogram. The procedure was experimentally tested and found to be a highly reliable and valid tool (Bofill Ródenas, 2008, 2010) .

Leg strength was measured with subjects standing on the foot-plate of a leg dynamometer (Takei-Kiki, Kogyo co., Ltd., Tokyo, Japan), with the scapulae and buttocks positioned flat against a wall. The back of the foot-plate was approximately 15cm from the wall. Participants flexed the legs, sliding down the wall until the leg extension angle was 120°. Participants then reached down with the elbows fully extended. The pull-bar of the dynamometer was placed in the hands and the chain length was adjusted appropriately. Subjects were instructed to extend the legs with maximal effort, pulling the bar continuously. Three trials were performed with a pause of 1 minute between each to avoid the effects of muscle fatigue. The best score from three pulls was recorded to the nearest 0.5 kilogram. The procedure was experimentally tested and found to be a highly reliable and valid tool (Bofill Ródenas, 2008, 2010).

SLJT was used to assess explosive leg power. Participants stood at a starting line marked on the ground with feet slightly apart. A two-foot take-off and landing were used, with swinging of the arms and bending of the knees to provide forward drive. The measurement was taken from take-off line to the nearest point of contact on the landing (back of the heels). The best of three trials was recorded (Mac Donncha et al., 1999; Skowroński et al., 2009).

VJT was performed on a contact platform (Chronojump-Boscosystem, Spain). This test was used to assess the height of a vertical jump. The participant was placed standing on the contact platform, with legs separated to a distance equal to the width of the hip. Then, each participant leaped vertically as high as possible using both arms and legs to assist in projecting the body upwards. At the moment of the jump, a flexo-extension of legs and hip and the help of the arm swing were performed to jump as high as possible. The subject must fall with outstretched legs and touch the contact platform with their tiptoes before the rest of the feet. Three trials were performed and the best was recorded. Between trials, participants rest for 1 minute. Data were analyzed using manufacturer's specific software (Chronojump v0.9.0.3.0, Spain). Even though reliability and validity of the system was tested in a previous study (De Blas, Padullés, López del Amo, & Guerra-Balic, 2012), the reliability in people with ID was calculated in the present study.

4.4.6 *Flexibility measurements*

Flexibility was measured by the sit and reach test (SRT). The participant sat on the floor, without shoes, in front of a sit and reach box, with the feet flat against the apparatus. Participants were instructed to reach as far as possible maintaining the legs straight and the arms extended for 2 seconds. The 0 point was where the feet were flat against the apparatus. Negative values were recorded when participants couldn’t reach the feet and positive values were recorded when reached behind the feet. Three practice and three trials were performed. The best trial was recorded to the nearest cm. (Mac Donncha et al., 1999; Skowroński et al., 2009).

Shoulder flexibility was assessed using the functional shoulder rotation test (FSRT) in the upright position. The extremity to be valued was above the shoulder on the same side, elbow pointing upward, the palm facing downwards and inwards and fingers extended. The other arm was placed behind the back, palm outward. The distance (centimeters) between extended middle fingers of both hands was assessed. The distance that was missing to join the extended middle fingers was classified as negative distance and the overlap of this, was a positive distance. Three trials were performed by either side, recording the best of them. The reliability of this test was assessed in a previous study (Boström et al., 1991).

4.4.7 *Balance measurements*

The single leg stand test (SLST) was used to assess the ability to stand successfully on a single leg. Participants stood upright without shoes, with hands on their hips. They balanced on their preferred leg with the non-supporting foot placed against the inside knee of the supporting leg. The duration of this position was recorded in seconds. The maximum time was set to 30 seconds. Three practice and three trials were performed. The best trial was recorded. The procedure was experimentally tested and found to be a highly reliable and valid tool (Blomqvist et al., 2012; Giorgetti, Harris, & Jette, 1998; Vellas et al., 1997).

Postural sway was assessed with a pressure platform (Podoprint Balance Platform, Namrol, Barcelona, Spain). All participants performed a double leg stance with closed eyes. Participants were instructed to stand erect on the platform with no shoes, motionless and with the arms by their sides. Heels were separated by 3 cm and toes forming a 30º angle. The software requires each participant to maintain this position for 52s. Three trials were performed with a 60 s rest between trials. Total travel distance (TTD), radial area (RA), mean mediolateral (MLD) and mean antero-posterior (APD) displacements of the center of pressure (COP) were measured at a frequency of 100Hz using manufacturer's specific software (PodoPrint v2.6, Namrol, Barcelona, Spain).

4.5 Exercise Protocol

Table 5 depicts the 3 phases of the progressive 14 weeks training period and Table 6 shows the different components of the CPAP.

All exercise sessions were performed on-site and were supervised by an exercise scientist (and assistant) and the CPAP was integrated into the center program. The IG exercised 3 days a week (Monday, Wednesday, Friday) for one hour. Each exercise session started with a 3 to 5 minute warm-up, followed by exercise at intensities that would produce HRs compatible to 50% to 80% of their VO_2 peak, as determined by treadmill test. During the last 5 minutes of each session stretching training was used as a cool-down period.

During the first two weeks of the program, participants were taught how to use the equipment safely (free weights, elastics bands, balls, medicine balls, balance board, balance pad), in order to be able to follow the training sessions.

Target heart rates were monitored every session with a pre-programmed Polar RS800CX heart watch monitors (Polar Electro OY, Finland). Endurance training consisted on brisk walking, jogging, running and aerobic dance. Resistance training consisted on biceps, triceps, deltoids, abdominals, quadriceps, hamstrings and gastrocnemius muscle training. During the Phase 1, they performed 2 sets of 15 repetitions. During the Phase 2, they performed 3 sets of 12 repetitions (increasing the weights and tension of the elastics bands). During the Phase 3, they performed 2 sets of 10 to 12 repetitions and a third set until exhaustion (increasing resistance).

Dynamic balance training consist in exercises like toe-to-heel walk, walking on a line, side walking, reverse walking, zig-zag walking and longer strides. The different types of displacements were combined as well as the different speeds at which they were performed.

The static balance training included exercises in different positions, tandem standing, double-leg stance with feet apart and together and one-leg stance.

These exercises were performed at different elevations on the floor and on balance pads (challenging the somatosensory systems), with eyes opened and closed (challenging the visual and vestibular systems).

Table 5.
Combined Physical Activity Program

Phase	Phase I				Phase II					Phase III				
Week	1	2	3	4	5	6	7	8	9	10	11	12	13	14
Sessions/week	3	3	3	3	3	3	3	3	3	3	3	3	3	3
Volume (mins/week)	180	180	180	180	180	180	180	180	180	180	180	180	180	180
Strength (mins/week)	45	45	45	45	55	55	60	60	60	60	60	60	60	60
Strength intensity	50%	50%	50%	55%	55%	55%	60%	65%	65%	70%	70%	70%	70%	70%
Aerobic training (mins/week)	45	45	45	45	60	60	60	75	75	75	80	90	90	90
Aerobic intensity	50%	55%	55%	60%	60%	65%	65%	65%	65%	70-75%	70-75%	70-80%	70-80%	70-80%
Balance and coordination (mins/week)	45	45	45	45	45	45	40	30	30	30	25	20	20	20
Balance and coordination (difficulty)	4	4	5	5	5	5	5	6	6	7	7	8	8	8
Flexibility (mins/week)	45	45	45	45	20	20	20	15	15	15	15	10	10	10
Flexibility (difficulty)	4	4	5	5	5	5	5	6	6	7	7	7	7	7

Table 6.
Components of the Combined Physical Activity Program

Component	Type of exercise	Repetitions[a]	Duration (exercise or repetition)	Session length
Warm-up	- Mobility. - Walking. - Low intensities exercises.	- 3-5 per exercise.	~2 seconds x repetition	~5-10 mins.
Aerobic exercise[c]	- Aerobic dance. - Running. - Fast walking.	Variable.	Variable.	15-30 mins.
Resistance exercise	- Calisthenics exercises[b]. - Resistance exercises. - Elastic bands and free weight are used.	- Phase I: 2 sets x 15 repetitions. - Phase II: 3 sets x 12 repetitions. - Phase III: 2 sets x 10 repetitions; 1 set until exhaustion.	~ 15-30 seconds x set.	15-20 mins.
Balance and coordination	- Movements in diverse directions and on different surfaces. - Comparison eyes open/eyes close. - Single leg static balance, tandem and semi tandem positions.	- 2 – 4 per exercise.	~ 30 seconds.	10-15 mins.
Cool-down	- Flexibility and stretching exercise.	- 1 a 2	30-45 seconds.	5-15 mins.

[a] Many factors determine the number of repetitions as the exercise component, the fitness level of the participants, the level of exercise progression, changes in the mood of participants and the total time of the session.

[b] Calisthenics exercises are those in which the weight of the self body are used as resistance.

[c] HRs of each participant was controlled with HRs monitors Polar RS800CX.

4.6 Statistical Analysis

Descriptive statistics were calculated for all variables. To test normality of the variables the Kolmogorov-Smirnov test was utilized.

To analyze test-retest reliability of the VJT the intraclass correlation coefficient (ICC) was used. Pearson's correlation test was used to analyze correlations between VJTs and SLJT.

To analyze the CPAP effects, a 2 x 2 (group x time) repeated measures analysis of variance (ANOVA) was performed to determine between and within group effects. Significant between-group differences at each level were examined using independent-samples t-tests, whereas within-group effects were examined using paired-samples t-tests. Analysis of covariance (ANCOVA) adjusting for initial VO_2 peak and peak workload was performed to compare the mean difference in these values (pre-post) between groups.

Total PA, PA levels, steps and DEE of each group was analyzed using independent-samples t-tests. A linear mixed-effects model was performed to analyze interactions between PA levels and groups through the week. Difference in PA levels between-groups each day were examined using independent-samples t-tests

The critical values for statistical significance were assumed at an alpha level less than or equal to 0.05. Statistical analyses were conducted using Statistical Package for the Social Sciences (SPSS) v19.0 (IBM SPSS Statistics, Chicago, IL, USA).

5. RESULTS

5.1 Test-retest Reliability of the Vertical Jump Test on a Contact Platform in Adults with Intellectual Disability

5.2 Participants Characteristics and Anthropometrics

5.3 Fitness Results

5.4 Physical Activity Levels Results

5.1 Test-retest Reliability of the Vertical Jump Test on a Contact Platform in Adults with Intellectual Disability

A pre intervention tests were performed to assess the reliability of the VJT in adults with ID on a 42 cm x 60 cm contact platform (Chronojump-Boscosystem, Spain), because in a previous study the reliability of the contact platform was assessed with a population of adults without ID (De Blas et al., 2012).

A total of 83 participants (38 women; 45 men; Table 7) with mild to moderate ID performed the test. Before the two VJTs that were used to evaluate the test-retest reliability on the contact platform (Chronojump-Boscosystem, Spain), familiarization sessions were performed to practice the VJT using the contact platform and the SLJT without a run-up. Two similar experimental sessions separated by 5 days were conducted. Anthropometric characteristics (body height and mass) were collected and afterwards, the participants performed a general warm up (5 min performing warming up exercises) followed by a specific warm-up, which included sub-maximal VJT.

During the preparatory trials, the subjects were instructed to bend their knees very fast and to jump as high as possible when reaching the lower point helped with the arm swim. The VJT was performed standing erect on the contact platform. Two leaps on the floor and two more on the contact platform were performed. The best trial was recorded. The procedure was repeated 5 days later. Finally, participants performed four SLJT. Before the tests, participants performed a 5 min general warm up, which included sub-maximal SLJT. The first two SLJT were used as practice. The best trial of the final two SLJT was recorded and used to make a comparison with the VJT.

Table 7
Descriptive of participants characteristics (n = 38 women; n = 45 men), SLJT and VJT 1 & 2

	n	Mean	Minimum	Maximum	SD
Age (years)	83	43.12	20	61	11.62
Height (cm)	83	161.11	132.00	194.10	11.45
Weight (kg)	83	70.71	39.00	111.80	13.05
BMI	83	27.38	18.93	44.42	5.15
VJT 1 (cm)	83	7.13	0.52	24.75	5.02
VJT 2 (cm)	83	7.32	0.71	25.69	5.25
SLJT (m)	83	0.59	0.10	1.42	0.35

Abbreviation: BMI (body mass index); VJT (vertical jump test); SLJT (standing long jump test).

As shown in table 8, Pearson's correlations between VJT 1, VJT2 and SLJT were significant ($p < .001$).

Table 8
Pearson correlation matrix for VJT 1, VJT 2 and SLJT (n=83)

	VJT1	VJT2	Long Jump
VJT1	1		
VJT2	.932*	1	
SLJT	.807*	.824*	1

Abbreviation: VJT (vertical jump test); SLJT (standing long jump test). * p < .001

Figure 6 depicts a very good correlation between VJT 1 and VJT2.

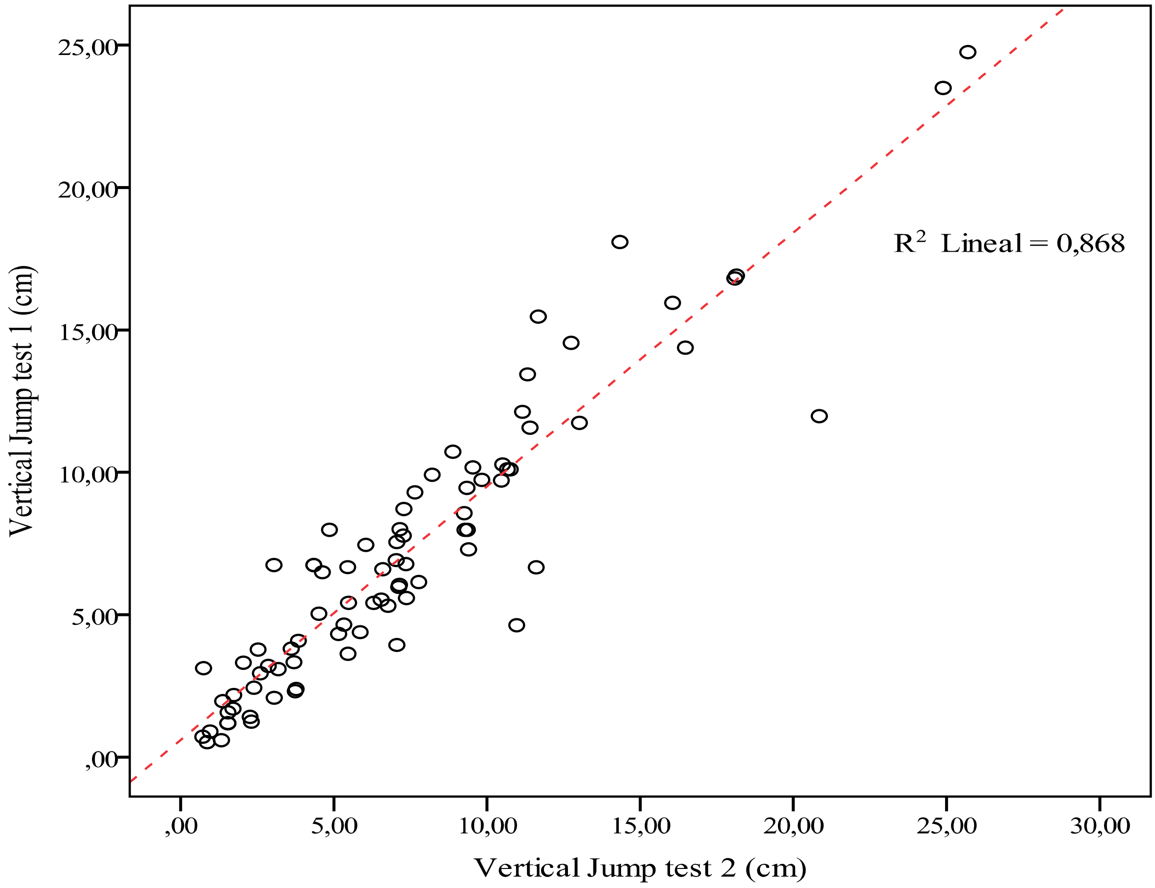

Figure 6. Pearson's correlation plot for VJT 1 and VJT 2 (n=83)

A very good reliability was observed for the VJT on the contact platform. Between VJT 1 and VJT 2 a high intraclass correlation coefficient (ICC = .964; 95%CI = .945; .977; *p* < .001) was found (five-day interval).

The results of the reliability test are shown in the Bland-Altman plot (Figure 7) where differences between VJT 1 and VJT 2 against the subjects' mean of the two VJTs are illustrated.

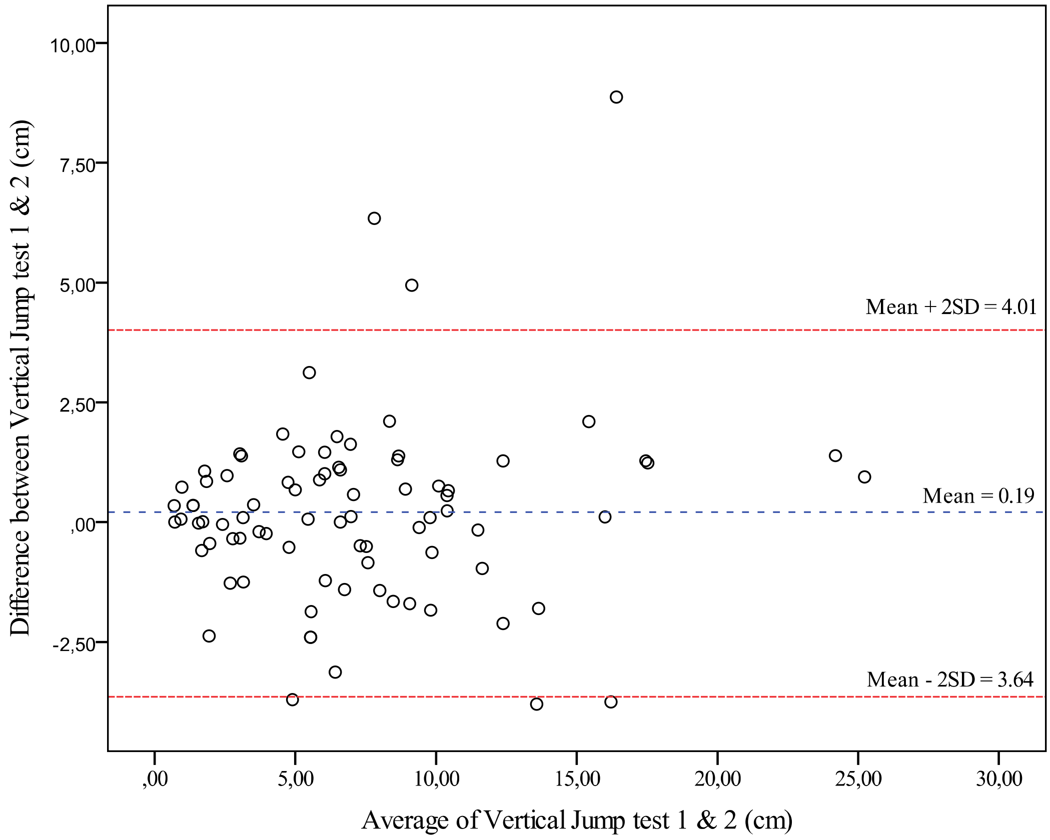

Figure 7. Bland-Altman plot of Vertical Jump test 1 & 2 (n=83)

5.2 Participants Characteristics and Anthropometrics

Among the 37 participants who were part of the IG, the adherence to training average 89.24 ± 8.50 %.

