# Physical fitness and health of Icelandic children with intellectual disability

Ingi Þór Einarsson

Dissertation submitted in partial fulfilment of a Ph.D.-degree


UNIVERSITY OF ICELAND
SCHOOL OF EDUCATION

# Physical fitness and health of Icelandic children with intellectual disability (Health ID)

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PhD Dissertation

April 2018

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# Hreyfing, þol og heilsa barna með þroskahömlun á Íslandi

Ingi Þór Einarsson

Fræðiritgerð lögð fram til að uppfylla kröfur um

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# Abstract

**Background:**

Very little is known about physical activity (PA) and PA patterns measured with objective methods among children with intellectual disability (ID) or their reasons to take part in PA and sport. Moreover, even less is known about their fitness and metabolic health. Of the few studies published, most suggest that PA levels are well below recommended guidelines and overweight and obesity are common. Furthermore, compared with typically developed individuals (TDI) at same age, children with ID are worse off in most health-related variables.

**Aims:**

To investigate PA, PA patterns and sedentary time during the whole week as well as specifically during school hours and after school on regular workdays among Icelandic children with mild-to-severe ID. Further, to investigate metabolic health and risk factors for metabolic syndrome as well as body composition and compare all these variables to an age- and-sex-matched TDI cohort.

**Methods and Procedures:**

Ninety-one children with ID and an age- and sex-matched group of 93 TDI children took part. PA was assessed with Actigraph accelerometers for 7-10 consecutive days and a questionnaire was used to collect data on PA behaviour. Anthropometric data were obtained, and adiposity was measured via dual energy X-ray absorptiometry (DXA). Maximal oxygen uptake ($VO_{2max}$), as an indicator of Aerobic fitness was measured using a Parvomedics Trumax2400 metabolic cart during a graded maximal test performed on a stationary bike (Monark 828E). For those children who did not want to be connected to the metabolic cart and those who were unable to reach $VO_{2max}$, the physical work capacity (in W) at a heart rate of 170 bpm (PWC170) was recorded. Blood pressure (BP) was measured with an automatic device (ADC Advantage 6013). A fasting blood sample was acquired from those children who were able to give blood and high-density lipoprotein (HDL), glucose, triglycerides and insulin were measured and low-density lipoprotein LDL) was calculated. Data on Tanner stage, commuting mode to and from school, and several aspects of PA were collected using a questionnaire consisting of closed questions.

**Results:**

A significantly higher proportion ($p<0.006$) of children with ID were categorized as having elevated percentage of body fat (41%) than TDI children (19%). Similarly, children with ID were smaller (8.6 cm, $p<0.001$) had higher sum of skinfold (22.7 mm, $p<0.001$), diastolic blood pressure (3.8 mmHG, $p=0.006$) and percentage of body fat (4.0 percent points, $p=0.008$). Over 20% of children with ID had elevated waist circumference, 34% had elevated BP, between 13 and 21% were found to have unfavourable blood lipid profile and 7% were diagnosed with metabolic syndrome. Although the PA levels of children with ID were 40% lower and they spent 9% more time sedentary than their TDI peers, there was an interaction between group and sex ($p<0.05$). TDI boys were more active and less sedentary than TDI girls ($p<0.05$) but no sex differences were found among children with ID on any PA variable. Also, there was no difference between workday PA and weekend PA among children with ID. Only 16% of children with ID walked or biked to school, whereas the proportion was 74% among TDI children ($p<0.001$). Both sexes with ID were more active and less sedentary during school than after school ($p<0.003$) but no such difference was found among TDI children. Similarly, a lower fraction (33%) of children with ID participated 2 hours a week or more in sports compared to TDI children (76%, $p<0.001$). No children with ID met the recommendation of 60 minutes of daily moderate-to-vigorous PA, whereas 40% of the TDI children met the recommendation. Children with ID (60%) were more likely to name weight loss as a reason to participate in PA than TDI children (34%, $p=0.002$) but a higher proportion (96%) of TDI children than children with ID (50%) participated in PA to improve skills ($p<0.001$). Only 25% of children with ID reached recommended levels of aerobic fitness whereas 75% of TDI children met those levels ($p<0.001$).

**Conclusion:**

PA of children with ID is considerably lower than among their TDI peers and there appears to be no sex differences in PA and PA patterns among children with ID. Furthermore, children with ID depend more on schools to accumulate their PA but the fact that no children with ID met the recommended daily MVPA calls for special PA measures in this group. Children with ID have different reasons for PA- and sport- participation than TDI children. These differences need to be considered when designing and implementing PA promotion campaigns for children with ID.

# Ágrip

**Bakgrunnur:**

Lítið er vitað um hreyfingu og hreyfimynstur, sem mæld eru á hlutlægan hátt, hjá börnum með þroskahömlun (ÞH) eða ástæður þess að þessi börn taki þátt í íþróttum eða almennri hreyfingu. Jafnframt er jafnvel minna vitað um þol og efnaskiptaheilsu þessara barna. Þær fáu rannsóknir sem birtar hafa verið benda til þess að hreyfing barna með ÞH sé langt undir ráðlögðum viðmiðum og ofþyngd og offita séu algeng. Ennfremur eru börn með ÞH ver á sig komin hvað varðar flesta heilsutengda þætti en almenn skólabörn.

