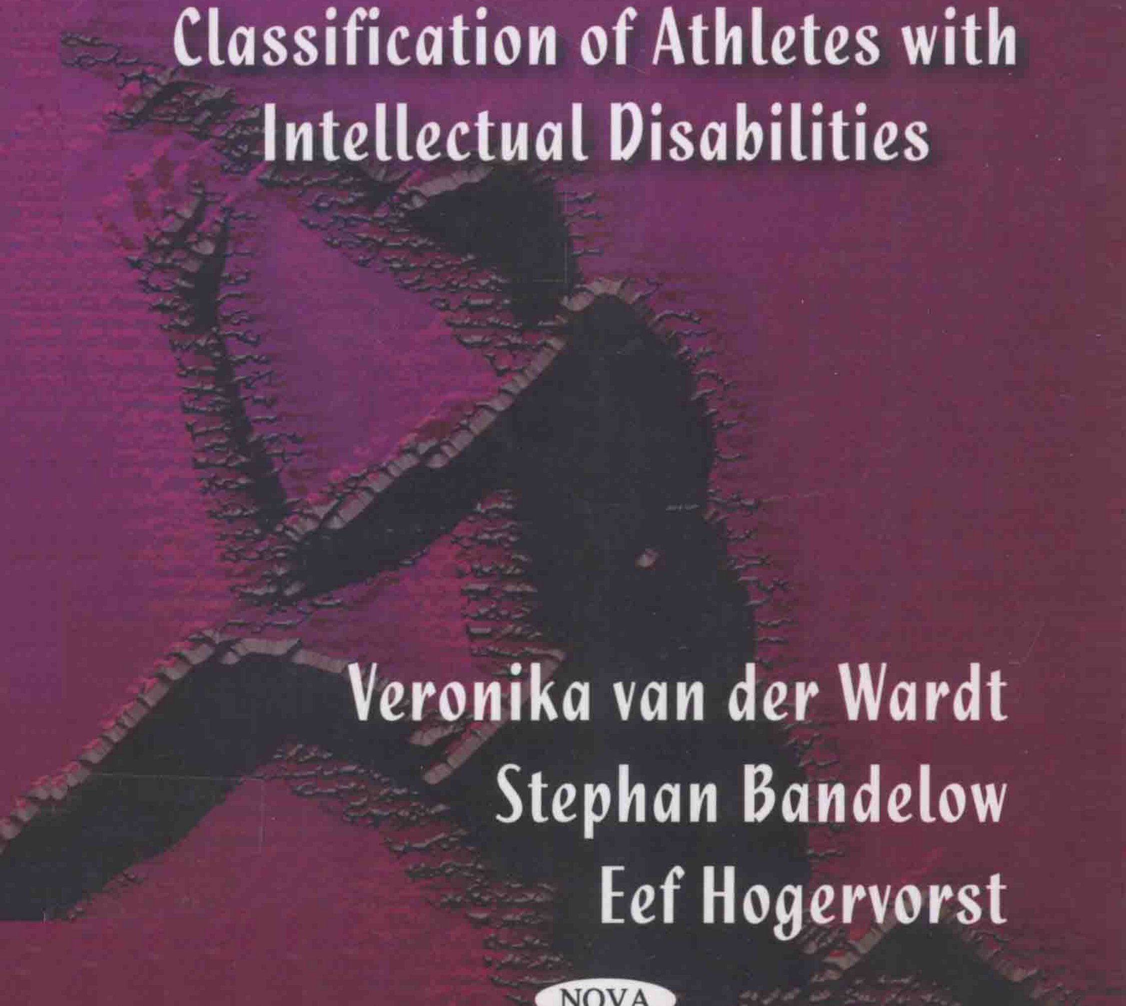
SPORTS AND ATHLETICS PREPARATION, PERFORMANCE, AND PSYCHOLOGY

Development of the Cognitive Computerized Test Battery for Individuals with Intellectual Disabilities (CCIID) for the Classification of Athletes with Intellectual Disabilities