No difference for age was observed between groups (Table 10). A chi-square test of independence was performed to examine the relation between groups and ID levels (Table 9). The relation between these variables was non-significant (X^2 = 0.256; *p* = .613).

Interactions were observed for body weight (*F* = 7.68; *p* = .007) and BMI (*F* = 7.94; *p* = .006).

Body weight (*t* = 4.28; *p* < .001) and BMI (*t* = 4.38; *p* < .001) slightly decreased among the IG after the intervention, with no change for the CG (Table 10).

Table 9
Participants with mild and moderate ID by group

Variables	Intervention Group		Control Group		Total	
	n	%	n	%	n	%
Participants with mild ID	11	29.73	7	24.14	18	27.27
Participants with moderate ID	26	70.27	22	75.86	48	72.73
Total participants	37	100	29	100	66	100

Note: X^2 = 0.256; *p* = .613

Table 10
Participants' characteristics and influence of CPAP on anthropometry indices.

Variables	Intervention group (n=37)		Control group (n=29)	
	Pretest	Posttest	Pretest	Posttest
Characteristics				
Age (years)	41 (11)	41 (11)	46 (12)	46 (12)
Gender (male/female)	22/15	-	17/12	-
Anthropometry				
Height (cm)	160.4 (13.8)	160.2 (13.5)	162.0 (9.3)	161.8 (9.8)
Weight (kg)	70.07 (13.55)	68.13 (13.08)¶	74.24(12.52)	74.31 (13.43)
BMI ($kg \cdot m^{-2}$)	27.38 (5.00)	26.62 (4.80)¶	28.56 (6.35)	28.62 (7.00)
WC (cm)	89.77 (12.19)	89.53 (11.79)	93.79 (13.92	94.93 (12.73)
Fat mass (%)	29.80 (10.50)	28.96 (10.30)	30.44 (9.52)	30.51 (11.50)
Fat-free mass (%)	34.18 (7.46)	34.93 (7.16)	33.06 (6.84)	32.82 (8.48)
Bone mass (%)	13.21 (2.59)	13.45 (2.65)	13.82 (2.44)	13.89 (2.52)
Residual mass (%)	22.80 (1.59)	22.66 (1.59)	22.66 (1.62)	22.77 (1.60)

Note: values are mean (Standard Deviation).

Abbreviations: BMI (body mass index); WC (waist circumference)

¶ Within-group differences between pre and post-tests ($p < .05$).

5.3 Fitness Results

5.3.1 *Cardiorespiratory fitness*

Table 11 and 12 show rest and peak at pre and post training values for cardiorespiratory fitness in the IG and CG.

Interactions were observed for relative VO_2 peak (F = 6.26; p = .015), absolute VO_2 peak (F = 6.11; p = .016), peak workload (F = 5.80; p = .019), HR at rest (F = 8.00; p = .006), diastolic blood pressure (DBP) at rest (F = 8.75; p = .004) and peak DBP (F = 7.07; p = .010).

The IG group increased their relative VO_2 peak (t = -3.59; p = .001), absolute VO_2 peak (t = -3.74; p = .001), and peak workload (t = -2.16; p = .038) and decreased their HR at rest (t = 3.14; p = .003) after training, with no change in the CG.

Because of baseline differences in VO_2 peak and peak workload between groups, we calculated the change these parameters, while controlling for baseline values. The ANCOVA maintained between group differences in their change scores for VO_2 peak absolute (F = 7.39; p = .008) and VO_2 peak relative (F = 8.59; p = .005), with the IG having larger improvements following the intervention period. The same held true for change in peak workload (F = 9.71; p = .003).

At rest and peak DBP decreased in the IG, while the CG remained unchanged (t = 4.12; p < .001; t = 2.68; p = .012). Only a time effect was observed for SBP at rest (F = 8.87; p = .004), in that SBP at rest decreased similarly over the intervention period for the both groups. Participants in the IG elicited higher peak HRs both pre and post-intervention than the CG (group main effect, F = 4.70; p = .034).

Non-significant differences between groups were observed for peak values of respiratory rate, ventilation, tidal volume, respiratory exchange ratio, VCO_2 , fraction of O_2 and CO_2 in the expired air, ventilatory equivalent ratios and peak end-tidal partial pressures of O_2 and CO_2.

As seen from figure 8, the IG had larger percent changes due to the intervention for peak workload, and VO_2peak. In the same way, the IG had larger percent changes due to the intervention for DBP (Figure 9).

Table 11
Cardiorespiratory measures for participants at rest (pre-post training)

Variables	Intervention Group (n=37)		Control Group (n=29)	
	Pretest (SD)	Posttest (SD)	Pretest (SD)	Posttest (SD)
Respiratory Rate ($resp \cdot min^{-1}$)	19.08 (4.33)	19.32 (3.43)	19.72 (4.53)	21.10 (5.74)
VE ($L \cdot min^{-1}$)	10.64 (2.80)	10.32 (2.77)	10.29 (3.04)	11.37 (3.40)
Tidal Volume ($L \cdot min^{-1}$)	0.51 (0.13)	0.48 (0.13)	0.48 (0.17)	0.51 (0.18)
VO_2 ($ml \cdot Kg^{-1} \cdot min^{-1}$)	4.99 (1.19)	4.94 (1.52)	4.45 (1.09)	5.05 (1.22)
VO_2 ($L \cdot min^{-1}$)	0.34 (0.10)	0.33 (0.09)	0.33 (0.09)	0.37 (0.09)
RER	0.84 (0.06)	0.82 (0.06)	0.83 (0.07)	0.81 (0.12)
VCO_2 ($L \cdot min^{-1}$)	0.29 (0.08)	0.27 (0.08)	0.27 (0.08)	0.29 (0.07)
FeO_2 (%)	17.03 (0.49)	17.08 (0.58)	17.05 (0.61)	16.99 (0.71)
$FeCO_2$ (%)	3.30 (0.38)	3.38 (0.42)	3.35 (0.42)	3.47 (0.49)
ERO_2 (L)	31.32 (3.97)	31.15 (4.51)	31.76 (5.81)	31.10 (9.79)
$ERCO_2$ (L)	37.32 (4.23)	38.09 (4.56)	37.95 (5.40)	37.75 (6.01)
$PETO_2$ (mmHg)	105.81 (5.35)	106.16 (4.65)	106.59 (5.46)	105.89 (6.13)
$PETCO_2$ (mmHg)	35.05 (4.47)	35.67 (3.37)	35.27 (3.15)	36.00 (3.88)
HR ($beat \cdot min^{-1}$)	85.92 (14.85)	81.76 (13.64) ¶	82.66 (14.77)	84.10 (13.81)
SBP (mmHg)	115.51 (13.87)	109.46 (14.13)* ¶	118.76 (17.47)	114.97 (17.00)
DBP (mmHg)	77.78 (9.06) ‡	71.11 (9.92))¶	71.28 (10.92)	71.76 (9.11)

Note: values are mean (Standard Deviation).

Abbreviations: VE (ventilation); VO_2 (oxygen consumption); RER (respiratory exchange ratio); VCO_2 (carbon dioxide production); FeO_2 (fraction of O_2 in the expired air) ; $FeCO_2$ (fraction of CO_2 in the expired air); ERO_2 (ventilatory equivalent ratio for O_2); $ERCO_2$ (ventilatory equivalent ratio for CO_2); $PETO_2$ (end-tidal partial pressure for O_2); $PETCO_2$ (end-tidal partial pressure for CO_2); HR (heart rate); SBP (systolic blood pressure); DBP(diastolic blood pressure)

* Significant time effect ($p < .05$)

¶ Within-group differences between pre and post-tests ($p < .05$)

† Between-group differences at pre and post-tests ($p < .05$)

‡ Between-group differences at pre-test ($p < .05$)

§ Between-group differences at post-test ($p < .05$)

Table 12

Peak cardiorespiratory measures for participants (pre-post training)

	Intervention Group (n=37)		Control Group (n=29)	
Variables	Pretest (SD)	Posttest (SD)	Pretest (SD)	Posttest (SD)
Respiratory Rate (resp·min^{-1})	41.23 (8.43)	42.19 (8.24)	39.41 (9.70)	39.83 (10.26)
VE (L·min^{-1})	59.31 (14.93)	61.55 (14.16)	57.73 (16.68)	59.26 (15.68)
Tidal Volume (L·min^{-1})	1.29 (0.39)	1.39 (0.39) ¶	1.34 (0.39)	1.38 (0.40)
VO_2 (ml·Kg^{-1}·min^{-1})	26.82 (6.81)	29.35 (7.52) ¶ §	24.07 (5.13)	24.14 (4.74)
VO_2 (L·min^{-1})	1.85 (0.47)	2.02 (0.51) ¶ §	1.77 (0.40)	1.78 (0.36)
RER	1.06 (0.06)	1.05 (0.05)	1.03 (0.08)	1.05 (0.09)
VCO_2 (L·min^{-1})	1.97 (0.50)	2.12 (0.53) ¶	1.84 (0.49)	1.89 (0.50)
FeO_2 (%)	16.89 (0.66)	16.92 (0.69)	16.97 (0.61)	17.08 (0.49)
$FeCO_2$ (%)	3.89 (0.51)	4.00 (0.50)	3.89 (0.48)	3.91 (0.43)
ERO_2 (L)	31.33 (5.70)	30.36 (5.17)	31.27 (5.10)	31.22 (4.06)
$ERCO_2$ (L)	30.54 (4.45)	29.49 (4.46)	31.26 (3.44)	31.46 (3.70)
$PETO_2$ (mmHg)	108.97 (6.29)	108.76 (5.79)	108.31 (5.54)	109.31 (4.51)
$PETCO_2$ (mmHg)	37.35 (4.61)	38.70 (4.64) ¶	38.52 (4.23)	38.27 (3.37)
Peak Workload (watts)	161.89 (38.78)	170.15 (38.43) ¶ †	128.89 (33.94)	125.16 (35.32)
Peak HR (beat·min^{-1})	157.38 (18.11)	157.62 (17.97) †	146.9 (20.93)	146.97 (25.03)
Peak SBP (mmHg)	135.39 (24.51)	132.42 (18.57)	135.61 (21.56)	131.77 (19.55)
Peak DBP (mmHg)	74.67 (15.12)	67.72 (9.97) ¶§	71.65 (14.35)	74.76 (12.82)

Note: values are mean (Standard Deviation).
Abbreviations: VE (ventilation); VO_2 (oxygen consumption); RER (respiratory exchange ratio); VCO_2 (carbon dioxide production); FeO_2 (fraction of O_2 in the expired air); $FeCO_2$ (fraction of CO_2 in the expired air); ERO_2 (ventilatory equivalent ratio for O_2); $ERCO_2$ (ventilatory equivalent ratio for CO_2); $PETO_2$ (end-tidal partial pressure for O_2); $PETCO_2$ (end-tidal partial pressure for CO_2); HR (heart rate); SBP (systolic blood pressure); DBP(diastolic blood pressure)
* Significant time effect ($p < .05$)
¶ Within-group differences between pre and post-tests ($p < .05$)
† Between-group differences at pre and post-tests ($p < .05$)
‡ Between-group differences at pre-test ($p < .05$)
§ Between-group differences at post-test ($p < .05$)

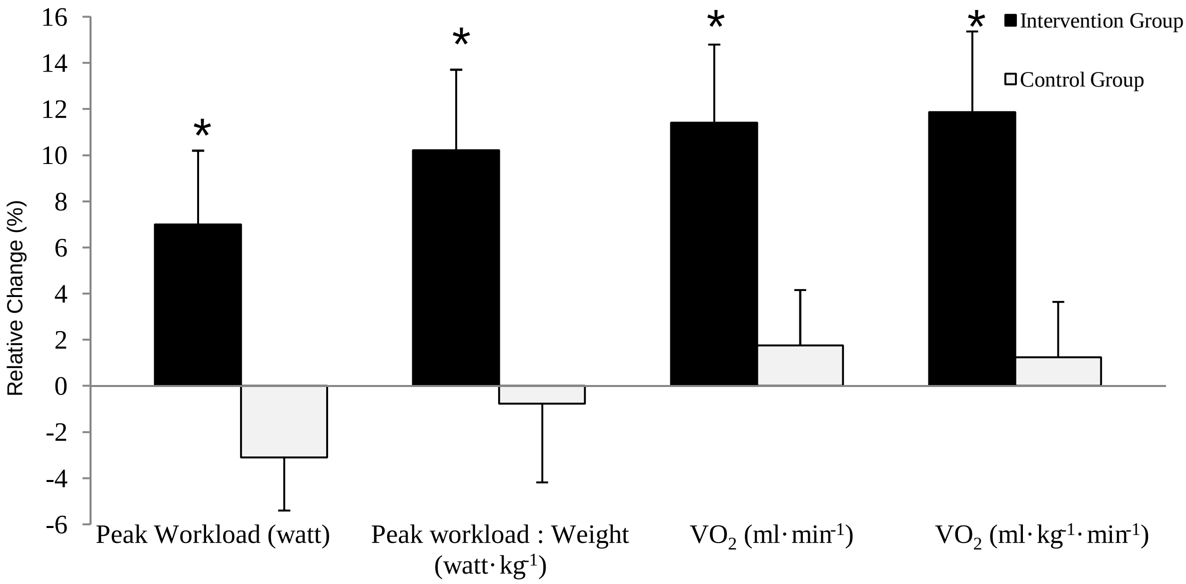

Figure 8. Relative change (%) in Peak Workload (W), Peak Workload : Weight (watt·kg^{-1}), absolute VO_2peak (ml·min^{-1}) and relative VO_2peak (ml·kg^{-1}·min^{-1}) in the intervention and control groups after CPAP. Values are mean (SE), n=37/29. * Between-group differences ($p < .05$)

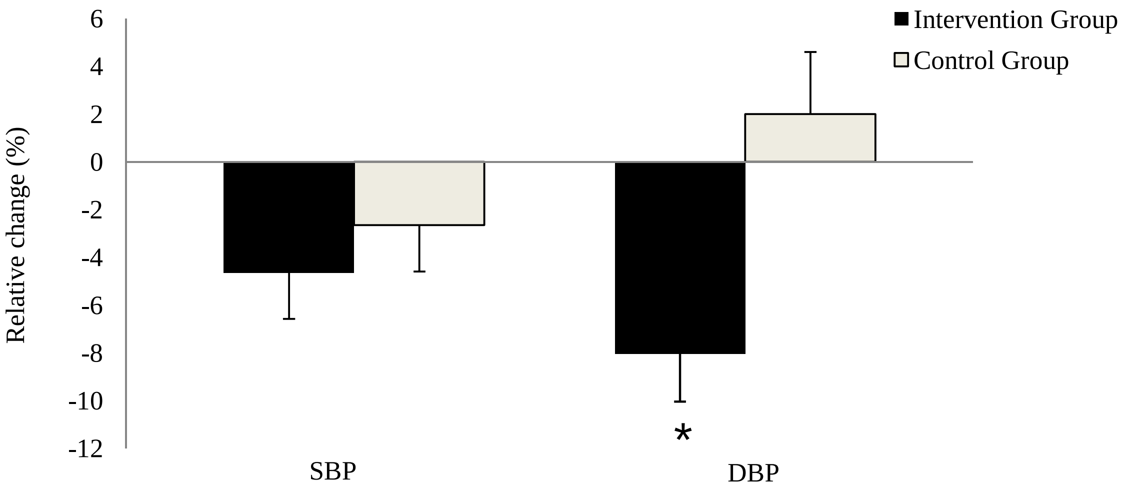

Figure 9. Relative change (%) in Systolic and Diastolic Blood pressure in the intervention and control groups after CPAP. Values are mean (SE), n=37/29. *Between-group differences ($p < .05$)

5.3.2 *Strength, balance and flexibility*

Table 13 lists fitness data for participants at pre and post training.

Interactions were observed for 6MWT (F = 26.12; p < .001), right hand grip (F = 11.75; p = .001), left hand grip (F = 6.93; p = .011), leg strength (F = 14.26; p < .001), long jump (F = 21.82; p < .001); vertical leap jump (F = 5.92; p = .018), SRT (F = 5.52; p = .022), left FSRT (F = 4.74; p = .033), SLST (F = 25.24; p < .001), TUGT (F = 15.4; p = < .001), COP TTD (F = 10.89; p = .002), COP RA (F = 4.16; p = .046); COP MLD (F = 5.24; p = .026).

Functional capacity, via the 6MWT, improved with training in the IG (t = -6.93; p < .001).