**Markmið:**

Að kanna hreyfingu, hreyfimynstur og tíma eytt í kyrrsetu yfir alla vikuna, sem og sérstaklega á skólatíma og utan skólatíma, hjá íslenskum börnum á grunnskólaaldri með milda til mikla ÞH. Jafnframt að meta efnaskiptaheilsu og áhættuþætti fyrir efnaskiptavillu sem og líkamssamsetingu og bera þessa þætti saman við úrtak almennra skólabarna á sama aldri og af sama kyni.

**Aðferðir og framkvæmd:**

Níutíu og eitt barn með ÞH og aldurs og kynjajafnað úrtak almennra skólabarna tóku þátt í rannsókninni. Hreyfing var metin með Actigraph hröðunarmælum í 7-10 daga samfleytt og spurningalisti var notaður til að safna gögnum um hreyfimynstur. Líkamsmælingar voru gerðar og líkamssamsetning var mæld með tvíorku-röntgengeislagleypnimælingu (dual energy X-ray absorptiometry, DXA). Hámarkssúrefnisupptaka ($VO_{2max}$) var mæld með Parvomedics Trumax2400 súrefnisupptökutækjum með stigvaxandi hámarksáreynsluprófi á þrekhjóli (Monark 828E). Fyrir þau börn sem ekki vildu vera tengd súrefnisupptökutækinu og þau sem ekki að náðu að uppfylla skilyrði fyrir $VO_{2max}$, var álagið (í wöttum) við 170 slög á mínútu jafnframt skráð. Blóðþrýstingur (BP) var mældur með sjálfvirku tæki (ADC Advantage 6013). Tekin var fastandi blóðprufa hjá þeim börnum þar sem blóðtaka var möguleg og heildarkólesteról, háþéttnifituprótein (high-density lipoprotein, (HDL), þríglýseríð, blóðsykur og insúlín mæld og lágþéttnifituprótein (low-density lipoprotein, LDL) var svo reiknuð út. Gögnum um Tanner stig, ferðamáta til og frá skóla og ýmsa þætti hreyfingar var safnað með spurningalista sem samanstóð af lokuðum spurningum.

**Niðurstöður:**

Marktækt hærra hlutfall (p <0,006) barna með ÞH voru flokkuð með of hátt hlutfall líkamsfitu (41%) en hjá almennum skólabörnum (19%). Börn með ÞH voru einnig lægri (8,6 cm, p<0,001) með hærri heildarsummu húðfellinga (22,7 mm, p<0,001), hærri þanþrýsting (3,8 mmHg, p=0.006) og hærra hlutfall líkamsfitu (4,0 prósentustig, p=0.008). Yfir 20% barna með ÞH höfðu hækkað mittismál, 34% höfðu hækkaðan BP, á milli 13 og 21% greindust með óæskilegar blóðfitur og tæplega 7% með efnaskiptavillu. Þrátt fyrir að hreyfing barna með ÞH væri 40% minni og kyrrsetutími 9% lengri en hjá almennum skólabörnum kom fram víxlverkun á milli hóps og kyns (p<0,05). Strákar í hópi almennra skólabarna hreyfðu sig meira en stelpur í sama hópi og eyddu minni tíma í kyrrsetu (p<0,05) en enginn kynjamunur fannst á milli barna með ÞH á neinum hreyfibreytum. Ekki fannst heldur munur á milli hreyfingar á virkum dögum og um helgar hjá börnum með ÞH. Aðeins 16% barna með ÞH gengu eða hjólaðu í skólann, en hlutfallið var 74% hjá almennum skólabörnum (p <0,001). Bæði kynin með ÞH hreyfðu sig meira og voru minna í kyrrsetu á skólatíma en eftir skóla (p<0,003) en enginn slíkur munur fannst hjá almennum skólabörnum. Á sama hátt stundaði lægra hlutfall (33%) barna með ÞH íþróttir tvo tíma á viku eða meira miðað við almenn skólabörn (76%, p<0,001). Ekkert barn með ÞH náði ráðlögðum viðmiðum um 60 mínútur af daglegri hreyfingu á meðal- til kröftugu álagi en 40% almennra skólabarna náðu sömu viðmiðum. Börn með ÞH voru líklegri (60%) til að nefna þyngdartap sem ástæðu fyrir þátttöku í hreyfingu en almenn skólabörn (34%, p=0,002) en hærra hlutfall (96%) almennra skólabarna heldur en barna með ÞH (50%) tók þátt í hreyfingu til að auka færni (p <0,001). Aðeins 25% barna með ÞH náðu ráðlögðum viðmiðum um loftháð þol en 75% almennra skólabarna náðu sömu viðmiðum (p <0,001).