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DEVELOPMENT OF THE COGNITIVE COMPUTERIZED TEST BATTERY FOR INDIVIDUALS WITH INTELLECTUAL DISABILITIES (CCIID) FOR THE CLASSIFICATION OF ATHLETES WITH INTELLECTUAL DISABILITIES

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Chapter 1

INTRODUCTION

ABSTRACT

The aim of this book was to investigate the relationship between intellectual functioning and sports performance for athletes with intellectual disabilities and to present the Computerized Cognitive test battery for Individuals with Intellectual Disabilities (CCIID), which was developed for that purpose. A literature review indicated that there is a significant difference between physical performance of athletes with and without intellectual disabilities, but so far, no studies have examined the association between the degree of intellectual functioning and sports performance for athletes with intellectual disabilities. Following an analysis of verbal and nonverbal intelligence tests, it was decided to develop a new Computerized Cognitive test battery for Individuals with Intellectual Disabilities (CCIID), which was focused on the target population (individuals with intellectual disabilities) and based on theories of intelligence and research of cultural fairness. The test battery includes two subtests for inductive reasoning and one subtest for visual processing.

Psychometric properties of the CCIID were assessed for individuals with intellectual disabilities using modern and classical test theories. Based on the results of an item analysis using latent trait models and proportion of correctly scored items, several items were revised. A reliability study confirmed internal consistency, test-retest reliability and inter-rater reliability. An exploratory principal component analysis showed one underlying component which supported the construct validity of the CCIID. Criterion validity was confirmed based on correlations using Wechsler Adult Intelligence Scale scores and scores on the nonverbal SON-R 5½ - 17 intelligence test.

Subsequently, the relationship between intellectual functioning and sports performance for table tennis athletes with intellectual disabilities was investigated using the CCIID. The results showed a significant association between scores on the inductive reasoning subtest 'Series' and predicted table tennis competition performance.

Further research should investigate this relationship for different sports disciplines and examine the role of adaptive behaviour and different cognitive abilities using a wider range of cognitive information processing tests.

1.1 Introduction

Cognitive abilities are an important factor in elite sports performance (Davis & Sime, 2005; Thomas, 1994). Research investigating the nature of this relationship is limited, in particular for athletes with intellectual disabilities (ID), but is essential for elite sports development for this group in several ways, which will be discussed later in this chapter. In order to assess the degree of intellectual limitations in an accurate way, a new instrument, the Computerized Cognitive test battery for Individuals with Intellectual Disabilities (CCIID) was developed as a review of verbal and nonverbal intelligence tests showed that they are not suitable for the target group. The design of the CCIID was based on theoretical structures of intelligence theories, cultural fairness, as well as considerations for the suitability for individuals with ID. Psychometric properties of the CCIID were evaluated using classical and modern test theories. Subsequently, the association between cognitive abilities and sports performance in athletes with ID was investigated using the new test battery.

Even for non-disabled athletes, research investigating the association between cognitive abilities and sports performance is not comprehensive and has only been examined for single sports disciplines. Although the importance of optimal cognitive function in elite sports performance is generally accepted, the investigation of the relationship is limited to particular cognitive abilities and sports disciplines. The term 'cognitive abilities' refers here to a large variety of mental processes, such as perception, memory, attention, problem solving, information processing, reasoning and concept formation.

Previous studies suggested that, for non-disabled athletes, different cognitive abilities were relevant, depending on sports discipline: for instance, elite rugby players showed significantly higher scores on cognitive tests for visuo-spatial abilities and processing speed than controls (Kasahara, Mashiko

& Niwa, 2008). Ryan, Atkinson and Dunham (2004) compared different sports disciplines using several cognitive ability measures, and found that hockey players performed significantly higher on perceptual-motor and accuracy tasks than swimmers or track and field athletes. This difference between sports disciplines in cognitive performance was also supported by the findings of Overney, Blanke and Herzog (2008) who demonstrated that elite table tennis players showed significant better performances in visual discrimination tasks requiring different visual aspects, such as motion detection, attention and temporal processing than elite tri-athletes and non-athletes. Decision-making was also found to differ between sports disciplines. A comparative study including tennis players, table tennis players, fencers and boxers competing on a national level showed that tennis players and fencers demonstrated faster and more accurate responses in a choice reaction time task than table tennis players and boxers (Mouelhi Guizani, Tenenbaum, Bouzaouach, Ben Kheder, Feki & Bouaziz, 2006).