Handgrip strength and leg strength in the IG also increased with the training program, with no change among the CG (right hand grip (t = -5.39; p < .001), left hand grip (t = -3.68; p = .001), leg dynamometry (t = -6.85; p < .001)), SLJT (t = 5.46; p < .001); and VJT (t = -2.37; p = .023).

Flexibility was improved after the intervention period as well in the IG (SRT (t = -6.06; p < .001), right FSRT (t = -2.31; p = .026), left FSRT (t = -4.87; p < .001)). Interestingly, SRT decreased in the CG (t = -2.26; p = .031).

Balance improved in the IG for the SLST (t = -7.51; p < .001), TUGT (t = 4.76; p < .001), COP TTD (t = 3.45; p = .002) and COP MLD (t = 2.28; p = .029), again, with no change in the CG.

Table 13

Fitness measures for participants by Pre-Posttest.

Variables	Intervention group (n=37) Pretest (SD)	Intervention group (n=37) Posttest (SD)	Control group (n=29) Pretest (SD)	Control group (n=29) Posttest (SD)
Functional tests				
6MWT (m)	461.51 (89.26)	519.02 (96.47)¶ §	426.15 (64.27)	423.10 (64.92)
TUGT (sec)	15.49 (3.53)	14.08 (3.32)¶ §	15.39 (2.49)	15.71 (2.93)
Strength				
Right hand grip (Kg)[a]	19.81 (7.79)	23.08 (8.01)¶ §	19.24 (7.39)	19.10 (7.27)
Left hand grip (Kg)	18.68 (6.83)	20.66 (6.57)¶	18.75 (7.78)	18.27 (7.41)
Leg Strength (Kg)	34.58 (22.11)	47.51 (21.13)¶ §	36.29 (22.07)	36.65 (20.44)
Standing Long Jump (m)[a]	0.67 (0.38)	0.81 (0.41) ¶ §	0.50 (0.27)	0.45 (0.28)
Vertical Jump (cm)	10.64 (6,07)	11.76 (6.71) ¶§	7.97 (4.37)	7.51 (4.50)
Flexibility				
SRT (cm)	-12.56 (11.04)	-4.89 (11.67)¶ §	-14.44 (16.28)	-11.24 (12.97)¶
Right FSRT (cm)	-14.20 (12.56)	-11.03 (9.37)¶	-15.53 (11.94)	-14.91 (12.08)
Left FSRT (cm)	-19.78 (13.82)	-13.08 (9.78)¶	-17.63 (11.82)	-15.31 (12.30)
Balance				
SLST (sec)[b]	6.91 (6.86)	11.99 (6.43)¶ §	6.37 (6.49)	5.89 (5.65)
COP TTD (mm)[c]	236.04 (138.86)	156.10 (59.32)¶ §	196.75 (91.98)	218.54 (104.24)
COP RA (mm^2)[c]	147.38 (112.81)	130.02 (120.84)	166.99 (142.35)	210.44 (176.30)
COP APD (mm)[c]	2.65 (1.33)	2.37 (1.37)	2.54 (1.44)	2.98 (1.59)
COP MLD (mm)[c]	2.47 (1.22)	1.98 (1.10)¶	2.50 (1.36)	2.90 (1.84)

Note: values are mean (Standard Deviation). [a] (IG n=37/CG n=28); [b] (IG n=34/CG n=28); [c] (IG n=32/CG n=26).

Abbreviations: 6MWT (six minute walk test); SRT (seat and reach test); FSRT (functional shoulder rotation test); SLST (single leg stand test); TUGT (timed up and go test); COP (center of pressure); TTD (total travel distance); APD (antero-posterior displacements); RA (radial area); MLD (medio-lateral displacements).

* Significant time effect ($p < .05$)

¶ Within-group differences between pre and post-tests ($p < .05$)

† Between-group differences at pre and post-tests ($p < .05$)

‡ Between-group differences at pre-test ($p < .05$)

§ Between-group differences at post-test ($p < .05$)

As previously mentioned, Figure 10 depicts the large net increase in the 6MWT distance performed by the IG and a slight decrease in the CG ($p < .05$).

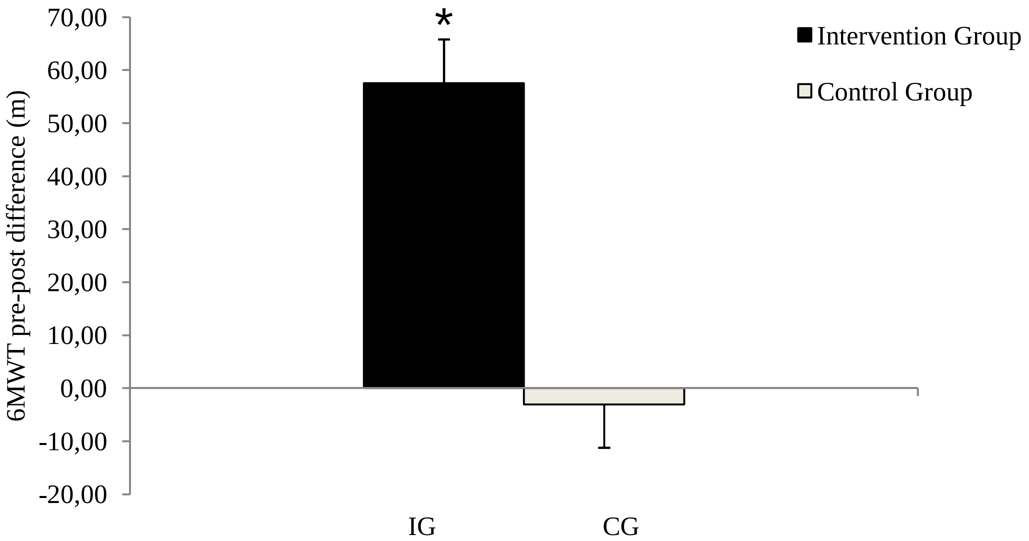

Figure 10. Pre-Post test difference in 6 MWT distance in the intervention and control groups. Values are Mean (SE), n=37/29. * Between-group differences (p < .05)

5.4 Physical Activity Levels Results

The initial sample was 66 participants where 37 were part of the IG and 29 from the CG. Finally, one participant from each group refused to use the accelerometer. Table 14 presents the main PA data collected during a week for IG and CG during the CPAP. The collection period correspond to Phase I and II of the CPAP. The IG averaged greater amounts of daily EE (306.46 vs. 240.96 kcal) and steps per day (7,071 vs. 5,680 steps) than the CG. Regardless of been part of the IG or CG groups most of the waking day was spent being sedentary (616.08; 611.04 mins/day) followed by LPA (122.45; 136.69 mins/day). The IG spent more time in MPA (37.80 vs. 25.26 mins/day), VPA (1.18 vs. 0.67 mins/day) and MVPA (38.98 vs. 25.95 mins/day) than the CG. Non-significant differences between groups neither in accelerometer days scored nor wear time were found.

Table 14
Physical activity data for Intervention and Control groups

Variables	IG (n=36)	CG (n=28)	*t*	*p*
Daily EE (kcal/day)	321.27 (143.56)	243.42 (99.33)	2.31	**.024**
Steps (steps/day)	7,071 (2893)	5,680 (2243)	2.10	**.039**
Total PA (counts/min)	309.96 (127.81)	221.89 (94.06)	3.06	**.003**
Sedentary (mins/day)	616.08 (103.99)	611.04 (80.57)	0.089	.929
LPA (mins/day)	122.45 (39.86)	136.69 (49.92)	-1.27	.209
MPA (mins/day)	37.80 (25.78)	25.26 (19.86)	2.13	**.037**
VPA (mins/day)	1.18 (0.99)	0.67 (0.45)	2.49	**.015**
MVPA (mins/day)	38.98 (26.15)	25.95 (20.58)	2.16	**.034**
Days Scored	5.81 (0.92)	5.89 (1.28)	-0.316	.753
Wear time (mins/day)	777.50 (111.18)	773.68 (73.11)	0.168	.867

Note: values are mean (Standard Deviation)
Abbreviations: EE (energy expenditure); PA (physical activity); LPA (light physical activity); MPA (moderate physical activity); VPA (vigorous physical activity); MVPA (moderate to vigorous physical activity). Statistically significant values are showed in bold.

Table 15 presents participants by group meeting the 30 min per day of MVPA recommendations.

Table 15

Total number of participants who meet or not with the 30 minutes of MVPA per day

	Intervention Group		Control Group		Total	
	n	%	n	%	n	%
Do not meet recommendations	31	86.11	26	92.86	57	89.06
Meet recommendations	5	13.89	2	7.14	7	10.94
Total	36	100	28	100	64	100

Note: $X^2 = 0.74$; $p = .391$

Table 16 presents participants by group meeting current PA recommendations (World Health Organization, 2010).

Table 16

Total number of participants who meet or not with the WHO recommendations (150 mins/week of MVPA)

	Intervention Group		Control Group		Total	
	n	%	n	%	n	%
Do not meet recommendations	11	30.55	19	67.85	30	46.87
Meet recommendations	25	69.45	9	32.15	34	53.13
Total	36	100	28	100	64	100

Note: $X^2 = 8.80$; $p = .003$

Table 17 presents the activity levels by steps by day zone collected during a week for IG and CG during the CPAP (Tudor-Locke, Hatano, Pangrazi, & Kang, 2008).

Table 17.
Participants' activity levels by steps/day zone by group

Activity levels by steps/day zone		Intervention Group		Control Group		Total	
		n	%	n	%	n	%
Sedentary	(> 5,000)	9	25.00	14	50.00	23	35.94
Low active	(5,000–7,499)	13	36.11	8	28.57	21	32.81
Somewhat active	(7,500–9,999)	10	27.80	4	14.29	14	21.87
Active	(10,000–12,499)	3	8.31	2	7.14	5	7.82
Highly active	(≥12,500)	1	2.78	0	0	1	1.56

Note: $X^2 = 5.12$; $p = .274$

5.4.1 *Physical activity levels through the week*

Tables 18 to 22 present the different intensities of PA through the week.

The analysis using linear mixed-effects models showed a significant interaction between factors time and group for MVPA (time x group: $F = 8.41$; $p < .001$).

As show in table 18 the IG spent significantly more time performing MVPA than the CG on Monday, Wednesday and Friday, corresponding to the days of the PA sessions. The IG spent on average an extra 25 minutes doing MVPA during each of these specific days.

Table 18
Time spent in MVPA through the week (minutes)

Day	Intervention Group (n=36)		Control Group (n=28)		*p*
	Mean (minutes)	95% CI	Mean (minutes)	95% CI	
Monday	51.66	(42.35; 60.98)	26.89	(15.92; 37.88)	**.001**
Tuesday	25.81	(15.90; 35.72)	23.83	(13.05; 34.61)	.790
Wednesday	49.31	(39.95; 58.68)	26.24	(15.62; 36.85)	**.002**
Thursday	30.16	(20.70; 39.63)	28.94	(18.47; 39.41)	.865
Friday	55.32	(45.95; 64.69)	27.02	(16.40; 37.63)	**.000**
Saturday	29.26	(19.72; 38.80)	21.73	(11.11; 32.35)	.298
Sunday	27.31	(17.76; 36.85)	24.87	(14.09; 35.65)	.738

Note: Statistically significant values are showed in bold.

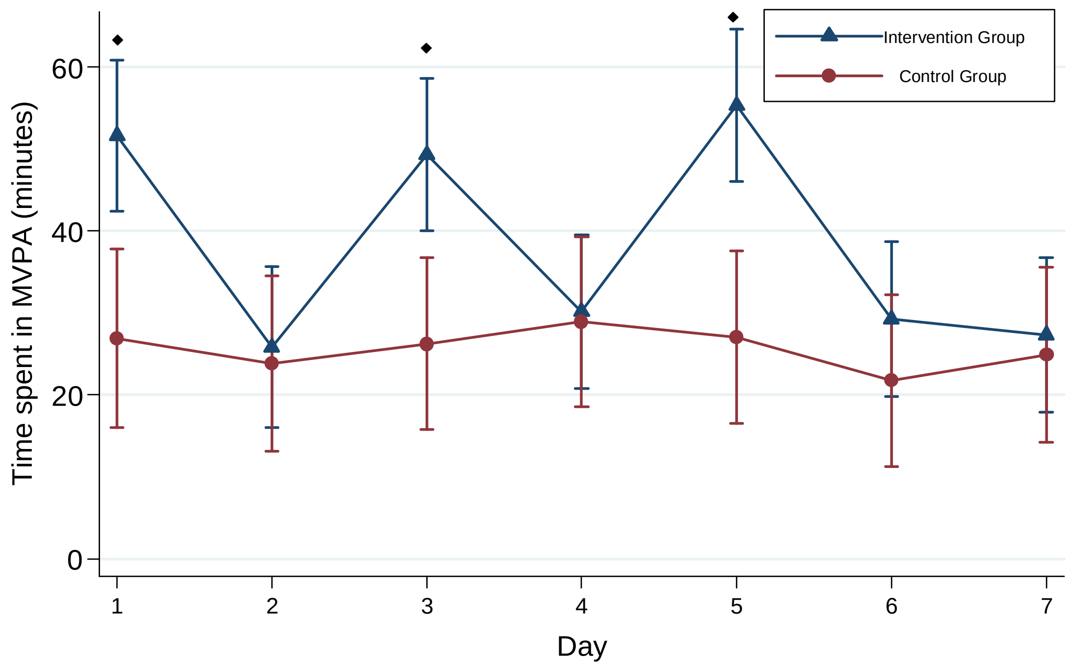

Figure 11. Time spent in MVPA through the week. 1 (Monday); 2 (Tuesday); 3 (Wednesday); 4 (Thursday); 5 (Friday); 6 (Saturday); 7 (Sunday). Values are mean (95% CIs); n =36/28.
♦ Between-group differences (p< .05)

The analysis using linear mixed-effects models did not showed a significant interaction between factors time and group for VPA (time x group: $F = 1.51$; $p = .175$).

Table 19 reports the VPA performed by IG and CG. In general the IG performed more VPA than the CG. However, significant differences of about a minute were only observed on Monday and Friday.

Table 19
Time spent in VPA through the week (minutes)

Day	Intervention Group (n=36)		Control Group (n=28)		*p*
	Mean (minutes)	95% CI	Mean (minutes)	95% CI	
Monday	1.76	(1.22; 2.31)	.72	(0.05; 1.40)	**.019**
Tuesday	.66	(0.03; 1.28)	1.07	(0.42; 1.72)	.369
Wednesday	1.39	(0.83; 1.94)	.91	(0.28; 1.54)	.269
Thursday	1.13	(0.56; 1.70)	.65	(0.04; 1.26)	.257
Friday	1.50	(0.94; 2.05)	.60	(0.03; 1.23)	**.036**
Saturday	.80	(0.22; 1.38)	.41	(0.21; 1.04)	.372
Sunday	.80	(0.20; 1.36)	.51	(0.13; 1.16)	.543

Note: Statistically significant values are showed in bold.

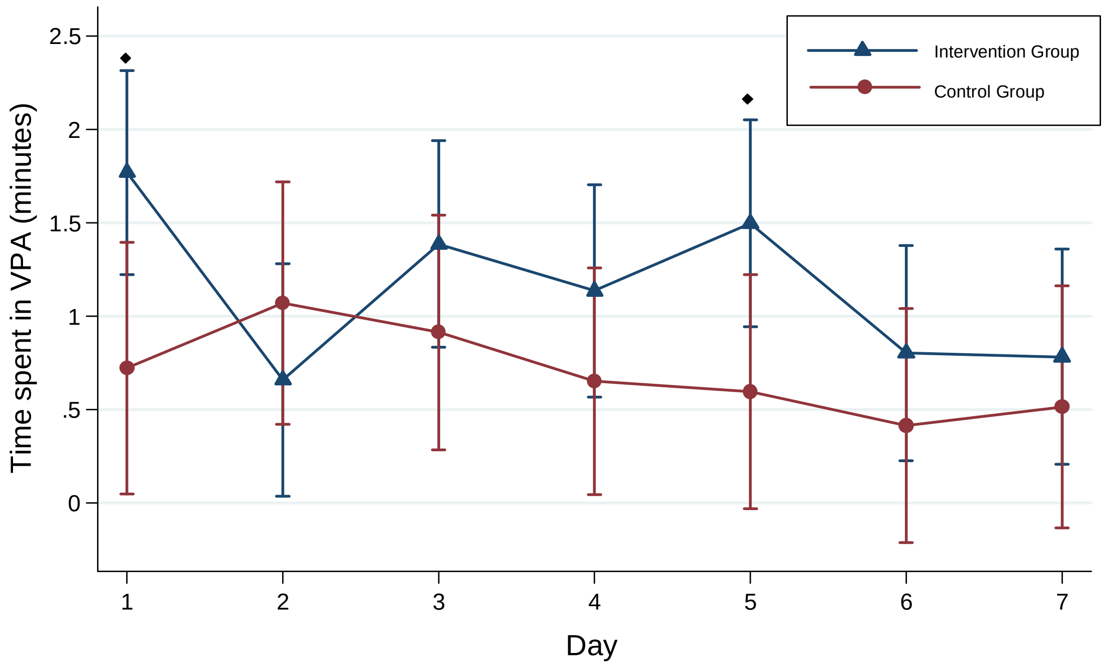

Figure 12. Time spent in VPA through the week. 1 (Monday); 2 (Tuesday); 3 (Wednesday); 4 (Thursday); 5 (Friday); 6 (Saturday); 7 (Sunday). Values are mean (95% CIs); n=36/28.
♦ Between-group differences (p< .05)

The analysis using linear mixed-effects models showed a significant interaction between factors time and group for MPA (time x group: $F = 8.41$; $p < .001$).

Table 20, report the MPA performed by IG and CG. The IG spent significantly more time at this intensity than the CG on Monday, Tuesday and Friday, corresponding to the days of the PA sessions. On average, an extra 24 minutes doing MPA were spent by the IG on these days. No differences were observed for the rest of days.