**Ályktun:**

Hreyfing barna með ÞH er töluvert minni en hjá almennum skólabörnum og það virðist ekki vera kynjamunur á hreyfingu og hreyfimynstri meðal barna með ÞH. Börn með ÞH reiða sig ennfremur meira á skóla til að fá hreyfingu en almenn skólabörn. Sú staðreynd að ekkert barn með ÞH náði ráðlagðri daglegri hreyfingu kallar á sérstakar ráðstafanir til að auka hreyfingu hjá þessum hópi barna. Börn með ÞH höfðu aðrar ástæður fyrir því að taka þátt í hreyfingu og íþróttum en almenn skólabörn, sem þarf að hafa í huga þegar verið er að hanna og innleiða hreyfingarátak fyrir börn með ÞH.

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would have been closed for me. I also need to thank the teachers and the staff in those schools that almost seemed as eager as I to get good data, they really made my work much easier. Part of the data collection took place in Icelandic Heart Association (Hjartavernd) and the staff there was absolutely amazing at their work. They had never encountered a group of children with ID before but they made the whole process just look simple and the children felt very welcome in their presence. These people I need to give a big thank you as well.

To me, the unsung heroes of this study are the children who volunteered to take part in the work with me. Of course I am talking about the children in both groups but I hope I am not crossing any line by saying that the children with ID came closer to my heart. It took some time for each of them to get used to us, the researchers, but after earning their trust, they were really quite easy to work with although they sometimes tested the limit of our patience. Still today, a few years after the data collection finished, I am getting a hug on the street from the participants in the study. To all those children I simply say thank you, you were great.

Lastly but not least, I need to thank my whole family who have tolerated me during this time and always supported me and giving me endless patience when I needed it most, thank you all, I would not have done this without you.

Reykjavík Apríl 2018

Ingi Þór Einarsson

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# List of Abbreviations

| | |
|---|---|
| ADHD | Attention deficit hyperactivity disorder |
| Anova | Analysis of Varience |
| BMI | Body Mass Index |
| BP | Blood Pressure |
| DBP | Diastolic Blood Pressure |
| DXA | Dual-energy X-ray absorptiometry |
| EST | Estimated |
| HDL | High-Density Lipoprotein |
| ID | Intellectual Disability |
| LDL | Low-Density Lipoprotein |
| MBS | Metabolic Syndrome |
| Min | Minutes |
| MVPA | moderate-to-vigorous physical activity |
| PA | Physical Activity |
| PWC170 | Physical work capacity at heart rate 170 beats/min |
| RPE | Rate of perceived exertion |
| Samp. | Sampling |
| SBP | Systolic Blood Pressure |
| SD | Standard Deviation |
| TDI | Typically Developed Individual |
| $VO_{2max}$ | Maximal Oxygen Optake |
| Waist c | Waist circumference |
| wePA | Weekend Physical Activity |
| wPA | Workday Physical Activity |
| ΣSKF | Sum of the four Skinfolds |

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## List of Original Papers

1.
Einarsson IÞ, G, Johannsson E, Daly D, Arngrimsson. Hreyfing og líkamlegt ástand íslenskra grunnskólabarna með þroskahömlun.
Læknablaðið 2015; 101: 243-8

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Einarsson IÞ, Olafsson A, Hinriksdottir G, Johannsson E, Daly D, Arngrimsson SA. Differences in Physical Activity among Youth with and without Intellectual Disability.
Med Sci Sports Exerc 2015; 47: 411-8.

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Einarsson IÞ, G, Johannsson E, Daly D, Arngrimsson. Physical activity during school and after school among youthwith and without intellectual disability.
Research in Developmental Disabilities 56 (2016) 60–70.

# 1 Introduction:

This study is the first to examine simultaneously physical activity (PA), fitness, and adiposity using state of the art methodology in children with intellectual disability (ID) and pioneer research in the interactions of these factors on metabolic health in this population. Previously no published data existed on the body composition, PA, physical fitness, metabolic risk factors or reasons why children with ID take part in PA or sport in Iceland. Therefore, it was unknown whether they meet Icelandic and international guidelines for acceptable levels of adiposity, PA, and fitness. It was also not known how much children with ID differ on these factors from typically developed individuals (TDI).

Detection of health risk factors in children with ID can lead to potentially cost-effective intervention strategies in this population, which is important from a public health perspective because physical inactivity and unhealthy lifestyle along with the development of obesity are the leading health indicators of the 21st century in the Western world (Promotion., 2000). Many children with mild to moderate ID display developmental motor delays (Rintala & Loovis, 2013) but they are often more limited when it comes to attention and comprehension than to physiological defects (Krebs, 2005) and differ very little from TDI children in their physical and motor characteristics (Krebs, 2005).