Furthermore, various studies found that experts or elite athletes performed significantly better than novices in various cognitive abilities, but again, this depended on sports discipline. Helsen and Pauwels (1993) showed that expert soccer players responded faster and more accurately in a sport-specific visual information processing task than novices. Similar results were found in an experimental study, which demonstrated that expert tennis players responded significantly faster and more accurately to visual cues than novices (Shim, Carlton, Chow & Chae, 2005). Experts also displayed better performances than novices in making the appropriate decisions and selecting the optimal responses in a sport-specific context (De Villar, Gonzalez, Iglesias, Perla & Cervello, 2007; Nougier, Stein & Bonnel, 1991). Several cognitive abilities were investigated in a meta-analysis (Mann, Williams, Ward & Janelle, 2007), which revealed that sport experts demonstrated better response times and accuracy than novices, showed fewer visual fixations suggesting they allocated less resources to information processing and displayed longer 'quiet eye' episodes. This indicated that task-relevant information is better processed and motor plans are better coordinated in expert athletes.

Although these studies indicated that experts demonstrated superior cognitive abilities than novices, it is not clear, if and to what extent these abilities are transferable to a context outside the expertise of the athlete. In addition, the causality of the relationship between cognitive abilities and sports performance is debatable: Did athletes learn these cognitive abilities during their training, or did those athletes with lower abilities drop out of their sporting career?

Independent of the causality, intellectual disabilities are likely to affect the development of elite sports performance for disciplines with a high relevance of cognitive abilities. It can be expected that athletes with ID will not be able to compete on the same level as athletes without disabilities in these disciplines. However, the relationship between cognitive abilities and sport performance has been insufficiently examined for individuals with ID to support this conclusion empirically.

Research regarding this relationship is important to advance the elite sport of individuals with ID on different levels:

- Separate sports competitions for individuals with and without ID are only necessary if they cannot reach the same level of performance due to their disabilities. Currently, athletes with ID are not allowed to participate in the Paralympics until the impact of intellectual disability on sports performance is actually confirmed. After the 2000 Sydney Paralympics, several Spanish gold-medalist basketball players were caught cheating as they pretended to have intellectual disabilities. Consequently, the International Paralympic Committee (IPC) decided to suspend the category 'Intellectual Disability' from the Paralympics. As a result, athletes with ID cannot enter competitions in the Paralympics until a) the impact of ID on sports performance is actually confirmed and b) a classification system is found that can confirm the impairment in those cognitive abilities that affect the sports performance in the discipline of the athlete (IPC, 2007). Both requirements depend on the determination of the relationship between cognitive abilities and sports performance of athletes with ID.
- If there is indeed a positive relationship between cognitive abilities and sports performance in athletes with ID, ability bands within the category 'Intellectual Disability' would ensure a fairer competition. Currently, even at national levels, all athletes with ID compete in one group, independent of their degree of disability. Different ability bands, created according to the extent to which the disability limits the sports performance, would give athletes with a higher degree of disability a fair chance at winning.
- Talent identification of athletes with disabilities is still in its early stages. Research into the relationship between cognitive abilities

> and sports performance for athletes with ID could identify those cognitive abilities related to superior sports performance in different disciplines. Further research could then establish if these cognitive abilities are predictive for future sports performances to identify talented young athletes.