Table 20
Time spent in MPA through the week (minutes)

Day	Intervention Group (n=36)		Control Group (n=28)		*p*
	Mean (minutes)	95% CI	Mean (minutes)	95% CI	
Monday	49.87	(40.77; 58.98)	26.18	(15.46; 36.91)	**.001**
Tuesday	25.12	(15.44; 34.81)	22.77	(12.24; 33.31)	.746
Wednesday	47.94	(38.78; 57.09)	25.32	(14.94; 35.69)	**.002**
Thursday	29.00	(19.74; 38.27)	28.29	(18.05; 38.53)	.919
Friday	53.84	(44.68; 62.99)	26.42	(16.05; 36.80)	**.000**
Saturday	28.45	(19.13; 37.78)	21.31	(10.93; 31.69)	.313
Sunday	26.54	(17.22; 35.86)	24.37	(13.84; 34.91)	.761

Note: Statistically significant values are showed in bold.

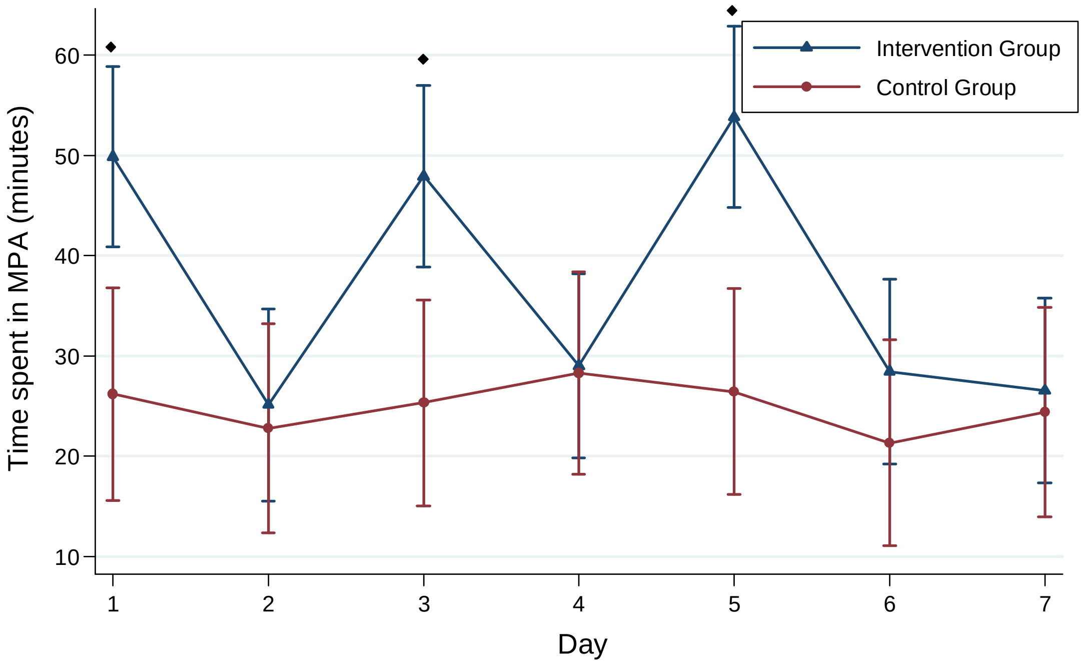

Figure 13. Time spent in MPA through the week. 1 (Monday); 2 (Tuesday); 3 (Wednesday); 4 (Thursday); 5 (Friday); 6 (Saturday); 7 (Sunday). Values are mean (95% CIs); n=36/28.
♦ Between-group differences (p< .05)

The analysis using linear mixed-effects models did not showed a significant interaction between factors time and group for LPA (time x group: $F = 2.26$; $p < .275$).

Table 21 reports the LPA performed by IG and CG. In general the CG performed more LPA than the IG. However, significant differences of about 33 minutes were only observed on Thursday. No differences were observed during the rest of the days.

Table 21
Time spent in LPA through the week (minutes)

Day	Intervention Group (n=36)		Control Group (n=28)		*p*
	Mean (minutes)	95% CI	Mean (minutes)	95% CI	
Monday	133.93	(115.43; 152.44)	138.24	(116.15; 160.32)	.768
Tuesday	119.06	(98.97; 139.15)	138.89	(117.33; 160.45)	.186
Wednesday	124.93	(106.29; 143.57)	139.50	(118.37; 160.63)	.308
Thursday	113.17	(94.23; 132.11)	146.65	(125.91; 167.40)	**.020**
Friday	139.75	(121.10; 158.40)	149.15	(128.02; 170.28)	.511
Saturday	109.34	(90.23; 128.45)	121.34	(100.21; 142.47)	.407
Sunday	115.65	(96.54; 134.76)	117.38	(95.82; 138.94)	.906

Note: Statistically significant values are showed in bold.

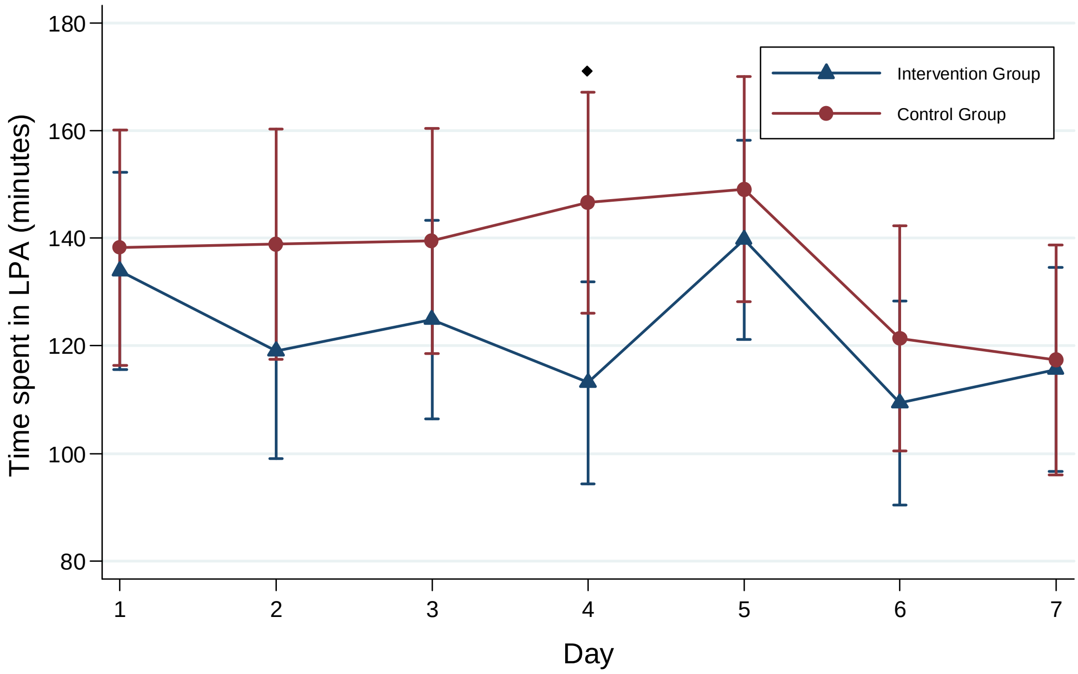

Figure 14. Time spent in LPA through the week. 1 (Monday); 2 (Tuesday); 3 (Wednesday); 4 (Thursday); 5 (Friday); 6 (Saturday); 7 (Sunday). Values are mean (95% CIs); n=36/28.
♦ Between-group differences (p< .05)

The analysis using linear mixed-effects models did not showed a significant interaction between factors time and group for time spent as sedentary (time x group: F = 0.91; p < .491).

Table 22 reports sedentary time through the week. Surprisingly, no difference between groups were observed and reflects that participants for both groups, IG or CG, spent most of the waking day being sedentary.

Table 22
Time spent as sedentary through the week (minutes)

Day	Intervention Group (n=36)		Control Group (n=28)		*p*
	Mean (minutes)	95% CI	Mean (minutes)	95% CI	
Monday	636.32	(594.30; 678.34)	610.05	(559.10; 661.01)	.434
Tuesday	645.89	(599.14; 692.65)	615.56	(566.17; 664.95)	.380
Wednesday	584.24	(541.80; 626.67)	608.56	(560.48; 656.64)	.455
Thursday	632.75	(589.41; 676.09)	628.63	(581.71; 675.55)	.899
Friday	645.30	(602.84; 687.75)	609.03	(560.96; 657.11)	.266
Saturday	592.13	(548.29; 635.97)	594.98	(546.89; 643.07)	.931
Sunday	592.58	(548.74; 636.41)	610.01	(560.62; 659.40)	.603

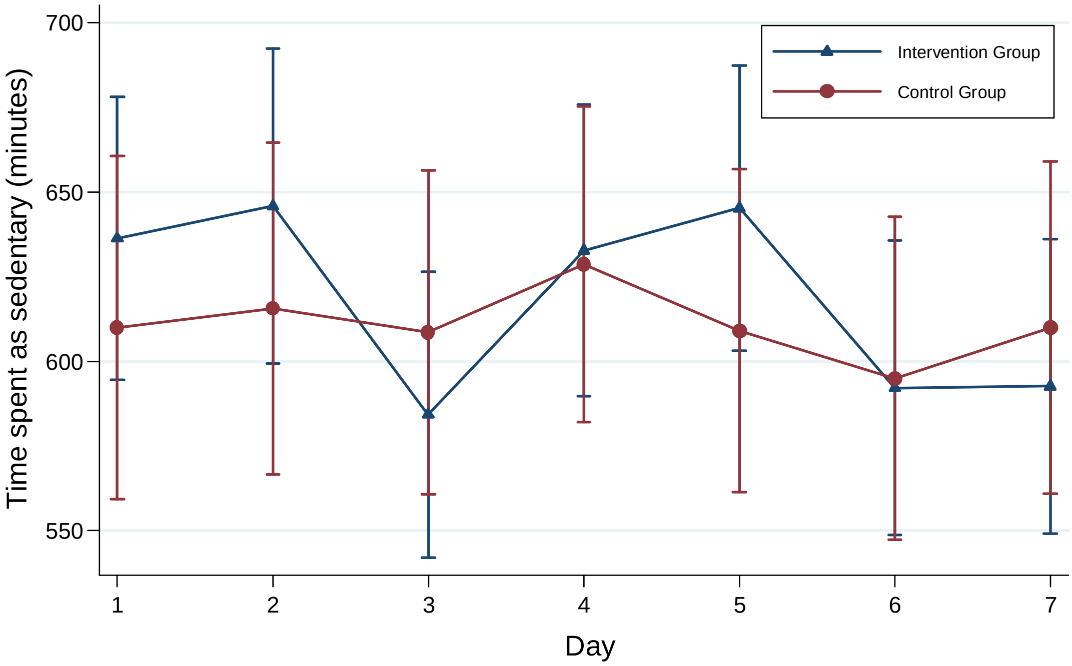

Figure 15. Time spent as sedentary through the week. 1 (Monday); 2 (Tuesday); 3 (Wednesday); 4 (Thursday); 5 (Friday); 6 (Saturday); 7 (Sunday). Values are mean (95% CIs); n=36/28.

6. DISCUSSION

Discussion

One of the purposes of this thesis was to test the reliability of the VJT in people with ID using a contact platform in order to evaluate leg power. Through vertical jump it is measured the height reached and leg power and strength information is obtained indirectly. As in this test there is a specific coordination requirement in order to achieve the maximum height during the jump, the timing and sequencing of muscles actions must somehow influence the results and previous studies (Guerra-Balic, 2001; Hassani et al., 2014) it was shown that this is a difficult test to be performed by adults with ID, it was necessary to establish its reliability before using it.

Other aim of the study was to evaluate the effects of a 14 weeks combined aerobic, strength and balance exercise program on physical fitness, as well as body composition, in adults with mild to moderate ID.

It was also of interest to know and describe the PA patterns of these groups of adults with ID that participated in the CPAP in comparison to a CG. That is why accelerometry was used following previous protocols already applied (Phillips & Holland, 2011; Troiano et al., 2008).

For legal issues this project was approved by our Institutional Research Board. Later information was given to parents and or legal guardians, in special sessions organized by the work-shop center, and they were able to clarify any doubt they could have. All of them, as well as all the participants, sign an informed consent. Even though participants had ID it was required that they also accept to follow the project. Moreover, if they decided not to follow it they were free to step off. That is why in some of the statistical tests, the sample appears not always with the same number because testers respected their decisions.

6.1 Vertical Jump Test

VJT was used to evaluate height reached, and indirectly the test gives information about legs strength. This evaluation is done by the fly time during the jump. As it is a difficult task for adults with ID, training was necessary, so the physical activity technicians introduced some exercises to work jumps in the program itself. Finally, the VJT was evaluated over the contact platform.

After performing the VJT on a contact platform, the results showed that this instrument is a reliable tool (ICC = .964) to assess the height reached during a vertical jump in adults with ID. When comparing with the SLJT we could observe a high correlation (r = .807 for SLJT vs. VJT1; , 7; r =.824 for SLJT vs. VJT2) between both tests.

The results obtained in this study for the contact platform cannot be generalized for children, older people or people with severe ID. Although the study was performed with adults with ID, as one of the factors that may condition the jump could be the ID level, we believe that these results could be applied for adolescents with mild to moderate ID too, because the level of ID does not change between adolescences and adulthood.

6.2 Anthropometry

As previously it was presented there are multiple methods to measure and evaluate anthropometry in adults with ID. In our case we used BMI, skinfolds and waist circumference. For skinfolds, there are several equations to calculate body fat %, we calculated it through Jackson & Pollock (1978) for men and Jackson, Pollock & Ward (1980) for women.

After training, we have observed weight reductions by ~2 kg in the IG and this value are in line with previously reported weight loss in this population (Guidetti et al., 2010; Mendonca et al., 2011; Rimmer et al., 2004). At the same time, the BMI decreased in our IG less than the 1.2 points reported by Guidetti et al. (2010) and more than the 0.5 and 0.4 points reported by Rimmer et al. (2004) and Mendonca et al. (2011). Our data are in contrast with Calders et al. (2011) whereby they demonstrated no significant changes in body weight following an exercise intervention and the results reported by Cowley et al. (2011) where participants followed only a resistance exercise training. The weight loss in our study may have reached significance due to training 3 days a week versus 2 days a week as reported by Calders et al. (2011). Yet, it is important to note that similar to others (Calders et al., 2011; Guidetti et al., 2010; Mendonca et al., 2011), we did not observe significant changes in body composition. Despite a slight reduction of fat mass % and a slight increase in fat free mass %, these changes were non-significant (p = .095; p = .079 respectively). Conversely, Boer et al. (2014) implementing a sprint interval training in adolescents and young adults with ID found significant reductions in fat mass % (~3.8%) in their participants.

Concerning body skinfolds, Savucu (2010) shows decreases of ~6.21 % in fat mass % in adolescents with DS that have participated in his study. In the same line, after a 12 week aerobic training program, Ordoñez et al. (2006) found that weight at baseline was reduced by ~3.6 kg at the end of the intervention and fat mass % was reduced by ~9.2 % in the male adolescents with DS. These are important changes in the body composition of the participants. Unfortunately these studies did not have a control group and did not report intensities of the training programs.

It would appear that longer term interventions, higher intensity, more stringent nutritional guidelines and interventions with a dietary component are necessary to induce substantial body fat changes.

Furthermore, the different methods used to assess body composition could also lead to errors in the results. For example, the use of BIA or skinfolds to calculate fat mass, depends on different equations that have been validated for different populations, and there is not always used the same valid equation for a given population like people with ID.

As for waist circumference measurement which shows CVD risk our results did not show changes after the CPAP in the IG nor in the CG.

6.3 Fitness

6.3.1 *Cardiorespiratory Fitness*

Previous to the laboratory test on the treadmill it was performed a familiarization process in order to get accurate data. As Rintala et al. (1995) showed, familiarization process needs to be done with the testers, materials, techniques, staff and place where the testing will be developed.

Previous studies have demonstrated that adults with ID have decreased cardiovascular fitness compared to persons without ID (Baynard et al., 2008; Draheim et al., 2002b; Fernhall & Pitetti, 2001; Frey, 2004; Skowroński et al., 2009; Temple et al., 2006). These authors have found values for adults with ID of ~22 to 53 $ml \cdot kg^{-1} \cdot min^{-1}$ for those without DS and ~14 to 37 $ml \cdot kg^{-1} \cdot min^{-1}$ for those with DS. Most of these studies involve all ages of persons with ID. We have shown it is possible to improve fitness in individuals with ID, with a well-designed CPAP. Our results show that relative VO_2 peak, absolute VO_2 peak and peak workload increased in the IG after the CPAP when compared with the CG (~0.17 vs. ~0.01 $L \cdot min^{-1}$; ~2.53 vs. ~0.07 $ml \cdot kg^{-1} \cdot min^{-1}$; ~8.26 vs. ~-3.73 watts). These improvements are very important, since cardiorespiratory fitness is related to work capacity and the ability to carry out day-to-day activities in people with ID (Fernhall, 1993). The improvements we observed in percent changes for aerobic capacity (~12%) and workload (~7%) indicate that participants in the IG should be able to work and carry out day-to-day activities more efficiently. These findings are in line with those reported by other groups (Calders et al., 2011; Mendonca et al., 2011; Rimmer et al., 2004), despite the different lengths of the interventions.

We did not only observe improvements in aerobic fitness, but we also saw increased functional capacity as measured by the 6MWT distance (Figures 16 and 17), which increased by ~58 meters in the IG, with no change in the CG. These improvements in the IG are similar to those reported by Calders et al. (2011), where the author suggests that these are clinical relevant changes in functional capacity (ATS Committee on Proficiency Standards for Clinical Pulmonary Function Laboratories, 2002).

