Chapter 1 General Introduction

Children and adolescents with intellectual disabilities (ID) already start off with more health problems than typically developing (TD) peers. These health problems can affect the quality of life of these young individuals, have a negative effect on their independent daily living skills, and thereby limit their possibilities to fully develop and participate. Low physical fitness levels are a risk factor for cardiovascular diseases, diabetes mellitus and poor mental health. Therefore, good physical fitness is not only important for their health during childhood and adolescence, but also for their health when they transition to adulthood.

Health-related physical fitness is the focus of the current study and consists of the components body composition, muscular strength, muscular endurance, and cardiorespiratory fitness. Measuring physical fitness in children and adolescents with ID is challenging. Since testing challenges are likely to increase when the level of ID is more severe, it not surprising that physical fitness testing has mainly been studied in children with mild to moderate levels of ID, resulting in almost a complete lack of information on physical fitness levels in children with moderate to severe ID.

Therefore, the aim of this thesis was to study the physical fitness of children with moderate to severe ID, and its relationship with physical activity and motor development. In order to be able to measure the physical fitness in this challenging population, a secondary aim was to find suitable field-based tests.

Chapter 2 Systematic review of field-based physical fitness tests

To provide an overview on psychometric properties of field-based physical fitness tests studied in children and adolescents with ID, we conducted a systematic literature review. Studies were included in the review if they evaluated feasibility, reliability and/or validity of a field-based physical fitness test in children and adolescents with ID. Twenty-six papers met the inclusion criteria and described 18 tests on body composition (n=4), muscular strength (n=4), muscular endurance (n=6), and cardiorespiratory fitness (n=4). Best results on feasibility, reliability and/or validity were found for bioelectric impedance analysis, body mass index, grip strength, arm hang and distance run/walk tests. These tests were mainly studied in adolescents with mild to moderate ID. Some tests were found feasible, reliable and/or valid in subgroups of children and adolescents with ID, but not in children and adolescents with all ages and levels of ID. In this chapter we conclude that further assessment is needed before these tests can be widely applied in all children and adolescents with ID.

Chapter 3 Pilot study on feasibility and reliability of physical fitness tests

Little was known on the psychometric properties of field-based health-related physical fitness tests for children with moderate to severe levels of ID. Therefore, we studied the feasibility and test-retest reliability of body composition tests, tests measuring muscular strength and

endurance and cardiorespiratory fitness, in thirty-nine children and adolescents (2–18 yrs) with moderate to severe ID. Short term (within an hour) and long term (2-4 weeks) test-retest reliability was assessed using intraclass correlation coefficient (ICC). Completion rates for the tests ranged between 30% and 97%. Short-term test-retest reliability of all tests was good (ICC > .8), long-term test-retest reliability was good for most tests (ICC > .7), but for most strength tests low ICCs were found. Measuring physical fitness of children and adolescents with moderate to severe ID with field-based tests is feasible, and can be reliably measured for the purpose of group analysis by using body mass index, waist circumference, overarm throwing, stair climbing and the modified 6-minute walk test.

Chapter 4 Physical fitness and its correlates

In this study we aimed to assess the health-related physical fitness of a relatively large group of children with ID, and study the association of physical activity and motor development with physical fitness. One hundred and twenty-eight children and adolescents with moderate to severe ID visiting specialized day program centers engaged in field-based physical fitness tests (body composition, muscular strength, muscular endurance and cardiorespiratory fitness). Scores were compared to reference values of TD children, and we studied the association between the fitness outcomes and physical activity and motor development with linear regression analysis. High rates of overweight (23-25%) and obesity (10-15%) were found. A majority of the participants (71-91%) scored below reference values for muscular strength, endurance and cardiorespiratory fitness tests. Physical activity and motor development were positively associated with scores on several fitness test (β=.27-.44; $p<.05$). This study indicates that children with moderate to severe ID visiting specialized day program centers have strikingly low physical fitness levels. Policies and interventions to increase the physical fitness for this specific group of children are urgently needed, in which increasing physical activity and motor skills are expected to be effective components.

Chapter 5 Physical activity and its correlates

Regular participation of children and adolescents with ID in physical activity is important to maintain good physical fitness, health and to acquire motor skills. The aim of this study was to investigate the habitual physical activity in these children. Sixty-eight children and adolescents with a moderate-to- severe ID were included in the analyses. They wore an accelerometer on eight consecutive days. Data was analyzed by use of descriptive statistics and multiple linear regression analyses. The participants took on average 6,677 ± 2,600 steps per day, with an average intensity of 1,040 ± 431 counts per minute. In total, 47% of the participants were meeting physical activity recommendations of 60 minutes of moderate to vigorous physical activity. Low motor development was associated with low physical activity. As more than half of the participants were not meeting the recommendations, family and

caregivers of these children should focus on supporting and motivating them to explore and expand their physical activities.

Chapter 6 Predicting maximal heart rates

Exercise guidelines for improving physical fitness are based on intensity of activities. The intensity can be estimated by use of individual's heart rate (HR). For this, it is important to know the theoretical maximal HR (HR_{max}). To find the best predicting equation for HR_{max} in children and adolescents with and without ID, a retrospective study was conducted. The sample consisted of 210 American and Spanish children (8-17 yrs), 56 with Down syndrome (DS), 80 with ID by other causes, and 74 TD children. Highest achieved peak HR (HR_{peak}) was obtained during a maximal incremental cardiopulmonary exercise test on a treadmill. Multiple linear regression analysis was used to find the best prediction equation for estimating HR_{peak}. This new equation was compared to two existing prediction equations, by calculating the absolute difference and standard error of the estimate (SEE) with achieved HR_{peak}.

The regression model showed that having ID with DS and having ID without DS, were associated with low HR_{peak}-values (respectively B=-23.2, p<.001 and B=-7.3, p<.001). Using group average to predict the HR_{peak} had the lowest measurement errors in children with ID (SEE=11-12 beats·min^{-1}). Even though this new prediction method fits better than the previous equations, high measurement error remains. For formulating appropriate training goals, and evaluating exercise intensity these equations are not accurate enough in children and adolescents with or without ID.

Chapter 7 General Discussion

The current thesis indicates low levels of physical fitness in children and adolescents with moderate to severe ID. The fitness levels were associated with physical activity and motor development. The results also demonstrate that 53% of the participants are not active enough to meet the Dutch physical activity guidelines, and that HR_{peak} of children and adolescents with ID is much lower than that of TD peers.

Taking the methodological limitations regarding bias and testing methods into account, the following implications for clinical practice are proposed: not all fitness tests we have studied are reliable enough to use at the child's or adolescent's individual level. Furthermore, one should remain cautious in predicting the maximal heart rate as one should take the relatively large measurement error into account.

We advise the professionals and parents to take off as soon as possible with increasing the physical fitness. One should start with raising the amount of physical activity and work on various motor skills. Children and adolescents with ID are highly dependent on their social environment. They need support from significant others, and they need enough time and opportunities to develop new skills. Therefore, physical education organized by physical activity experts should be a requirement. National guidelines are needed, in which amount,

intensity and quality of physical education should be warranted. Lastly, physical activities during daily living should be encouraged by professional caregivers and parents, in which proper bar setting is necessary.

Further research should focus on the still-existing measurement issues, and effective interventions to increase the physical fitness in this specific group should be evaluated. Longitudinal studies can contribute to insight into the development of physical fitness, activity and motor development over time, related to health and participation.

The available practice-based and science-based knowledge should be used now to increase the physical fitness of this group of youngsters, thereby increasing the opportunities to become and remain fit for the future.