Prior to participation in sport events, the disability of athletes with ID has to have been established. According to the World Health Organisation (WHO, 2007) and the American Psychiatric Association (APA, 2000), intellectual disability is defined by three criteria: 1) onset of the disability before the age of 18; 2) impairment of intellectual functioning and 3) significant limitations in adaptive behaviour. Impairment of intellectual functioning is commonly measured using a standardized intelligence test, while limitations in adaptive behaviour are assessed using adequate scales. The two criteria, impairment of intellectual functioning and limitations in adaptive behaviour, determine the degree of the disability: The lower the IQ score and the more limitations in adaptive behaviour, the higher the degree of the intellectual disability. Therefore, IQ score as well as limitations in adaptive behaviour will have to be investigated to determine the association between intellectual disability and sports performance.

The studies included in this book will be limited to the cognitive aspects of intellectual disability. The association between adaptive behaviour and sports performance of athletes with ID is outside the focus of this study

The following sections will discuss physical performance of individuals with ID and examine different intelligence tests, which could be used to investigate the association between intellectual functioning and physical as well as sport performance in individuals with ID.

There are several explanations of how cognitive impairments of athletes with ID could limit physical performance, as well as sport performance. These will be discussed in the following section.

Physical performance of individuals with ID has been widely researched over the last 15 years. Most studies focused on the differences between sedentary individuals with and without intellectual disabilities, and only a few studies investigated athletes with ID. A literature review, presented in chapter 1, section 1.1.2, evaluated existing knowledge about physical performance of individuals with ID and identified limitations of these studies.

Different intelligence tests were analysed as the investigation of the relationship between intellectual impairment and sports performance required an intelligence test suitable for the target group (athletes with ID from different countries). A review of intelligence tests in chapter 1, section 1.2. examined the requirements for an appropriate test, discussed psychometric issues and looked at different intelligence tests. On the basis of this analysis, a new computerized cognitive test battery for individuals with intellectual disabilities (CCIID) was developed (chapter 2) to investigate the relationship between sports performance and intellectual functioning in athletes with ID (chapter 3).

1.1.1. Possible Causes for the Impact of Intellectual Disability on Physical Performance

Before examining the differences in physical performance between individuals with and without intellectual disabilities in the next section, the underlying biological causes for these differences will be investigated. Up to now, research has identified several biological causes that underlie physical performance and intellectual disability:

1) Genetic disorders, such as Down's syndrome, William's syndrome or fragile x-syndrome can be a common cause for the association between intellectual disability and physical performance (Black, Smith, Wu & Ulrich, 2007; Charlton, Ihsen & Lavelle, 2000; Hagerman & Hagerman, 2002; Kubo & Ulrich, 2006; Morris & Mervis, 1999). The symptoms of these genetic disorders include impaired cognitive functioning, as well as physical disabilities. Even if the intellectual disability is not caused by a genetic disorder, other biological reasons can cause the association between physical performance and intellectual disability, such as:
2) Pre-term birth (before 33 weeks' gestation) can lead to brain lesions and a subsequently reduced cerebellar volume (Nguyen The Tich, Anderson, Shimony, Hunt, Doyle & Inder, 2009). This can cause lasting cognitive impairments and motor function problems (Allin & al., 2001; Hall, McLeod, Counsell, Thomson & Mutch, 1995). Brain lesions and impairment of the cerebellum due to very pre-term birth might, therefore, be a possible cause for impairments in intellectual functioning, as well as in physical performance.