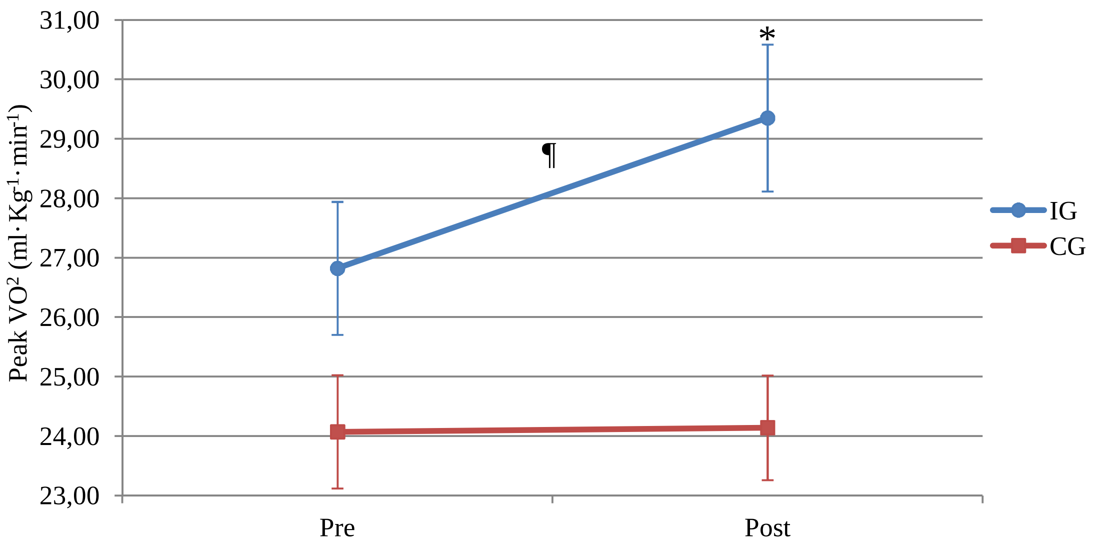

Figure 16. Pre-Post test difference in VO_2 peak in the intervention and control groups. Values are Mean (SE), n=37/29. ¶ $p < .05$ IG pre-posttest following significant interaction; * $p < .05$ between-group difference.

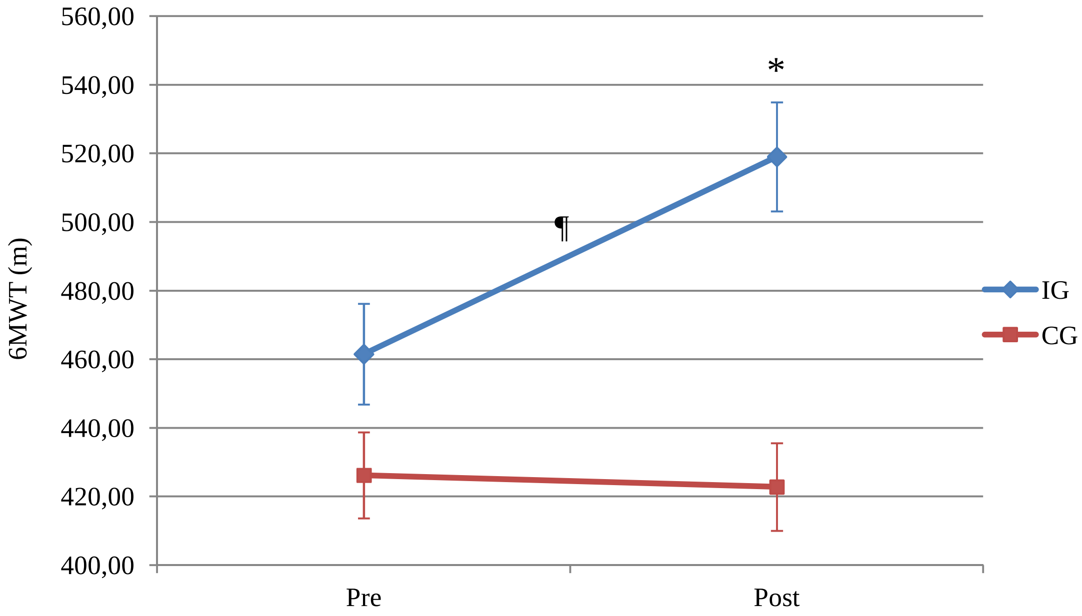

Figure 17. Pre-Post test difference in 6 MWT in the intervention and control groups. Values are Mean (SE), n=37/29. ¶ $p < .05$ IG pre-posttest following significant interaction; * $p < .05$ between-group difference.

Our data showed a decrease in DBP in the IG. These results are in line with those showed by Calders et al. (2011), although their initial values were higher than those found in our study. Our results found net reductions in BP by 6/7 mmHg, while Calders et al. (2011) found reductions by 15/2 mmHg. The training-induced improvement in BP could be mediated through a reduction of vascular resistance, in which the sympathetic nervous system and the renin-angiotensin system appear to be involved (Cornelissen & Fagard, 2005; Cornelissen & Smart, 2013). Interestingly, both groups in our study were found to have reductions in SBP over the intervention period. Nevertheless, a slightly greater reductions on SBP was observed in the IG (6 vs. 4 mm Hg), and it could have happened because a natural familiarization process. On the other side, the HR at rest decreased by ~4 beats·min^{-1} in the IG after the training period (Figure 18).

These reductions on BP and HR at rest could lead reductions in the cardiovascular risk on the participants of the CPAP. Taking into account that this was just a 14-week intervention, a prolonged intervention like this in this population with ID may lead to major reductions in BP and HR. Even though reductions on basal HR and BP on the IG do not reach significance when compared with the CG, they surely will allow the cardiovascular system to work more efficiently, because, at least at rest, HR and BP are lower. We hypothesize that reductions on BP values could be due to decrease in peripheral resistance.

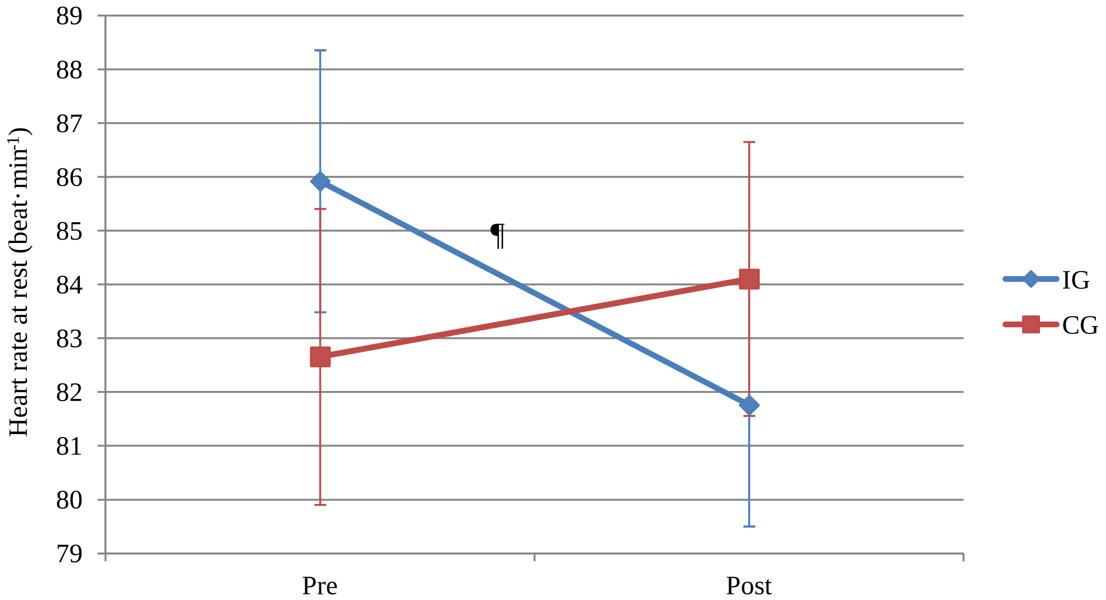

Figure 18. Pre-Post test difference in HR at rest in the intervention and control groups. Values are Mean (SE), n=37/29. ¶ $p < .05$ IG pre-posttest following significant interaction.

6.3.2 *Strength, balance and flexibility*

Upper and lower limb isometric muscle strength improved in the IG after the training period, while these values remained almost stable in the CG. Other authors also found improvement in muscular strength after a training period (Calders et al., 2011; Carmeli et al., 2005; Guidetti et al., 2010; Mendonca et al., 2011). Specifically Guidetti et al. (2010) reported improvements of 9-10 kg on the HG test in their population, which may be due to the longer training duration of 9 months.

Improved leg strength is an important factor that contributes to VO_2 peak in individuals with ID (Pitetti & Boneh, 1995; Pitetti & Fernhall, 1997). Nevertheless, other authors have not found relations between leg strength and VO_2 peak (Cowley et al., 2011; Nasuti et al., 2013). Cowley et al. (2011) in their study found that gains in leg strength and VO_2 peak were related to improvements in functional performance in those participants with DS. Thus, the improvements found in the IG values on VO_2 peak and leg strength could possibly lead to an improvement in their performance of daily-living tasks.

For the VJT, it is known that people with ID have lower performance than people without ID (Guerra-Balic, 2001; Hassani et al., 2013, 2014). Individuals without ID jumped higher than their counterparts with ID and had lower take-off velocity, lower knee joint power and stiffness, lower knee joint extension angle and angular velocity, longer braking and propulsion phase, lower agonist and higher antagonist lower limbs activation (Hassani et al., 2014).

In our study the results obtained at the end of the intervention were lower than those presented by Guerra-Balic (2001) and Hassani et al.(2013, 2014), but their participants were younger (~24 and ~15 year-old) and the technique used in these studies were Squat Jump (SJ) and Counter Movement Jump (CMJ) (Guerra-Balic (2001): SJ ~17.04 cm and CMJ ~18.80 cm; Hassani et al. (2013): SJ ~19 cm; Hassani et al. (2014): CMJ ~23 cm). Two others studies report mean values of 43.48 ± 10.98 cm for the Abalakov jump test in athletes without ID (more similar to the VJT used in this study) (Garrido Chamorro & González Lorenzo, 2004) and 19±6.45 cm for the Sergeant test in adolescents with ID (Giagazoglou et al., 2013). Giagazoglou et al. (2013) found improvements by ~6.22 cm using the Sergeant test and ~ 30.11 cm in the SLJT, whereas we observed improvements of ~0.14 cm. and ~1 cm in the

SLJ and the VJT respectively (Figures 19 and 20). Guidetti et al. (2010) did not found changes in the SLJT in their participants.

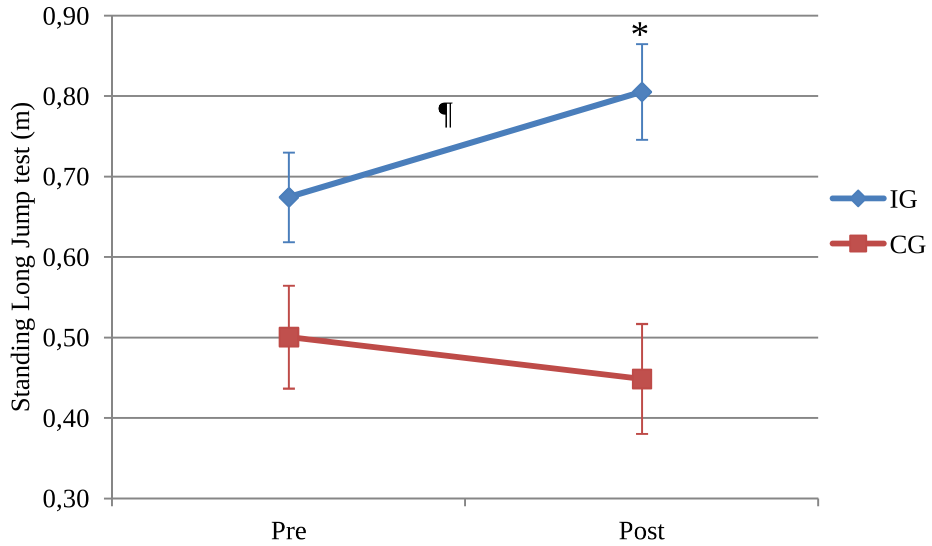

Figure 19. Pre-Post test difference in SLJT in the intervention and control groups. Values are Mean (SE), n=37/28. [¶] p < .05 IG pre-posttest following significant interaction; * p < .05 between-group difference.

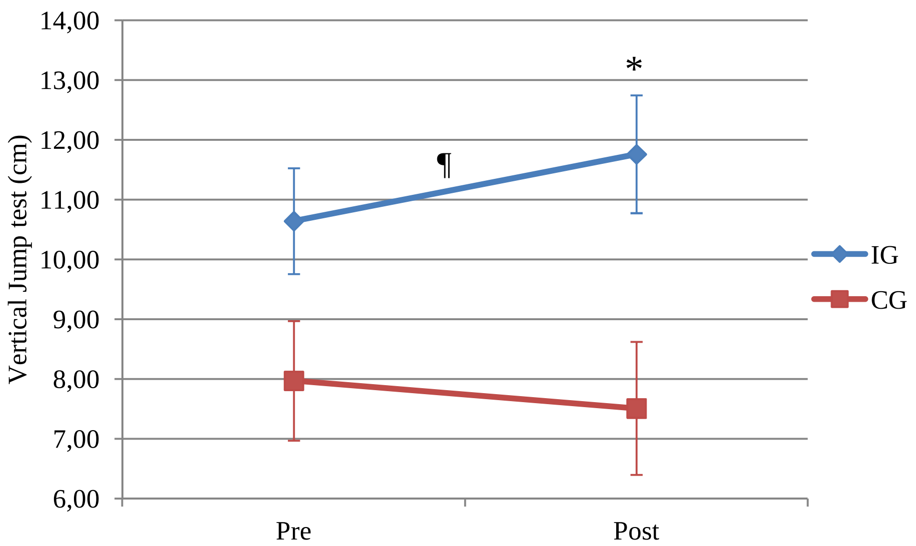

Figure 20. Pre-Post test difference in VJT in the intervention and control groups. Values are Mean (SE), n=37/29. [¶] p < .05 IG pre-posttest following significant interaction; * p < .05 between-group difference.

To make sure the participants did not bend their knees during the SRT, two testers were necessary. One tester was holding participants' knees with hands while the second was reading the values. The participant was counseled, too, to reach forward slowly without any sudden movements. It was noted that this task was unpleasant to perform, because hamstring tightness usually caused the feeling of pain. Interestingly, flexibility improved significantly for both groups after the intervention period; however, the improvement was greater in the IG, which followed the program, meanwhile the CG was more familiarize with the testers and the technique. The improvement in the IG is in line with data from Giagazoglou et al. (2013), despite participants were children with a mean age of ~10 years. In contrast, Carmeli et al. (2002) found no changes in flexibility, which may be due to the mean age of their participants that was ~60 years old for individuals with DS and ~61 years old for non-DS individuals, which is older than the mean age of our participants (~43 yrs). Nevertheless, in the present study the sample was ID with and without DS, and as it is known persons with DS show more flexibility than the ones without DS (American College of Sports Medicine, 2009b).

While we observed some improvement in shoulder flexibility in the IG, it was not observed when comparing IG with CG. Surprisingly, the CG exhibited a very modest increase, yet significant improvement for SRT, which may be due to a learning effect (Figure 21). To increase or maintain flexibility is important in order to prevent injuries, to maintain a normal range of movement and to allow people to perform daily-living tasks and complex movements naturally (American College of Sports Medicine, 2011). At the same time, it is important to remember that flexibility is one of the physical capacities that begins to decrease earlier and quicker in adults and elderly (Chesworth & Vandervoort, 1989).

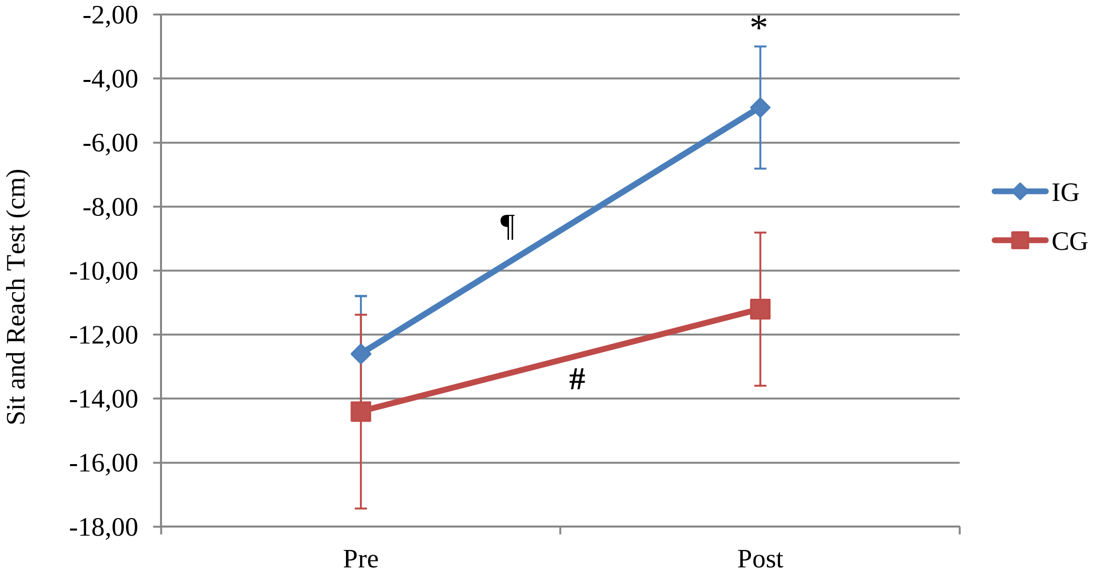

Figure 21. Pre-Post test difference in SRT in the intervention and control groups. Values are Mean (SE), n=37/29. [¶] and [#] $p < .05$ IG and CG pre-posttest following significant interaction; * $p < .05$ between-group difference.

A unique aspect of this study, was the inclusion of balance training in combination with a more general and applied training (resistance and aerobic) in order to improve balance and motor performance. It is known that a subconscious process is carried out to coordinate and make possible the cooperation between the organ of sight, the inner ear, deep sensibility and the central nervous system and allow people to keep balance in changeable conditions of external environment. Most authors agree with the opinion that the capability of keeping a stable posture of the body in people with ID is smaller than in the population without ID (Dellavia, Pallavera, Orlando, & Sforza, 2009; Vuijk, Hartman, Scherder, & Visscher, 2010). The reason for smaller stability of the body balance of the people with ID has not been clearly identified yet. Some authors show to decreased postural control resulting from slowing down equivalent reactions (Cimolin et al., 2011; Galli et al., 2008), disturbing the functioning of the vestibular system (Cabeza-Ruiz et al., 2011) or auditory or visual impairment accompanying ID (Hale et al., 2007; Hale et al., 2009).