The adverse effects of obesity and unhealthy lifestyle on health begin early in life and physical inactivity, sedentary behavior and adiposity are associated with metabolic diseases and cancers (Ebbeling, Pawlak, & Ludwig, 2002; Freedman et al., 1987; Kasa-Vubu, Lee, Rosenthal, Singer, & Halter, 2005; Lytle & Kubik, 2003; Pinhas-Hamiel et al., 1996; Sinha et al., 2002; Thorsdottir, Gunnarsdottir, Palsson, & Johannsson, 2006; Whitaker, Wright, Pepe, Seidel, & Dietz, 1997). In contrast, higher levels of PA and fitness have been associated with lower risk for metabolic diseases (Andersen et al., 2006; Gutin et al., 2004; Johannsson, Arngrimsson, Thorsdottir, & Sveinsson, 2006; Kasa-Vubu et al., 2005; Mitchell et al., 2009; Schmitz et al., 2002) as well as improved cognitive performance in children (Castelli, Hillman, Buck, & Erwin, 2007; Coe, Pivarnik, Womack, Reeves, & Malina, 2006). Although it is anticipated that children with ID experience the same adverse effects of health from obesity and lack of PA and physical

fitness, it has not been comprehensively studied. In addition, the interactive effects of body composition, physical fitness, and PA on metabolic health are not characterized in this population.

# 2 Theoretical background

## 2.1 Adiposity in children with intellectual disability:

The prevalence of overweight and obesity in all age groups continues to rise in most parts of the world (Canning, Courage, & Frizzell, 2004; Chinn & Rona, 2001; Ekblom, Engstrom, & Ekblom, 2007; Flegal, Ogden, Wei, Kuczmarski, & Johnson, 2001; French, Story, & Jeffery, 2001; Heude et al., 2003; Johannsson et al., 2006; Kautiainen, Rimpela, Vikat, & Virtanen, 2002; Lee, Jackson, & Blair, 1998; Lissau, 2004; Lumeng, Gannon, Appugliese, Cabral, & Zuckerman, 2005; Luo & Hu, 2002; Schroder et al., 2007; Tremblay, Katzmarzyk, & Willms, 2002; Valdez, Greenlund, Wattigney, Bao, & Berenson, 1996; Vaska & Volkmer, 2004). The same development has been observed in Iceland where the prevalence of overweight and obesity among 6-15 year-olds ranges from 12-24% (Johannsson et al., 2006; Jóhannsson, Arngrimsson, Sveinsson, Briem, & þórlindsson, 2003; Thorsdottir et al., 2006) although one study showed that the increase in prevalence has somewhat dropped in last few years (Jónsson, Héðinsdóttir, Erlendsdóttir, & Guðlaugsson, Reykjavik 2011). Children who enter the primary schools overweight are 10.4 times more likely to graduate from secondary schools overweight (Johannsson et al., 2006). Specifically, childhood overweight is a primary risk factor for adult obesity (Whitaker et al., 1997) and is implicated in multiple serious health consequences such as cardiovascular disease, impaired glucose tolerance, insulin resistance, and type 2 diabetes mellitus (Freedman et al., 1987; Olshansky et al., 2005; Pinhas-Hamiel et al., 1996; Sinha et al., 2002; Thorsdottir et al., 2006).

Despite this alarming prevalence in TDI individuals, it has been demonstrated in several studies that children of all ages with ID and/or physical disability may present a higher risk of developing obesity (Bandini, Curtin, Hamad, Tybor, & Must, 2005; De, Small, & Baur, 2008; Ells et al., 2006; Emerson, 2005; Hsieh, Rimmer, & Heller, 2014; Lobstein, Baur, & Uauy, 2004; Marshall, McConkey, & Moore, 2003; Melville, Hamilton, Hankey, Miller, & Boyle, 2007; Reinehr, Dobe, Winkel, Schaefer, & Hoffmann, 2010; Rimmer, Rowland, & Yamaki, 2007; Rimmer & Yamaki, 2006). In the UK this increased risk of overweight and obesity has lead the Royal College of Physicians to recommend that children with ID and/or physical disability should be a health priority (Ells et al., 2006).

Nevertheless, very few studies on children with ID have specifically investigated the prevalence of obesity in this group. Children with ID have been found to have ~ 40% prevalence of overweight and obesity, and some studies report that they have twice the prevalence of their TDI peers (Bandini et al., 2005; De et al., 2008; Marshall et al., 2003; Reinehr et al., 2010). Among individuals with ID, adults with mild-to-moderate ID disability tend to have higher rates of overweight/obesity than adults with severe ID problems (Fox & Rotatori, 1982; Rimmer et al., 2007; Rimmer & Yamaki, 2006), probably due to increased independent living of people with mild to moderate ID in recent years (Rimmer & Yamaki, 2006). This trend towards independent living leads to an unhealthy lifestyle, whereas those with severe ID live under constant supervision and, therefore, often live healthier lives (Foley & McCubbin, 2009). On the other hand, among students attending schools for children with ID, a direct relation between decreased fundamental motor skill and increased adiposity were observed (Foley & McCubbin, 2009; Frey & Chow, 2006). This development is also prominent in Iceland since more and more families who have children with disability choose to send them to integrated schools, and not special schools for children with ID. It is, therefore, important to monitor children with ID closely from a young age concerning their lifestyle.