3) Another possible cause for intellectual disability is presented by white matter hyperintensities (WMH), which are frequently associated with cognitive impairments (Gunning-Dixon & Raz, 2000) and physical deficits, such as gait and balance problems (Steffens, Bosworth, Provenzale & al., 2002), fine motor coordination and grip strength (Sachdev, Wen, Christensen & Jorm, 2004). Although WMH are more common in an elderly population, children diagnosed with WHM present similar cognitive and motor function impairments (Tartaglia & al., 2008). White matter abnormalities are also found in individuals with developmental delay (Widjaja, Nilsson, Blaser & Raybaud, 2008) and cerebral palsy (Robinson, Peake, Ditchfield, Reid, Lanigan & Reddhough, 2008), which again are frequently linked to physical, as well as cognitive disabilities (Dinnage, 1986; Belligni & al., 2009).
4) Individuals with ID often have additional physical disabilities (Eichstaedt & Lavay, 1992). For instance, Wuang, Wang, Huang and Su (2008) found that scores on the Wechsler Intelligence Scale for Children were positively associated with fine and gross motor skills in early school-age children with mild ID. A comparison showed that individuals with ID had significantly lower perceptual-motor coordination than individuals without ID (Carmeli, Bar-Yossef, Ariav, Levy & Livermann, 2008). In a study investigating balance and coordination, the results showed significant lower scores in different sensorimotor tests in adults with ID than in non-disabled controls (Carmeli, Bar-Yosssef, Ariav, Paz, Sabbag & Levy, 2008). A comparative study including individuals with and without ID showed that strength measures and endurance are lower in individuals with ID than in non-disabled controls (Lahtinen, Rintala & Malin, 2007). In an investigation assessing grip strength during the Texas Special Olympics, O'Connell, Rutland and O'Connell (2006) found that individuals with ID had significantly lower grip strength than the age-matched controls.

Limitations in sports performance cannot only stem from causes underlying both physical, as well as cognitive impairments, but could also be the direct result of the intellectual disability. Cognitive impairment will affect the ability to understand, memorize and transfer instructions given by sports coaches. These instructions form an important part of the skills acquisition in sports (Allison & Ayllon, 1980). Hodges and Franks (2002) reported that the selection and execution of instructions and demonstrations given by the coach requires attention and cognitive processing, particularly in the early stage of skill acquisition. Implicit and explicit motor learning was investigated in a comparison between children with and without Down syndrome. Although both groups performed equally well in the implicit learning condition, the results showed that children with Down syndrome performed at a significant lower level than non-disabled controls in the explicit learning condition (Vinter & Detable, 2008). The extent to which the intellectual disability influences the skill acquisition will depend on the degree and nature of the disability (Horvat, 1990). Consequently, it can be concluded that sports performance is influenced by cognitive functioning, which subsequently affects skills acquisition.

Despite the fact that intellectual disability is often linked to limitations in physical performance, training was found to improve physical performance of individuals with ID (Mached, Stopka, Tillman, Sneed & Naugle, 2008, Tsimares& Fotiadou, 2004). Therefore, it is necessary to investigate not only the causes underlying the association between intellectual disability and physical performance, but the actual impact of intellectual disability on physical performance itself, which has been reported in many studies. The following section will look at studies examining the difference in physical performance between individuals with and without ID and the limitations of these studies.

1.1.2. Research on Physical Performance of Individuals with Intellectual Disabilities

Various studies have investigated fitness parameters such as cardiovascular fitness, muscular strengths and obesity. The results indicated that individuals with ID are physically less fit than non-disabled individuals:

Cardiovascular fitness (CVF) was investigated in two reviews (Fernhall, Tymeson & Webster, 1988, Lavay, Reid & Cressler-Chaviz, 1990), which both reported that most studies found lower than average performances on CVF parameters for individuals with ID. CVF observed in children and adolescents with ID, when measured through field walk-run tests or 300-yard runs, were around 25-30% lower than those of children and adolescents without ID (Rarick, Widdop & Broadhead, 1970; Halle, Silverman & Regan, 1983). CVF levels in adults were measured in walk-run tests or a 1.5 mile run and were also substantially below those of adults in the general population (Cressler, Lavay & Giese, 1988; Pitetti & Campell, 1991).

In addition, studies reported that individuals with ID had lower muscular strength and endurance than individuals without disabilities. For instance, the results of field tests with children with ID showed below average sit-up and pull-up performances, compared to non-disabled peers (Rarick & al., 1970). Investigations based on adults with ID showed similar results: muscular strength and endurance measured in sit-ups and push-ups were significantly below average, with men performing significantly worse than women (Reid, Montgomery & Seidl, 1985).