In this study the IG improved static balance (SLST), dynamic balance and gait speed (TUGT) after training, with no changes for the CG (Figures 22, 23 and 24). These improvements may be due to alterations in the complex sensory motor stimulation of the participants' efforts to adapt to the different unstable surfaces used during the CPAP (Giagazoglou et al., 2013). Others studies have also found improvements in dynamic balance and gait speed (Carmeli et al., 2005; Guidetti et al., 2010; Tsimaras & Fotiadou, 2004), as well as in static balance (Giagazoglou et al., 2013). But this last study involved children and didn't train aerobic capacity nor strength and balance. The TUGT assess the ability of a person to perform a task that is probably performed several times across the day by adults with ID, in our sample both groups performed the test in less than 16 seconds, but only the IG improved after the training period by ~1.4 seconds.

However, when we compare the results obtained with the pressure platform, the IG improved their pre-post-test scores on COP TTD (~79.90 mm) and COP MLD (~0.49 mm), but only the COP TTD improvement was significant (p = .018) when compared with the CG results. During the SLST 3 participants from the IG and 1 from the CG could not perform correctly the baseline test and were excluded from the final assessment. When assessed with the pressure platform, 5 participants from the IG and 3 from the CG could not complete the test. These could be a result of disruption of attention during the test, lack of concentration and others unknown reasons.

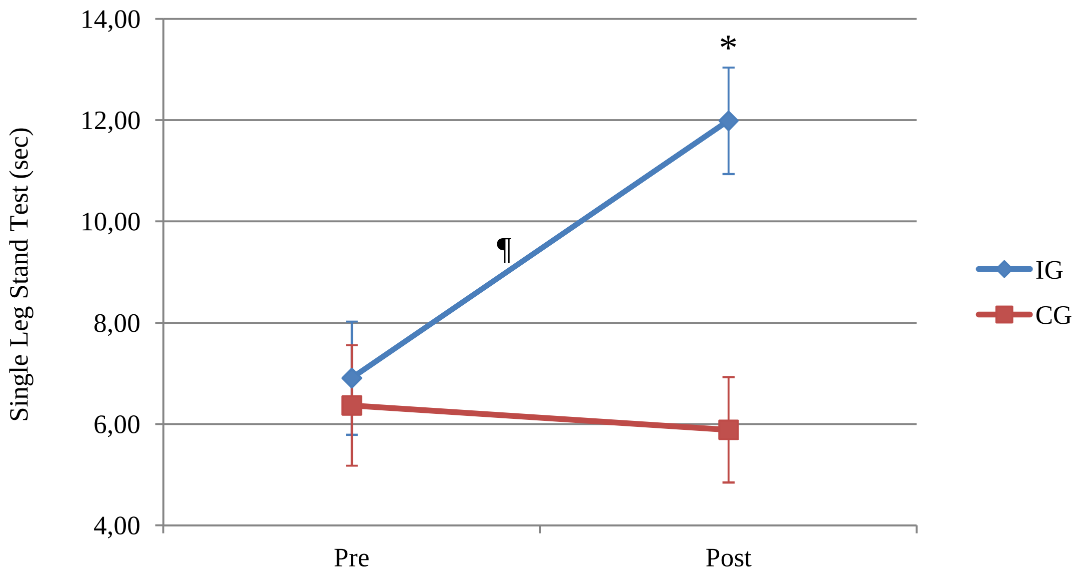

Figure 22. Pre-Post test difference in SLST in the intervention and control groups. Values are Mean (SE), n=34/28. [¶] p < .05 IG pre-posttest following significant interaction; * p < .05 between-group difference.

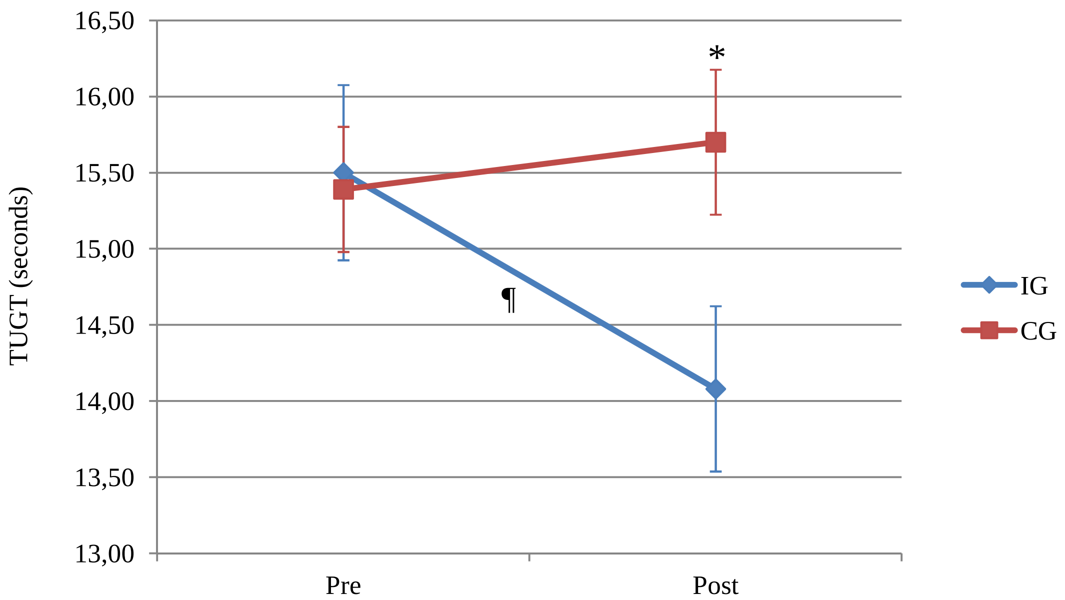

Figure 23. Pre-Post test difference in TUGT in the intervention and control groups. Values are Mean (SE), n=34/28. [¶] p < .05 IG pre-posttest following significant interaction; * p < .05 between-group difference.

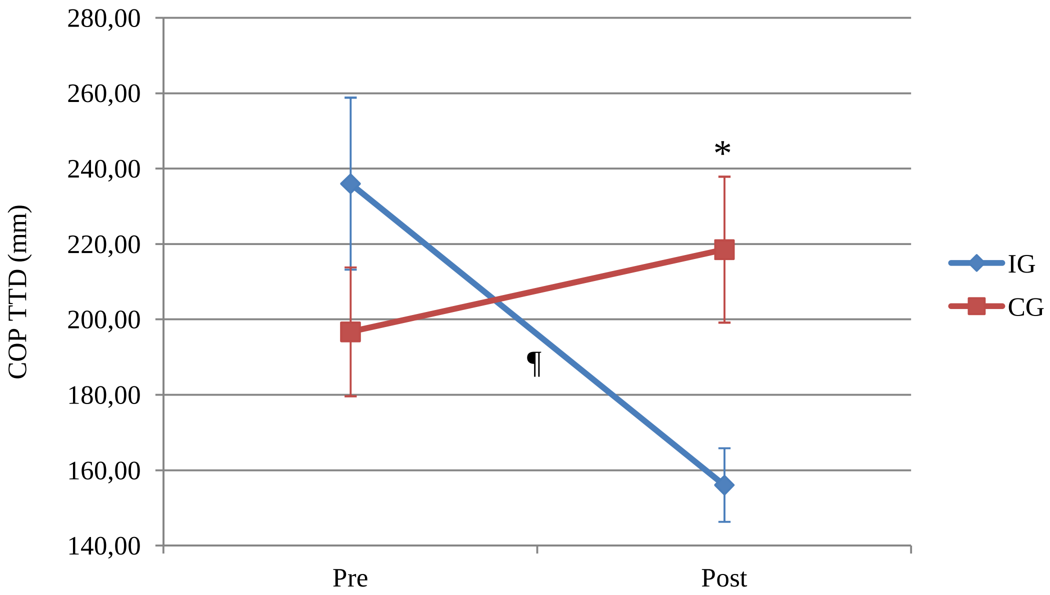

Figure 24. Pre-Post test difference in COP TTD in the intervention and control groups. Values are Mean (SE), n=32/26. ¶ $p < .05$ IG pre-posttest following significant interaction; * $p < .05$ between-group difference.

Thus, performance improvements in balance tasks were benefited not only by balance training, but also by the strength and aerobic training, and all together have affected positively the trunk stability, that is required during many gross motor skills and daily-living activities (Carmeli et al., 2005; Mendonca et al., 2011). Intervention to prevent the onset of functional decline and to improve general elements of physical condition in people with ID as well as aspects related to propioception and sensory perception in this population, is a major challenge for health-care workers, because any functional decline or debility could lead to a more sedentary lifestyle and increase the requirement of support and health-care costs. As informed by Enkelaar et al. (2012) in their review, balance and gait are potentially trainable in people with ID and such interventions can be expected to improve quality of life and reduce the risk and number of falls and the incidence of degenerative processed caused by time.

6.4 Physical Activity Levels

This study provides a general vision of PA patterns and EE in this sample of adults with ID. The main finding is that participants from both groups spent most of their time awake being sedentary and only during the PA sessions the IG increased the quantity of MVPA performed when compared with the CG. This is in line with others studies that have found that time spent in sedentary behaviors is high between adults with ID (Finlayson et al., 2009; Frey, 2004; Temple & Walkley, 2003).

In different studies approximately 17.50% to 33% of adults with ID accumulated the 30 minutes of MVPA recommended per day (Frey, 2004; Stanish & Draheim, 2005; Temple et al., 2000, 2006; Temple & Walkley, 2003). In our study only 5 (13.89%) participants from the IG and 2 (7.14%) participants from the CG met the recommendation of performing at least 30 min of MVPA per day (Figure 25). The total number of participants from all the sample (IG and CG) that have met these recommendations was 7 (10.94%). Moreover, in our study only 6 (9.37%) participants achieved ≥10,000 steps/day, while 35 (54.69%) perform between 5,000 to 10,000 steps/day and 23 (35.94%) did not achieved the 5,000 steps/day.

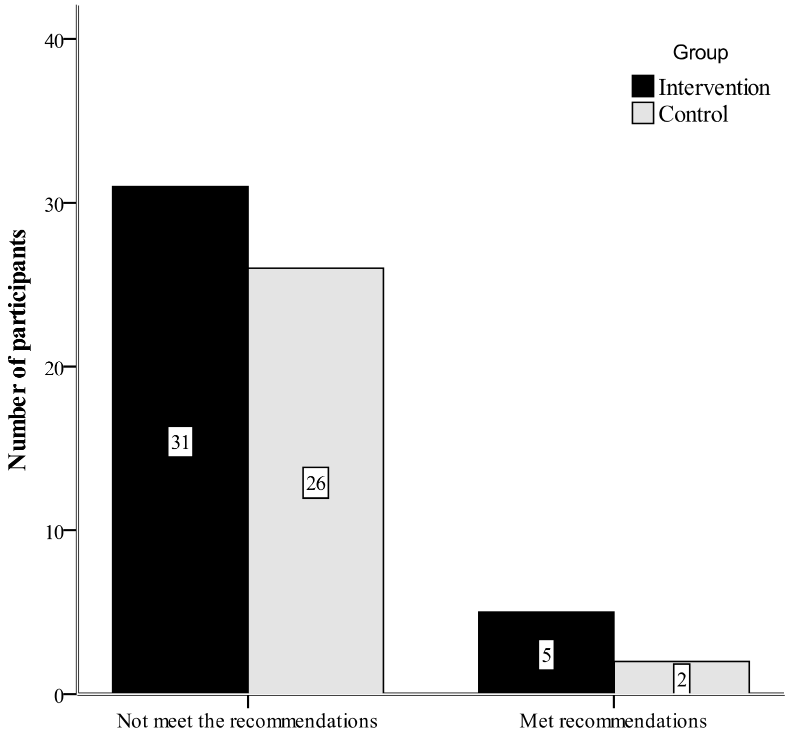

Figure 25. Number of participants from the IG and CG meeting or not the recommendations of perform 30 mins/day of MVPA

When split by groups (Figure 26), 4 participants (11.11%) in the IG achieved the recommended 10,000 steps per day and 2 (7.14%) did it in the CG. In the IG 23 participants (63.78%) performed between 5,000 to <10,000 steps per day and in the CG the result was 42.86%. Neither 9 (25%) participants in the IG nor 14 (50%) in the CG achieved 5,000 steps/day.

So, even though we study our whole sample of participants or all the sample divided into two groups (IG and CG), we can see that the number of adults with ID that accumulated recommended quantities of steps/day in our study are less than the ones reported by other studies (Finlayson et al., 2009; Hilgenkamp et al., 2012; Stanish & Draheim, 2005; Temple et al., 2006), in which the achievement was 16% to 45%, approximately.

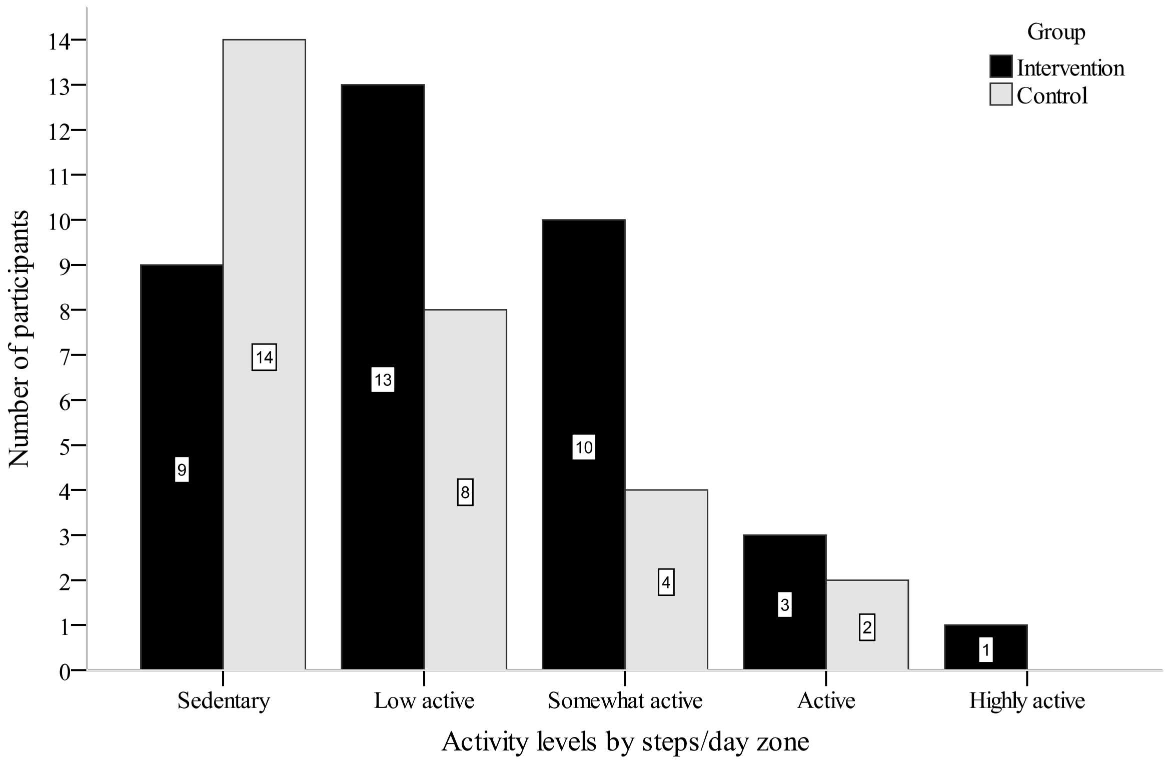

Figure 26. Activity levels of participants by group and by step/zone.

Following the WHO recommendations, 34 (53.12%) participants in our study performed at least 150 minutes of MVPA a week. When divided by groups, in our study the 25 (69.45) participants in the IG and only 9 (32.14%) in the CG met these recommendations (Figure 27). This values are higher than those presented by Dixon-Ibarra et al. (2013) where adults with ID were a 6% of older adults with ID and a 13% of younger adults with ID met the recommendations of 150 minutes of MVPA across the week.

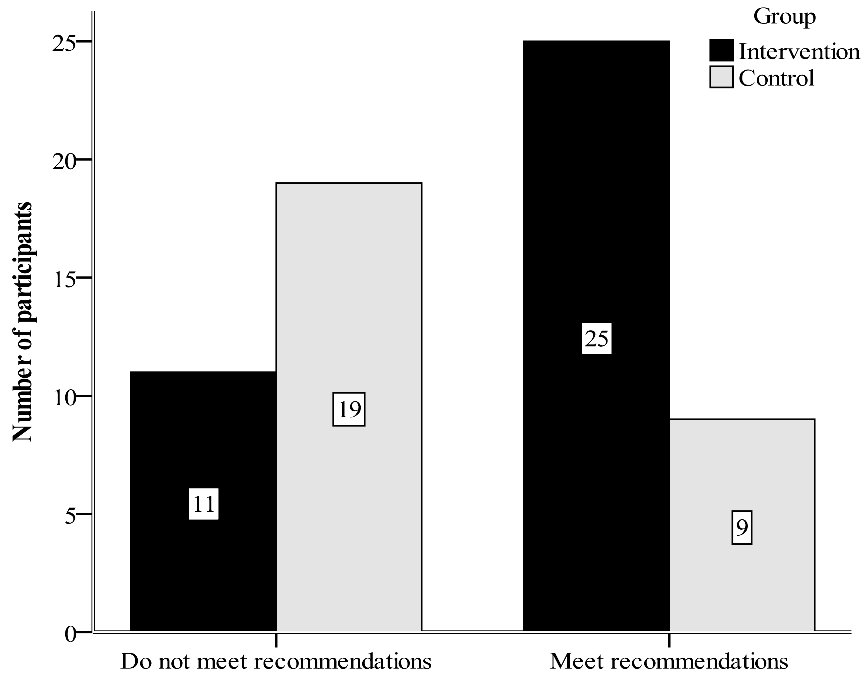

Figure 27. Total number of participants from the IG and CG meeting or not the WHO recommendations for PA (≥ 150 mins/week of MVPA)

The average time for MVPA in our study was ~32 minutes during a week. However, when dividing the sample, the IG average was ~39 minutes of MVPA and the CG was ~26 minutes of MVPA during a week. These values are higher than the results presented by Frey (2004), but they are still lower when compared with the active people without ID in the study by Frey (2004).