## 2.2 Physical Activity and sedentary time among children with intellectual disability:

Physical activity among children has gradually declined over the last decades (Dollman, Norton, & Norton, 2005; Ekeland et al., 1999; Rippe & Hess, 1998), and vigorous PA has declined the most (Dollman et al., 2005). Fewer and fewer young people meet the recommended guidelines of 60 minutes/day of moderate-to-vigorous physical activity (MVPA) (Ortega et al., 2013; Riddoch et al., 2004) needed to maintain good health (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Riddoch et al., 2004). Furthermore, various studies have shown that PA declines with age (Magnusson, Arngrimsson, Sveinsson, & Johannsson, 2011; Nader et al., 2008), boys are more physically active than girls, (Nader et al., 2008; Riddoch et al., 2004) and PA is greater during workdays (wPA) than on the weekend (wePA) among children (Nader et al., 2008). In Iceland, almost a third of 15-year-old boys and approximately half of 15-year-old girls do not meet the Nordic guidelines for PA (Magnusson et al., 2011), and overweight nine year old children are less physically active than their peers of normal weight (Jóhannsson et al., 2003). Correspondingly, sedentary behaviour has increased during the past few decades (Ekeland et al., 1999; Pate, Mitchell,

Byun, & Dowda, 2011) and today children spend 4-8 hours every day sedentary (Pate et al., 2011) or around 40%- 60% of their waking time (C. E. Matthews et al., 2008; Syvaoja et al., 2013) and children who spend an inordinate amount of time sedentary have the highest risk of becoming overweight or obese with associated health problems (Levin, Lowry, Brown, & Dietz, 2003).

Very little is known about PA and PA patterns of children and adolescents with ID. Studies on PA in persons with ID generally agree that this population is less physically active than the TDI population (Foley & McCubbin, 2009; Hinckson, Dickinson, Water, Sands, & Penman, 2013; Peterson, Janz, & Lowe, 2008; Reinehr et al., 2010; Rimmer & Yamaki, 2006) and that PA also declines with increased level of ID (Hinckson & Curtis, 2013). Similarly, sedentary time is greater among adults with ID (Dixon-Ibarra, Lee, & Dugala, 2013; Hsieh et al., 2014; Lotan, Henderson, & Merrick, 2006; L. Matthews et al., 2011; Melville et al., 2011; Melville et al., 2015).

Those few studies who have used objective methods to investigate PA among children with ID agree that they are much less physically active and very few or no children meet the recommendation of 60 min/day of (MVPA) (Eiholzer et al., 2003; Foley, 2006; Horvat & Franklin, 2001; Kim, 2006; Kozub, 2003; Lorenzi, Horvat, & Pellegrini, 2000; Peterson et al., 2008; Whitt-Glover, O'Neill, & Stettler, 2006). Studies using questionnaires to estimate PA and time spent in MVPA confirm these findings (Lin et al., 2010; Rimmer & Yamaki, 2006). However, a study using heart rate monitors to assess PA found that with increased PA classes in school, children with ID could achieve the recommended daily 60 minutes of MVPA (Pitetti, Beets, & Combs, 2009). A study using accelerometers showed that nine children with ID were only 50% as active as their TDI peers although no differences were found in their total self-reported sedentary behaviour a different pattern was observed between Children with ID and TDI children (Foley & McCubbin, 2009). Differences in PA between boys and girls with ID are also not clear, but a study on 150 individuals with ID aged 12 – 70 years found men to be more active than women and a trend for a decline in PA with age (Phillips & Holland, 2011).

Children and adolescent 6-16 years old spend a large amount of their waking time at school. Due to differences in total school time and different cut-offs used for MVPA and sedentary behaviour, a direct comparison between studies on the ratio of PA, MVPA and sedentary time during school is difficult (Arundell et al., 2013). Studies have found that children spend 65

-71% of their day sedentary and accumulate 5 - 61% of their MVPA during school hours (Bailey et al., 2012; Taylor et al., 2011). Studies also agree on boys being more physically active and less sedentary than girls during school hours as well as after school (Bailey et al., 2012; Guinhouya et al., 2009; Taylor et al., 2011).

## 2.3 Reasons to do sport and PA among children with intellectual disability:

In general, participation in sport and PA seems to be less common among children with ID than among children without ID (Simeonsson, Carlson, Huntington, McMillen, & Brent, 2001). Nevertheless, very little is known about organized sports participation among children with ID (Frey, Stanish, & Temple, 2008). Furthermore, little is known about the reasons for PA or sports participation or the frequency and type in which children with ID take part. However, one study on young teens with ID reported: "meeting friends," "having fun" and "learning new skills" as the main reasons for taking part in every-day PA (Pozerine, Adomaitiene, Ostaseviciene, Reklaitiene, & Kragniene, 2008). On the other hand, it is well documented that TDI children and adolescents take part in sports "to be with friends" and "have fun" as well as "to improve skills" and, among adolescents, "for weight control" (Allender, Cowburn, & Foster, 2006). No firm conclusion can, therefore, be drawn about PA opportunities for children with ID, but at least some reports claim that they are more limited among adolescents than children (Frey et al., 2008).