Although findings suggest a prevalence of obesity for individuals with ID when diagnosed with mild or moderate intellectual disability, this is not the case for individuals diagnosed with severe or profound intellectual disability (Hove, 2004). For children, the difference in prevalence in obesity between intellectually disabled and non-disabled groups is reported to be relatively small (Maksud & Hamilton, 1975) or insignificant (Pizarro, 1990). For adults, obesity has a higher prevalence in intellectually disabled individuals (when diagnosed with mild or moderate ID) compared to non-disabled individuals (Fox, Burkhart & Rotatori, 1983). Therefore, it can be assumed that obesity is only a minor factor in the difference in physical performance between children with and without ID, while it is a more important aspect in the difference in physical performance between adults with and without ID.

In sum, all these studies suggest that individuals with ID have an inferior physical performance compared to their non-disabled peers. This difference could be due to the causes that underlie both intellectual disability and physical performance. However, as Fernhall (1993) and Pitetti and Campell (1991) noted, various other factors have been established to be responsible for the inferior physical performance of individuals with ID. These factors are described below:

First, physical performance can be influenced by lifestyle, e.g. physical exercise, smoking, drinking, dietary habits, etc. A study evaluating the effect of a 16-week training program indicated that physical exercise can have a substantial influence on cardiovascular fitness (CVF) for individuals with ID (Pitetti & Tan, 1990; 1991). Similar results for improvements in CVF were found in other training studies (Tomporowski & Ellis, 1985; Croce, 1990). Draheim et al. (2002) investigated differences between trained and untrained individuals with ID in cardiovascular disease risk factors. Their results showed that trained individuals with ID (participants of the Special Olympics) had significant lower diastolic blood pressures, body fat percentages, abdominal fat, triglycerides and insulin than inactive individuals with ID. Consequently, it can be concluded that exercise has a significant influence on physical performance for intellectual disabled individuals.

In addition, other lifestyle factors, such as dietary habits, smoking and drinking are regarded to have the same impact on individuals with ID as they have on the general population (Van de Louw, Vorstenbosch, Vinck, Penning & Evenhuis, 2009; Wallace & Schluter, 2008) and, therefore, will contribute to the physical performance of individuals with ID. Consequently, studies should control for these lifestyle factors.

Second, physical performance, when measured in scientific studies, could be influenced by a lack of motivation. Motivation is particularly important for studies, which require the participant to perform with maximum effort. Studies suggested that individuals with ID interpret instructions like "give your best effort" differently to individuals without disabilities as they might stop when feeling breathlessness, lack the ability to pace themselves over an extended period of time, or lack the persistence to continue beyond feeling fatigued which can be necessary to measure fitness parameters such as CVF (Baumgartner & Horvat, 1988; Lavay & al., 1990). Furthermore, motivational problems seem to expand with increasing levels of intellectual disability (Fait & Dunn, 1984).

Third, although most of the measures for physical performance are proven valid and reliable for the general population, they are not investigated for their validity and reliability to test individuals with ID (Pitetti & Tan, 1990; Lavay & al., 1990).

In addition, other possible confounding factors should be considered which have not yet been included in any of the studies. Possible factors could be the range of IQ scores of the participants, differences in hours of training and coaching, differences in training methods, etc. These factors should all be investigated in future studies.

It is important to note that, although there are differences in physical performance between individuals with and without ID, these differences can be caused by the disability itself, or confounding factors. The following studies compared physical performance of individuals with and without ID, but controlled for some of these factors.

In a retrospective study, Fernhall et al. (1996) collected records of 111 individuals with ID in the USA. These records contained cardiorespiratory data (VO2 peak[1], VE peak[2], peak heart rate and peak respiratory exchange ratio) collected during treadmill exercises in a laboratory setting. All participants had been familiarized with the locations and the exercises. The testing protocol had been proven valid and reliable for individuals with ID (Fernhall, Millar, Tymeson & Burkett, 1991). Results were controlled for age, height, weight and gender and showed that individuals with ID had sub-average cardiorespiratory levels compared to the general population.