In the same line with Phillips & Holland (2011) and Melville et al. (2011), in our study both groups spent most part of the waking time being sedentary (IG = ~616 mins/day and CG = ~611 mins/day). The LPA (IG = ~122 mins/day and CG = ~136 mins/day) performed by participants in our study was similar to the study by Phillips & Holland (2011) and higher than the values reported by Melville et al. (2011). MPA (IG = ~39 mins/day and CG = ~26 mins/day) is similar at the values reported by Phillips & Holland (2011) and the time spent in VPA (IG = 1.18 mins/day and CG = ~0.67 mins/day) are lower to those reported by these authors. The MVPA in our study (IG = ~39 mins/day and CG = ~26 mins/day) is higher than those presented by Melville et al. (2011).

Something that calls our attention is that the number of steps/day performed by participants in the study by Phillips & Hollan et al. (2011) is similar to the average steps/day performed by our groups of participants (6,334 vs. 6,375 respectively), however the total PA (counts / min) reported by these authors for mild to moderate ID is much higher than the values found in our study (639 vs. 282 counts/mins respectively).

In the study by Melville et al. (2011) where the intervention's main objective was the weight loss of their participants, the final assess of PA levels showed significant decreases in the time spent in sedentary behaviors (~623 vs. ~582 mins/day), but no changes were observed for LPA or MVPA. In our study, participants from the IG present significantly higher values for MVPA, but lowers for LPA and no difference in the time spent in sedentary when compared with the CG.

The choice of the accelerometer cut-point may affect PA levels performed by participants, and the proportion of participants who meet PA recommendations. We should not forget that that the cut-points selected by Melville et al. (2011) differs from those used in the present study. We decided to use the cut-points developed by Troiano et al. (2008) because these ones were applied in the NHANES project that involved a large sample and were used in the study by Phillips & Hollan (2011) and by Dixon-Ibarra et al. (2013) too. This allows us to compare our results with biggest samples of population.

The high level of sedentary activity and low adherence to PA recommendations found in our study and reported by several researchers indicate that levels of PA in adults with ID are low. Adults with ID spend most of their time pursuing sedentary activities (~613 mins/day), only 53% of the sample meets the current WHO guidelines for PA and just a 9.38% meets the criterion of 10,000 steps/day. Furthermore, we could see in our study that between participants behavioral changes regarding PA levels are not quite different in the IG and CG. It makes us hypothesize that PA interventions should be part at least from Monday to Friday during their working time.

Worryingly, the proportion of sedentary behavior during the week in participants of this study, for both groups IG or CG, reaches the ~79% of their monitoring time. Only a 5.01% of the monitored time in the IG and 3.35% in the CG were spent in MVPA. This values spent in sedentary behaviors is higher than the results presented by Dixon-Ibarra et al. (2013) (~61%) and those in the US adult population (~55%) (Matthews et al., 2008).

The amount of time adults with ID are inactive is problematic, especially if participants were pursuing sedentary activity during non-wear time. Fortunately for sedentary and low activity populations, reductions in mortality risk begin to accumulate with the first increase in physical activity beyond base-line (Powell, Paluch, & Blair, 2011). This demonstrates that even small increases in activity could provide substantial health benefits. Therefore, health promotion programs for adults with ID should focus on purpose not only in increase MVPA, but decreasing sedentary activity too (Powell et al., 2011).

Compared to less than 0.5 hour per week of MVPA, engaging in approximately 1.5 hours per week of such activity is associated with about a 20% reduction in risk of all-cause mortality (Figure 28) (Physical Activity Guidelines Advisory Committee, 2008; U.S. Department of Health and Human Services, 2008).

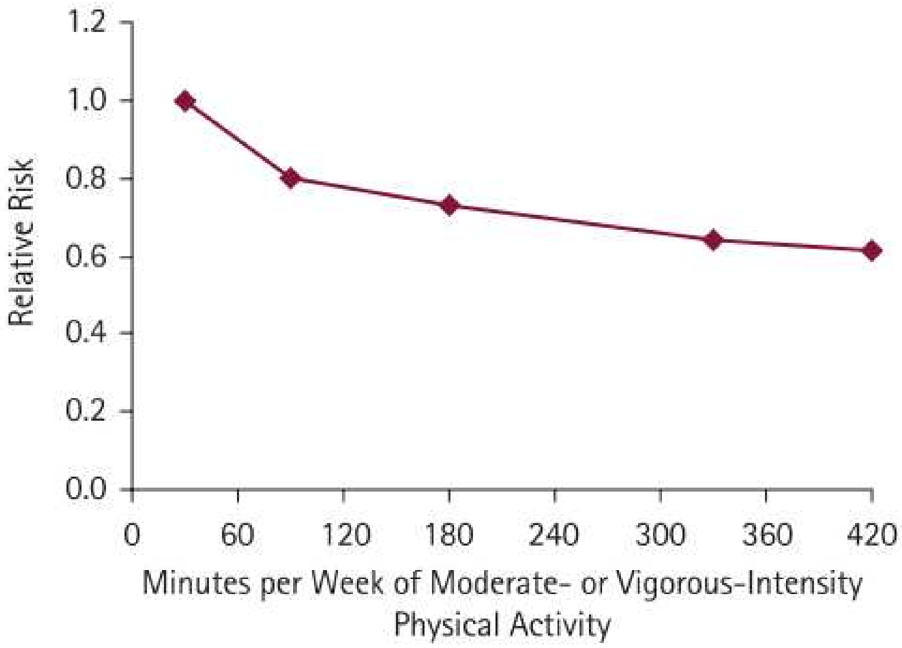

Figure 28. Risk of all-cause mortality by minutes/week of MVPA (U.S. Department of Health and Human Services, 2008)

Possibilities to engage in PA programs may be hindered due to many social, cognitive, motor and behavioral factors associated with the presence of ID. It would be important to remember that low participation in these PA programs for adults with ID may be related to lack of appreciation of the benefits of PA, lack of support from their caregivers and difficulty finding experienced personnel to train them (Carmeli, Merrick, Imam, & Levy, 2012). A very important point is to assess the opportunities for practicing PA among ID people. Assessments typically are aimed to determine how much time these people move, but we forget their difficulties and problems to be part of structured PA programs.

In the total sample, the caloric consumption was ~1,976 kcal/week. While when divided in groups, the IG consumed ~2,249 kcal/week and the CG consumed ~1,704 kcal/week. We think that this caloric consumption generated by the activities they performed is acceptable and would achieve the ACSM recommendations (2010), which states that the weekly caloric consumption would have o be approximately 2,000 kcal. Unfortunately, in our study and because of budget issues, it was not possible to evaluate the nutritional habits of our participants, what also can explain why the small reduction of weight in the IG and the maintenance of weight in the CG.

6.5 Limitations

This study has some limitations, such as not being able to perform a more extensive and specific determination of changes in the parameters of strength, though standardized and internationally accepted methods were used. Second, the lack of blinded assessors to collect data at pre- and post-training periods may also correspond to a limitation of the present study. Third, a strict randomization of the participants was not possible. In order to respect the will of the participants, they were allowed to choose the group in which they wanted to be (IG or CG). At the same time schedule and agenda of the institution was respected, which in some cases take us to include or exclude participants from a group or other. For that reason it is possible that selection bias influenced our results. Fourth, other limitations to our study that should be highlighted is that PA may have been underestimated because ActiGraph accelerometers were mounted at the hip level and PA or movements with the upper-body was not measured and these accelerometers cannot be worn during swimming or bathing activities. Fifth, the cut-points previously used by other authors were established for adults without ID using a different model of ActiGraph accelerometer and they may therefore not be completely suitable to assess PA in this population. It is also possible that there may be differences in metabolic equivalent derived cut-points between individuals with and without ID; according to Agiovlasitis et al. (2011) cut-points for identifying sedentary time and PA intensities in people with DS should be different. Caution should be taken when using the energy expenditure values obtained in this work because equations used by the accelerometer's software was developed using specific activities and sample populations that may not adequately represents the metabolic and movements characteristics of adults with ID. Sixth, it is known that PA levels shows seasonal variation (Shephard & Aoyagi, 2009) and such variation was not investigated in this study. It may be possible that analyzing seasonal variation in PA in this population with ID will help to identify individual and environmental factors that may be targets of specific strategies to enhance participation in PA programs during adverse environmental conditions. Seventh, the inclusion of participants with DS could have an effect on the PA levels results, but we believe, based on a validation study conducted by Temple & Stanish (2009) where they determined that although those with DS have overall lower PA, the patterns of PA throughout the week is similar to those with ID without DS; and by the fact that in our sample there were just 9 and 5 participants with DS in the IG and the CG respectively, including this participants would not be a problem and would be acceptable. Finally, it is not possible to claim that our results are representative of adults with ID population because we assess a specific sample from an Occupational Day Center for people with ID (Girona, Spain).

7. CONCLUSIONS

7.1 General Conclusions

This study showed that the VJT is a reliable test that could be used to assess leg power and strength in adults with ID. At the same time, the present study showed that a CPAP could improve aerobic fitness, muscle strength and balance of people with ID. In addition, some positive changes in anthropometric parameters and the decrease in BP values, which together with the aforementioned improvements would imply a decrease in the risk factors associated with cardiovascular disease or metabolic disorders.

The current program differed from previous studies because it was based on aerobic, strength and balance as principal components. Specific, well structured, fun and interesting physical activity programs are necessary to promote an active lifestyle, increase work capacity, improve motor skills and decrease health risks in this population.

All participants in the study reported that they enjoyed the exercise program and caregivers inform positive changes of attitude related to exercise practice between participants. These findings support the claim that the adoption of active physical exercise program that improve cardiorespiratory fitness, muscular strength, flexibility, and balance in relatively inactive people with ID may be beneficial, and the support provide by professionals working with individuals with ID to perform these activities is essential.

When assessing the PA levels, it was observed that participants presented important sedentary behaviors in both groups. The IG despite participating in a program of PA and most of them meeting the guidelines of PA from the WHO, they did not decrease the time spent in sedentary activities. We believe that including well designed and structured PA programs into their workdays could be of great help to enhance daily PA levels in adults with ID.

In our opinion, the present findings suggest that not only aerobic training is important because in people with ID becoming older, muscle strength and balance should be trained to increase or maintain their daily-living activities and prevent or delay functional decline, risks of falls and injuries. At the same time, PA interventions aimed at reducing the time spent on sedentary activities should be performed immediately in this population.

It will be necessary to enhance the cross working between public administrations, local authorities and Occupational Day Centers for people with ID to design and implement programs of health promotion for people with ID to reduce secondary conditions (obesity, hypertension, poor nutritional habits, psychological problems), chronic disease, to maintain their functional independence and provide opportunities for recreation and enjoyment that will help to improve their quality of life.

7.2 Future Directions for Research

The present CPAP was effective to promote changes in the CRF, strength and balance, but it will be necessary to implement this program in different centers in order to indentified and evaluate its effectiveness when used in different social, cultural and economic realities. At the same time, to evaluate the psychological, emotional and cognitive benefits that a program of like this could cause on these people would be tremendously valuable.

As previously mentioned, increase PA levels and reduce the time spent in sedentary activities by adults with ID should be a primary aim for future researches. Studies using appropriately powered samples and acceptable assessments methods should be performed.

Future validation studies are needed to determine the accuracy of specific cut-points across various activities and age for adults with ID. Develop new cut-points for this population may help to obtain more accurate values when PA patterns and energy expenditure are evaluated.

8. SUMMARY

8.1 Versión en Español

8.2 English Version

8.1 Resumen (Versión en Español)

Las personas adultas con discapacidad intelectual (DI) presentan bajos niveles de capacidad cardiovascular y fuerza, al mismo tiempo que realizan poca actividad física (AF) y frecuentemente presentan problemas funcionales y de equilibrio. Uno de los propósitos de esta tesis fue investigar la fiabilidad del salto vertical en perdonas con DI sobre una plataforma de contacto y compararlo con el test de salto en largo sin pulso, normalmente utilizado en el EUROFIT Special, para evaluar la potencia de las piernas. Otro de los objetivos del estudio fue evaluar los efectos de un programa de AF combinado utilizando ejercicios aeróbicos, de fuerza y de equilibrio sobre la condición física, la fuerza, el equilibrio y medidas funcionales en un estudio controlado. También se evaluaron las características y niveles de AF en el grupo de adultos con DI que participó en la intervención (GI) en comparación con un grupo control (GC).

Los participantes, adultos con DI leve a moderada, fueron asignados a un grupo intervención (GI; n = 37) y otro grupo control (GC; n = 29). El GI entrenó 3 veces por semana, 1 hora durante 14 semanas, mientras que el GC no participó en ningún tipo de programa de AF. La resistencia aeróbica, fuerza, equilibrio, flexibilidad y habilidades funcionales fueron evaluadas pre y post entrenamiento en ambos grupos. Como resultado, el GI mejoró su capacidad aeróbica (26.8 vs. 29.3 $ml \cdot Kg^{-1} \cdot min^{-1}$), la fuerza de prensión manual (19.2 vs. 21.9 kg), la fuerza de piernas y el equilibrio luego del período de entrenamiento ($p < .05$). El peso corporal (70.1 vs. 68.1 kg) y el índice de masa corporal /27.4 vs. 26.6 kg·m-2) también disminuyeron ($p < .05$) en el GI. El GC no presentó cambios en estos parámetros. Así también, los adultos con DI del GC realizaron menores cantidades de AF moderada a vigorosa (AFMV) que el GI. Sin embargo, el comportamiento sedentario en ambos grupos fue elevado (~79% del tiempo monitorizado). El 69.40% y el 32.10% de los participantes del

GI y GC respectivamente cumplieron con las recomendaciones de realizar ≥150 minutos de AFMV/semana. Estos resultados sugieren que un programa de AF aeróbico, de fuerza y equilibrio es beneficioso para los adultos con DI. Las intervenciones para disminuir el tiempo empleado en actividades sedentarias y aumentar la AFMV deberían formar parte del tiempo en el cual estas personas están trabajando.

8.2 Abstract (English Version)

Adults with ID have decreased cardiovascular fitness and strength with lower rates of PA, and often have balance and functional impairments. One of the purposes of this study was to investigate the test-retest reliability of the vertical jump test on a contact platform and compare with the standing long jump test, normally used in the EUROFIT Special, to assess leg power. Other aim of the study was to assess the effects of a combined PA program (CPAP) utilizing aerobic, strength and balance training on cardiovascular fitness, strength, balance and functional measures in a controlled clinical trial. It was also of interest to know and describe the PA patterns of these groups of adults with ID that participated in the CPAP in comparison to a CG. Adults with mild to moderate ID were assigned to an intervention group (IG; n = 37) and/or a control group (CG; n = 29). The IG trained 3 d/wk, 1 h/d over 14 wks, while the CG did not participate in any exercise program. Cardiovascular fitness, strength, balance, flexibility and functional ability were assessed pre-post training. The IG increased cardiovascular fitness, (26.8 vs. 29.3 $ml \cdot Kg^{-1} \cdot min^{-1}$), handgrip strength (19.2 vs. 21.9 kg), leg strength, and balance following the training period ($p < .05$). Body weight (70.1 vs. 68.1 kg) and body mass index (27.4 vs. 26.6 $kg \cdot m^{-2}$) decreased ($p < .05$) in the IG group. The CG showed no changes in any parameter. Adults with ID in the CG are performing less MVPA than the IG. Nevertheless, important sedentary behaviors were observed in both groups (~79% of their monitoring time). In the IG a 69.4% of participants and a 32.1% in the CG met the PA of recommendations of ≥150 minutes of MVPA/week. These data suggest that a combined aerobic, strength and balance exercise training program is beneficial among individuals with ID. Interventions to decrease sedentary time and increase PA levels in adults with ID should be included into their work days.

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10. APPENDIX

10.1 Appendix I – Collaborations Letters

fundació Ramon Noguera

L'entitat **Fundació Ramon Noguera**, amb domicili al carrer indústria, 22 de Girona (17005) i amb CIF núm. G17462128, representat per la seva directora-gerent, la senyora Pepita Perich i Pujol, facultada per l'acord d'1 d'octubre de 2010, i amb DNI 40288912L;

Participa i col·labora de forma activa en el projecte de recerca *"Efectivitat d'un programa d'activitat física en la millora de la condició física i la qualitat de vida de les persones amb discapacitat intel·lectual"* dirigit per Dra. Myriam Guerra Balich, investigadora principal del grup de recerca "Salut, Activitat Física i Esport" de la Facultat de Psicologia, Ciències de l'Educació i de l'Esport Blanquerna (Universitat Ramon Llull).

NIF: G-17.462.128

I perquè així consti firmo el present document a Girona, 6 de Juny de 2011

fundació Ramon Noguera
C/ Indústria, 22
17005 GIRONA
Telèfon 972 23 76 11
Fax 972 24 45 47

c/ Indústria, 22 – 17005 GIRONA – Telèfon 972 23 76 11 – Fax 972 24 45 47 – E-mail: administracio3@fundaciornoguera.com – http://www.fundaciornoguera.cat

esport 3

Barcelona, 4 de febrero de 2012

Distiguidos Señores:

La entidad **Asociación Esport 3**, con domicilio en Ronda Sant Antoni 36-38, 2o 3a y CIF número G08880577, representada por Jesús Fortuño Godes con DNI. 43400814K;

Mediante el presente escrito expresa su participación y colaboración en el proyecto de investigación titulado "Efectos de la Actividad Física en la condición Física, Cognición y Calidad de Vida relacionada a la salud en adultos y adultos mayores con Discapacidad Intelectual" que ha sido presentado dentro del plan I+D+i (2011) del MEC y cuyo investigador principal es la Dra. Miriam Guerra Balic, de la FPCEE-Blaqnuerna (Universidad Ramon Llull).