## 2.4 Aerobic fitness in children intellectual disability:

Similar to the decrease in PA, the physical fitness of children has been declining over the last few decades. After analysing fitness data from 25.5 million children worldwide, Tomkinson and Olds (Tomkinson & Olds, 2007) reported that since 1958, physical fitness of children had declined 0.36% per year. The decline in fitness is supported by the results of other studies on children measuring maximal oxygen uptake ($VO_{2max}$) directly (Fredriksen, Thaulow, Nystad, & Ingjer, 1998). Regardless of this decline, the physical fitness of Icelandic children seems to be as good as, or better than the fitness of their peers residing in Western Europe or the US (Arngrimsson, Sveinsson, & Johannsson, 2008). Nevertheless, overweight Icelandic children have poorer fitness than their normal weight counterparts (Jóhannsson et al., 2003).

Most studies on physical fitness in the general population of youth with ID consistently demonstrate lower levels of aerobic fitness, muscular strength, and higher level of obesity than among TDI children (Baynard, Pitetti, Guerra, Unnithan, & Fernhall, 2008; Fernhall et al., 1998; Foley & McCubbin, 2009; Gillespie, 2003; Golubovic, Maksimovic, Golubovic, & Glumbic, 2012; Hartman, Smith, Westendorp, & Visscher, 2015; MacDonncha, Watson, McSweeney, & O'Donovan, 1999; Salaun & Berthouze-Aranda, 2012; Wallen et al., 2009). The age-related changes in physical fitness during growth and development are similar among the ID and TDI children, however (Lahtinen, Rintala, & Malin, 2007). Nevertheless, studies on high-performance athletes have demonstrated that people with ID can reach a high level of physical fitness (Chia, Lee, & Teo-Koh, 2002; Pitetti, 2000; Van de Vliet et al., 2006).

Most studies to date in children with ID have used indirect measurements of cardiovascular fitness, which have mostly been validated in TDI children (Frey et al., 2008). Performance tests predicting $VO_{2max}$ validated in individuals with Down syndrome do exist, however (Fernhall et al., 1998). One recent study estimated aerobic fitness from submaximal cycle ergometer test in more than 60 ID students aged 16-21 and compared them with a non-ID control group of similar age (Wallen et al., 2009). The ID students had lower absolute and relative estimated $VO_{2max}$ (Wallen et al., 2009). Finally, studies done among mobile students varying in level of ID which all had similar opportunities to participate in PA have shown that the participants with highest degree of ID (most disabled) had lowest physical fitness, after correcting for age and sex and vice versa, the students with the lowest level of ID had the highest physical fitness. (Foley, 2006; Golubovic et al., 2012).

## 2.5 Physical Activity, Physical fitness, adiposity, and metabolic risk factors in children with intellectual disability:

Body fatness negatively impacts risk factors for cardiovascular disease and insulin resistance in adults whereas high level of PA or physical fitness have the opposite effect (Christou, Gentile, DeSouza, Seals, & Gates, 2005; Clevenger, Parker Jones, Tanaka, Seals, & DeSouza, 2002; Racette, Evans, Weiss, Hagberg, & Holloszy, 2006; Thorsdottir et al., 2006) mediated primarily through its beneficial effects on insulin sensitivity or resistance (Helmrich, Ragland, Leung, & Paffenbarger, 1991; Mayer-Davis et al., 1998; Nassis et al., 2005) and blood lipids (Eisenmann et al., 2005). Fitness can

even counteract the negative effects that fatness has on health (i.e., people who are fit and fat often do not have the same metabolic disease risk as people who are unfit and fat) (Church et al., 2002; Wei et al., 1999). Although this same positive effect of PA and physical fitness on metabolic disease risk has been determined in children (Andersen et al., 2006; Anderssen et al., 2007; Ekelund et al., 2009; Kriemler et al., 2008; Ku, Gower, Hunter, & Goran, 2000; Rizzo, Ruiz, Hurtig-Wennlof, Ortega, & Sjostrom, 2007; Schmitz et al., 2002), the interactive impact of physical fitness and adiposity is not well characterized. Studies in children have reported that fitness does not impact cardiovascular risk factors and insulin resistance independent of fatness (Ball et al., 2004; Gutin et al., 1994; Shaibi et al., 2005). In contrast, more recent studies suggest that fitness can independently of fatness attenuate metabolic disease risk (Andersen et al., 2008; Eisenmann, DuBose, & Donnelly, 2007; Eisenmann, Welk, Ihmels, & Dollman, 2007; Ekelund et al., 2007) and its importance escalates with increasing level of fatness among children (Allen et al., 2007; DuBose, Eisenmann, & Donnelly, 2007; Ruiz, Rizzo, et al., 2007). Also, it seems as fit, and fat children have similar insulin resistance as fit and thin children (Arngrimsson, Sveinsson, Gunnarsdottir, et al., 2008).