Although this study used measures that are proven valid and reliable, the results were not controlled for lifestyle (as weight alone is not an accepted lifestyle indicator) and motivation. In addition, it is not clear if participants completed the task with maximum effort and if, therefore, the highest possible values for cardiorespiratory data were obtained (Fernhall & al., 1996).

In a study assessing flexibility and strength, Pitetti and Yarmer (2002) compared 269 children and adolescents without ID with 449 children and adolescents with ID (diagnosed with mild mental retardation) in knee flexion, knee extension and combined leg and back strength measures. Each measurement was taken twice and the better result used for the analyses. The instrument to measure knee flexion and extension was proven to be valid and reliable for children and adolescents with and without ID (Croce, Horvat & Pitetti, 1999; Hill, Croce, Miller & Cleland, 1996). However, validity and reliability had not been proven for the instrument assessing combined leg and back strength. The results showed that individuals with ID had significantly lower strengths levels in all age groups (8 to 10 years, 11 to 14 years and 15 to 18 years) compared to their non-disabled peers when controlled for sex.

Again, the study indicated that there is a significant difference in physical performance between individuals with and without ID. However, only one of the two instruments was proven valid and reliable for the use for individuals with ID but correlation coefficients between the first and the second measurement for all participants were significantly high (Pearson's r between .82 and .95, depending on test). Again, differences in levels of exercise, lifestyle and motivation between individuals with and without ID might have influenced the outcomes.

In another study, Pitetti, Yarmer and Fernhall (2001) compared aerobic fitness and body mass index (BMI) of children and adolescents with and without mild ID. Aerobic fitness was measured with the 20 meter shuttle run (20-MST). The 20-MST was proven to be a valid and reliable instrument to

[1]VO2 peak is a plateau effect in oxygen consumption, while workload continues to increase
[2]VE peak is the total volume of gas in liters exhaled from the lungs per minute at peak exercise

assess aerobic fitness for children and adolescents (Leger, Mercier, Gadoury & Lambert, 1988; Fernhall & al., 1998). Independent of age and sex, individuals without ID ran significantly more laps and had a lower BMI than their peers with ID. When the influence of BMI on the aerobic test was controlled for, the individuals with ID still showed lower aerobic fitness.

A similar study was conducted by Pitetti and Fernhall (2004) who also compared running performance in a 20-MST of youth (11-18 years old) with and without ID. All participants received verbal encouragement during the run. Again, results showed, after controlling for age, BMI and sex, that individuals without ID performed better than their peers with ID.

An investigation with the Eurofit Special test battery (Skowronski, Horvat, Nocera, Roswal & Croce, 2009) compared three groups of individuals with ID (mild, moderate and severe ID). The Eurofit Special measured strength, local muscle endurance, speed, flexibility and balance. Reliability of the Eurofit test battery was established for individuals with ID (MacDonncha, Watson, McSweeney & O'Donovan, 1999). The results showed a significant difference in performance between individuals with mild, moderate and severe ID. This study indicated a relationship between intellectual disability and physical performance, but did not control for motivation and lifestyle issues, which might have influenced the outcome.

None of these studies controlled for all possible confounding factors, but they excluded many of them: for most studies, instruments were proven valid and reliable, and the results were controlled for BMI. However, other lifestyle factors such as alcohol consumption, smoking and dietary habits were not included, and a difference in motivation between individuals with and without intellectual disability might have further influenced the results.

Additionally, it is interesting to note that the studies from Pitetti, Yarmer and Fernhall (2001), Pitetti and Yarmer (2002) and Pitetti and Fernhall (2004) all described their participants as being recruited in a summer camp in a Midwest metropolitan area in the USA. Therefore, it is possible that these three studies recruited the same participants or from the same pool of participants making a generalization of results difficult.

Consequently, it would be necessary to compare physical performance of individuals with and without ID with valid and reliable instruments while controlling for lifestyle factors and motivation in order to confirm the results of these studies.