Cordialmente,

Jesús Fortuño Godes

Presidente

Pl. Pes de la Palla, 3, entl. 2a - 08001 Barcelona
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HUB^c Health Universitat de Barcelona Campus

L'Hospitalet, 06 de maig de 2014.

En Casimiro Javierre Garcés, com a coordinador de la Unitat de Fisiologia de l'Exercici del Departament de Ciències Fisiològiques II, INFORMO que:

La nostra unitat ha participat i col·laborat al projecte: *"Efectividad de la Actividad Física en la condición física, aspectos cognitivos y calidad de vida relacionada a la salud en adultos y adultos mayores con discapacidad intelectual".*

Per a que consti a efectes acadèmics i a petició de l'interessat,

Signat: Casimiro Javierre

10.2 Appendix II – Inform Consent and Medical Screening

Consentimiento Informado

Facultat de Psicologia, Ciències de l'Educació i de l'Esport Blanquerna
Universitat Ramon Llull

fundació Ramon Noguera

Jo,... amb DNI: ....actuant com a mare, pare o tutor legal de ....

Després d'haver rebut la informació sobre el projecte d'estudi mèdic-esportiu "............." i que inclou proves de valoració funcional, l'**autoritzo** a participar en ell de manera voluntària.

També **autoritzo** el coordinador d'aquest estudi i als seus col·laboradors, que en cas d'accident, puguin prendre les decisions mèdiques precises.

Tanmateix, **autoritzo** la comunicació dels resultats i conclusions de l'estudi, així com a reproduir qualsevol imatge que es cregui oportuna, sempre preservant la identitat de la persona i mantenint el seu anonimat.

S'entén que aquesta col·laboració és voluntària, i per tant es pot abandonar sempre que es desitgi.

Signatura mare/pare/tutor   Signatura del participant

Nom informant/ Nº Col·legiat:

Signatura:

Barcelona, a ___ d _____________ de ______

Facultat de Psicologia, Ciències de l'Educació i de l'Esport Blanquerna
Universitat Ramon Llull

fundació Ramon Noguera

Cuestionario de Historial Médico

Por favor, intente contestar todas las preguntas de la manera más concisa y clara posible. En caso de tener alguna duda, utilice el apartado de observaciones que se encuentra al final del cuestionario. Si lo creemos oportuno, nosotros contactaremos con Ud.

Nombre de la persona que rellena el cuestionario:

....

Parentesco o relación con el participante en el estudio:..

Fecha en la que se rellena el cuestionario: ....

Datos Personales del participante en el estudio:

Apellidos:...

Nombre: ....

Domicilio:..

Ciudad...DP:.................................

Tel:.........................

Fecha de nacimiento:.....................................

Lugar de nacimiento:.....................................

Actualmente con quién convive…………………………………

Diagnosticado de...

% de Disminución..........................

Datos Perinatales

Datos del embarazo:

-¿Cuántas semanas duró el embarazo?..................................

-¿Tuvo enfermedades durante el embarazo: infecciones, golpes, etc.?

si ☐ no ☐ no sabe ☐

-Si tuvo enfermedades, ¿cuáles?..

-¿Amenaza de aborto?

si ☐ no ☐ no sabe ☐

-¿Tomó la madre alguna medicación durante el embarazo?

si ☐ no ☐ no sabe ☐

-Si tomó medicación, ¿cuál?...

Datos del Parto

-Peso al nacer:................kg.

-Talla al nacer:.................cm.

-¿Fue un parto normal, o necesitó cesárea, fórceps, u otra instrumentación?

normal ☐ cesárea ☐ instrumentado ☐ no sabe ☐

Datos del Recién Nacido

-APGAR: ....

- Ictericia (¿se puso amarillo?)

si ☐ no ☐ no sabe ☐

-¿Le hicieron análisis de detección precoz?

si ☐ no ☐ no sabe ☐

Si le hicieron análisis, ¿salió alguna enfermedad?, ¿cuál?…………

<u>Datos de la familia del participante</u>

- Edad de la madre cuando nació el bebé: ………………años

- Edad del padre cuando nació el bebé: …………………años

- ¿Existe algún parentesco entre los padres?

si ☐ no ☐ no sabe ☐

a.-¿Tiene <u>la madre </u>alguna enfermedad importante? (Tensión alta, colesterol, hipertiroidismo, diabetes, cardiopatía, …)

si ☐ no ☐ no sabe ☐

Si existe enfermedad, ¿cuál?……………………………………

Si la madre ha fallecido, ¿por qué causa?…………………………

b.-¿Tiene <u>el padre</u> alguna enfermedad importante? (Tensión alta, colesterol, hipertiroidismo, diabetes, cardiopatía, …)

si ☐ no ☐ no sabe ☐

Si existe enfermedad, ¿cuál?……………………………………

Si el padre ha fallecido, ¿por qué causa?…………………………

c.-¿Tiene el participante algún <u>hermano/a</u>?

si ☐ no ☐

Diga la edad y sexo de los hermanos, si los tiene: ………………….

…………………..

…………………..

¿Tienen los hermanos alguna enfermedad importante? (Tensión alta, colesterol, hipertiroidismo, diabetes, cardiopatía,…)

si ☐ no ☐ no sabe ☐

Si existe enfermedad, ¿cuál y quién?……..…………………………

Si alguno ha fallecido, ¿por qué causa?…………………………

d.-¿Tiene el participante algún tío/a?

si ☐ no ☐

¿Tienen los tíos alguna enfermedad importante? (Tensión alta, colesterol, hipertiroidismo, diabetes, cardiopatía,…)

si ☐ no ☐ no sabe ☐

Si existe enfermedad, ¿cuál y quién?……..……………………….

Si alguno ha fallecido, ¿por qué causa?……………………….

e. ¿Tiene el participante algún abuelo/a?

si ☐ no ☐

¿Tienen los abuelos alguna enfermedad importante? (Tensión alta, colesterol, hipertiroidismo, diabetes, cardiopatía,…)

si ☐ no ☐ no sabe ☐

Si existe enfermedad, ¿cuál y quién?……..……………………….

Si alguno ha fallecido, ¿por qué causa?……………………….

f.- ¿Algún otro familiar tiene Sd. de Down, alguna enfermedad hereditaria o alguna malformación congénita?

si ☐ no ☐ no sabe ☐

Si la tiene, ¿cuál?………………………………………………..

Datos Personales

(Referidos a la persona que participa en el estudio, no a la que rellena el cuestionario)

1.- ¿Ha tenido alguna enfermedad del Corazón?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?………………………………………….

¿Qué le dijeron los médicos que tenía?……………….

…………………………………………………….

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?…………….

……………………………………………………

(aporte informes, si puede)

2.- ¿Ha tenido alguna enfermedad del apto. Digestivo (estómago, intestino, hígado, recto, ano, páncreas)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?………………………………………….

¿Qué le dijeron los médicos que tenía?……………….

…………………………………………………….

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?…………….

……………………………………………………

(aporte informes, si puede)

3.- ¿Ha tenido alguna enfermedad de la sangre (anemia, púrpura, trombocitosis,…)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?………………………………………….

¿Qué le dijeron los médicos que tenía?……………….

…………………………………………………….

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?……………..

………………………………………………………

(aporte informes, si puede)

4.- ¿Ha tenido alguna enfermedad de la <u>visión</u> (miopía, bizco,…)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?……………………………………….

¿Qué le dijeron los médicos que tenía?………………

……………………………………………………..

¿Utiliza gafas?……………………………………..

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?……………..

………………………………………………………

(aporte informes, si puede)

5.- ¿Ha tenido alguna enfermedad del <u>oído</u> (sinusitis, otitis, sordera,…)?
si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?……………………………………….

¿Qué le dijeron los médicos que tenía?………………

……………………………………………………..

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?……………..

………………………………………………………

(aporte informes, si puede)

6.- ¿Ha tenido alguna enfermedad de los <u>genitales</u> (fimosis, malformaciones, mala posición de testículos,…)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?………………………………………….

¿Qué le dijeron los médicos que tenía?……………….

……………………………………………………..

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?…………….

………………………………………………………..............

(aporte informes, si puede)

7.- <u>Madurez sexual</u> :

¿A qué edad hizo el cambio (le salió el vello, se desarrolló,…)? ………………………………………………………………………………………..

Si es chica, ¿a qué edad tuvo la primera regla?…………….

¿cuántos días le dura la regla?…………………

¿cada cuántos días le viene?……………………

8.- ¿Ha tenido alguna enfermedad de las <u>glándulas tiroides</u>? (bocio,…)

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?………………………………………….

¿Qué le dijeron los médicos que tenía?……………….

……………………………………………………..

¿Estuvo ingresado? si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?……………..

(aporte informes, si puede)

9.- ¿Ha tenido alguna enfermedad del riñón?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?………………………………………..

¿Qué le dijeron los médicos que tenía?………………

……………………………………………………..

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?……………..

……………………………………………………

(aporte informes, si puede)

10.- ¿Ha tenido alguna enfermedad pulmonar (asma, infecciones,…)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?………………………………………..

¿Qué le dijeron los médicos que tenía?………………

……………………………………………………..

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?……………..

……………………………………………………

(aporte informes, si puede)

11.- ¿Ha tenido alguna enfermedad de los huesos (malformación, contusiones, fracturas, pies planos, problemas de cadera, desviación de columna vertebral,…)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?………………………………………….

¿Qué le dijeron los médicos que tenía?……………….

…………………………………………………………………………….

¿Utiliza plantillas u ortesis?………………………….

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?…………….

…………………………………………………………………………….

(aporte informes, si puede)

12.- ¿Ha tenido alguna enfermedad de la piel (acné, hongos, nevus, verrugas,…)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?……………………………………………………..

¿Qué le dijeron los médicos que tenía?……………….

…………………………………………………………………………….

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?…………….

…………………………………………………………………………….

(aporte informes, si puede)

13.- ¿Le han operado de alguna cosa?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?……………………………………….

¿De qué? ……………………………………………..

¿Hubo alguna complicación?

si ☐ no ☐ no sabe ☐

¿cuál fue?…………………………………………..

………………………………………………………

(aporte informes, si puede)

14.- ¿Tiene alguna <u>enfermedad neurológica,</u> (alteración psiquiátrica, crisis epiléptica, hemiplejía,…)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?…………………………………………………

¿Qué le dijeron los médicos que tenía?……………….

…………………………………………………………………..

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?……………..

……………………………………………………………………

(aporte informes, si puede)

15.- ¿Ha tenido alguna enfermedad en la <u>boca o garganta</u> (gingivitis, mala posición dental, anginas, caries, infecciones,…)?

si ☐ no ☐ no sabe ☐

Sólo en caso afirmativo:

¿Cuándo fue?…………………………………………………….

¿Qué le dijeron los médicos que tenía?……………….

…………………………………………………………………………..

¿Lleva ortodoncia?…………………………..…………………..

¿Con qué frecuencia va al dentista?…………………..

¿Estuvo ingresado?

si ☐ no ☐ no sabe ☐

Si se le realizó alguna prueba, ¿cuál fue?……………..

…………………………………………………………………..……

(aporte informes, si puede)

Observaciones:

Desarrollo Psicomotor

(Sólo si recuerda estos datos, si no los recuerda no se preocupe, ponga una ralla al lado de la pregunta. No deje ninguna pregunta en blanco, por favor).

1.- ¿A qué edad aguantó la cabeza?

2.- ¿A qué edad se mantuvo sentado?

3.- ¿A qué edad gateó o se arrastró?

4.- ¿A qué edad reconoció su nombre?

5.- ¿A qué edad se puso de pie?

6.- ¿A qué edad dijo *papá* o *mamá*?

7.- ¿A qué edad obedeció órdenes?

8.- ¿A qué edad fue capaz de bajar escalones solo?

9.- ¿Tuvo problemas para succionar la leche?

10.- ¿A qué edad le empezaron a salir los primeros dientes?

11.- ¿A qué edad empezó a masticar?

12.- ¿A qué edad controló el pipí?

13.- ¿Se le escapa alguna vez el pipí?

14.- ¿Tiene el sueño inquieto o ronca?

15.- ¿Tiene tics?

16.- ¿Tiene convulsiones?

17.- ¿Se descontrola cuando está nervioso? (por ej. cogiendo rabietas)

18.- ¿Come yeso, pelo u otras cosas no comestibles?

19.- ¿Es hiperactivo, se mueve mucho y no puede estarse quieto?

20.- ¿Suele decir palabrotas?

21.- ¿A qué edad fue al colegio?

22:- Si va o fue al colegio, ¿a cuál? ¿es un colegio ordinario o no?

23.- ¿Siguió un programa de estimulación precoz?

24.- Actualmente, ¿asiste a un taller o a algún esplai?

25.- ¿Qué actividad realiza en el taller o en el esplai?

26.- ¿Tiene amigos/as?

27.- ¿Hace deporte?

28.- Si practica deporte, ¿Cuál, o cuáles?

29.- ¿Va a algún centro especializado a practicar deporte?

30.- ¿Cuánto tiempo (horas por semana) dedica a cada deporte?

31.- ¿Es autónomo?

32.- ¿Sabe leer/escribir/contar numéricamente?

33.- ¿Toma alguna medicación actualmente?

Datos sobre la persona que rellena el cuestionario

1.- ¿Quién rellena el cuestionario?

Padre ☐ Madre ☐ Tutor ☐ Otro ☐

2.- Fecha y lugar de Nacimiento…………………...........................………

3.- Estado Civil ……………………………………

4.- Nivel de estudios………………………………

5.- Situación laboral actual……………………….

Screening Médico

En la exploración por aparatos se valoraron:

Sistema cardiovascular

- Inspección, auscultación i palpación.
- Exploración i obtención de parámetros en reposo: frecuencia cardíaca (FC) y tensión arterial (TA) y electrocardiograma (ECG).
- Valoración de posibles patologías.

Aparato Respiratorio

- Inspección, auscultación, medición del índice torácico de Hirtz y evaluación espirométrica.

Sistema Nervioso

- Valoración del sistema nervioso central (SNC): pares craneales, respuesta de las pupilas a la luz, simetría de movimiento a nivel facial y lingual; y del periférico (SNP): sensibilidad al tacto, fuerza, reflejos osteotendinosos, reflejo cutáneo-plantar (Babinsky).
- Coordinación.

Abdomen

- Inspección, palpación, auscultación y percusión.

Piel, boca, orejas y nariz

- Inspección, exploración para descartar alteraciones y déficits.

Aparato locomotor

Columna Vertebral

- Análisis de la pelvis: horizontalidad, grados de libertad de movimiento en rotación interna y externa.
- Escoliosis.

Extremidades

- Extremidades superiores (EESS). Exploración y evaluación de alteraciones.
- Extremidades inferiores (EEII). Exploración y evaluación de alteraciones.

Podoscopia estática

- Observación del apoyo de la planta de los pies y evaluación de la presencia de otras alteraciones a nivel digital.

Perímetros

- Cefálico, con brazo relajado, con brazo contraído, con antebrazo relajado, con antebrazo contraído, cintura, cadera, pierna.

Diámetros

- Biacromial, bicrestal, biestiloideo, bicondíleo, femoral, índice torácico.

10.3 APPENDIX III – Data Recording Sheets

Facultat de Psicologia, Ciències de l'Educació i de l'Esport Blanquerna
Universitat Ramon Llull

fundació Ramon Noguera

Nombre y apellidos: **Edad:**

Fecha de evaluación: **Sexo:**

Peso: **Altura:**

DINAMOMETRÍA

	1ra Toma	2da Toma	3ra Toma	Media
Mano derecha				
Mano izquierda				
Lumbar				
Piernas				
Peso total				
I. Morehouse				
Peso magro				
Morehouse Mod.				

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		Edad (años)	Peso (Kgs)	Talla (cms)	Flexibilidad			Fuerza		Coordinación/Equilibrio		Get up and Go Test
					Sit and Reach (cms)	Alcance Posterior (cms)		Salto Longitudinal (mts)	Lanzamiento de Pelota (mts)	Test del Flamenco (seg)	Barra de Gessell	
Nombre	Test					D	I					
	T1											
	T2											
	T3											
	T1											
	T2											
	T3											
	T1											
	T2											
	T3											
	T1											
	T2											
	T3											
	T1											
	T2											
	T3											

Fecha de las Evaluciones:

Evaluador:

Facultat de Psicologia, Ciències de l'Educació i de l'Esport Blanquerna
Universitat Ramon Llull

ANTROPOMETRÍA

fundació Ramon Noguera

Nombre y apellidos: **Fecha de evaluación:**
Deporte: **Horas/semanales:**
Fecha de nacimiento: **Edad:**

		1ra Toma	2da Toma	3ra Toma	Media
	Peso (kg)				
	Talla (cm)				
PLIEGUES GRASOS	Tríceps				
	Subescapular				
	Bíceps				
	Pecho				
	Cresta Ilíaca				
	Suprailíaco				
	Abdominal				
	Muslo				
	Pierna				
PERIMETROS	Brazo relajado				
	Brazo contraído				
	Antebrazo relajado				
	Antebrazo contraído				
	Cintura				
	Cadera				
	Muslo				
	Pierna				
	Cabeza				
DIAMETROS	Biacromial				
	Bicrestal				
	Humeral				
	Cúbito-radial				
	Femoral				
	Índice Torácico				

Universitat Ramon Llull

Esta Tesis Doctoral ha sido defendida el día _______ de ____________________ de 2014

En el Centro ____

de la Universitat Ramon Llull

delante del Tribunal formado por los Doctores abajo firmantes, habiendo obtenido la calificación:

Presidente/a

____

Vocal

____

Secretario/ria

____

Doctorando

____

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