Although it is established that a larger percentage of adults with ID suffer from cardiovascular diseases and high blood pressure (BP) than the general population (Beange, McElduff, & Baker, 1995; Draheim, 2006; Rimmer & Yamaki, 2006; Stanish, Temple, & Frey, 2006; Walsh, Kerr, & van Schrojenstein Lantman-de Valk, 2003), very little is known about the metabolic health of children or adolescents with ID. Contemporary Swedish data (Wallen et al., 2009) on 16-21 year-olds with ID suggest that this group has a higher prevalence of obesity and metabolic health risk factors as well as lower aerobic fitness levels than their non-ID peers. Sixty-four percent of ID participants had at least one metabolic risk factor compared to 11% among the non-ID subjects (Wallen et al., 2009). No studies have investigated the interactive effects of PA/physical fitness and adiposity on metabolic risk factor in the ID population, thus it is unknown whether these effects are the same as among non-ID individuals.

## 2.6 Summary of literature review:

Children with ID have been found to have ~ 40% prevalence of overweight and obesity, and some studies report that they have twice the prevalence of their TDI peers (Bandini et al., 2005; De et al., 2008; Marshall et al., 2003; Reinehr et al., 2010). Among individuals with ID, adults with mild-to-moderate ID disability tend to have higher rates of overweight/obesity than

adults with severe ID problems (Fox & Rotatori, 1982; Rimmer et al., 2007; Rimmer & Yamaki, 2006), probably due to increased independent living of people with mild to moderate ID in recent years (Rimmer & Yamaki, 2006). These findings are important for Iceland since increasingly more parents of children with disability choose not to send their children to special schools but to send them to integrated schools, where they possibly have less health monitoring and individual attention than in the special schools.

Individuals with ID are less physically active than the TDI population (Foley & McCubbin, 2009; Hinckson et al., 2013; Peterson et al., 2008; Reinehr et al., 2010; Rimmer & Yamaki, 2006) and PA also declines with increased level of ID (Hinckson & Curtis, 2013). Very few or no children meet the recommendation of 60 min/day of (MVPA) (Eiholzer et al., 2003; Foley, 2006; Horvat & Franklin, 2001; Kim, 2006; Kozub, 2003; Lorenzi et al., 2000; Peterson et al., 2008; Whitt-Glover et al., 2006), and sedentary time is greater among adults with ID (Dixon-Ibarra et al., 2013; Hsieh et al., 2014; Lotan et al., 2006; L. Matthews et al., 2011; Melville et al., 2011; Melville et al., 2015). Differences in PA between boys and girls with ID are, however, not clear, but men with ID seem to be more active than women with ID (Phillips & Holland, 2011).

People with ID have lower levels of aerobic fitness and muscular strength than the TDI population (Baynard et al., 2008; Fernhall et al., 1998; Foley & McCubbin, 2009; Gillespie, 2003; Golubovic et al., 2012; Hartman et al., 2015; MacDonncha et al., 1999; Salaun & Berthouze-Aranda, 2012; Wallen et al., 2009). Nevertheless, studies on high-performance athletes have demonstrated that people with ID can reach a high level of physical fitness (Chia et al., 2002; Pitetti, 2000; Van de Vliet et al., 2006).

Larger percentage of adults with ID suffer from cardiovascular diseases and high blood pressure than the general population (Beange et al., 1995; Draheim, 2006; Rimmer & Yamaki, 2006; Stanish et al., 2006; Walsh et al., 2003). In addition, 16-21 year-olds with ID had a higher prevalence of obesity and metabolic health risk factors as well as lower aerobic fitness levels than their non-ID peers (Wallen et al., 2009).

In general, participation in sport and PA seems to be less common among children with ID than among children without ID (Simeonsson et al., 2001). Nevertheless, very little is known about organized sports participation among children with ID (Frey et al., 2008). Furthermore, little is known about the reasons for PA or sports participation or the frequency and type in which children with ID take part. However, one study on young teens with ID reported: “meeting friends,” “having fun” and “learning new skills” as the main reasons for taking part in every-day PA (Pozerine et al., 2008). On the other hand, it is well documented that TDI children and

adolescents take part in sports “to be with friends” and “have fun” as well as “to improve skills” and, among adolescents, “for weight control” (Allender et al., 2006). No firm conclusion can, therefore, be drawn about PA opportunities for children with ID, but at least some reports claim that they are more limited among adolescents than children (Frey et al., 2008).

## 2.7 Aims and hypotheses

### 2.7.1 Overall aims of the study:

Aim I: To study the prevalence of overweight and obesity in Icelandic primary and secondary school children with ID as well as to determine the levels of PA, aerobic fitness, and other risk factors for metabolic diseases in this population.

Aim II: To compare body composition, aerobic fitness, PA, other risk factors for metabolic diseases with that of children without ID of the same age and gender.

Aim III: To compare School and after school PA and sedentary time behaviour among children with ID and with that of children without ID of the same age and gender.

Aim IV: To study reasons for sport partitions and PA among children with ID.

### 2.7.2 Overall hypotheses

We hypothesized:

That children with ID would have higher prevalence of obesity, be less physically active and be more sedentary than their TDI peers.

That the children with ID would not meet recommended levels of daily MVPA, and that boys with ID would be more active than girls with ID.

That children with ID would have a higher risk of developing cardiovascular and metabolic diseases than TDI children.

That children with ID would depend more on schools for PA than TDI children but there would be no differences between these two groups in the reasons for taking part in sports and PA.

# 3 Methods

## 3.1 Study design and sampling

For this study, data were obtained from Icelandic primary and secondary school children (aged 6-16 years) with and without ID. All (n=120) children with ID from one special school and four inclusion schools were offered participation, and 94 children agreed to take part (78%). Sixty-two percent of the children with ID came from the special school, which only accepts children with moderate-to-severe ID, and 38% came from inclusion schools, which accept children with mild-to-moderate ID. All children lived at home with their parents or legal guardians (none was institutionalized), and none of the participants had Down syndrome. All children with ID had been diagnosed with mild-to-severe ID from the State Diagnostic and Counselling Centre in Iceland. All participants were able to walk unassisted and did not exhibit motor disabilities except three children with ID who had mild Cerebral Palsy. In addition, four children with ID had epilepsy and took medication (Lamotrin, Abilfy) to control their conditions, which potentially could have affected their willingness to be physically active.

Age- and sex-matched TDI group (n=124) was randomly selected from the class registers from the four inclusion schools and offered to participate with 93 children accepting (75%). Prior to participation in the study, which was approved by the National Bioethics Committee in Iceland (VSNB 2010120007/03.7), a written informed consent was obtained from the children's parents and/or legal guardians along with concurrence from the children themselves. The written consent form was in two parts; the first part was for all the measurements that took part in the schools and the second part was for more invasive measurements namely blood sampling and adiposity measurements that took place in the Icelandic Heart Association. In the group of children with ID, 76 participants signed (81%) the second part of the informed consent form whereas 81 participants (86%) did the same in the TDI group. Three children with ID dropped out during the study, seven were too small to ride the bicycle ergometer and three could not complete the aerobic fitness test, but all TDI children completed the study as depicted in Figure 1.

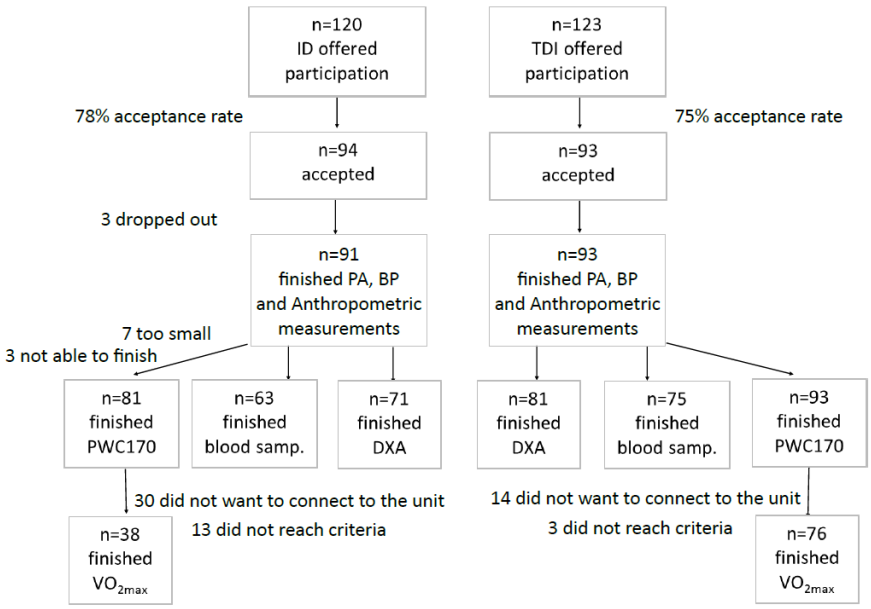


**Figure 1: Participation and dropout. ID = children with intellectual disability, TDI = typically developed individuals, DXA = dual-energy X-ray absorptiometry, PWC170 = physical work capacity at heart rate 170 beats/min, $VO_{2max}$ = maximal oxygen uptake, samp. = sampling, PA= physical activity and BP = blood pressure.**

## 3.2 Anthropometric- and adiposity measures

Standing height was measured three times to the nearest mm with a stadiometer (Seca 220, Seca Ltd., Birmingham UK) and the mean was used for analysis. Body weight was determined to the nearest 0.1 kg using a calibrated scale (Seca 708, Seca Ltd., Birmingham UK) with participants in light clothing. Body mass index (BMI) was calculated ($kg/m^2$), and participants were categorized as normal weight, overweight, or obese using international standards (Cole, Bellizzi, Flegal, & Dietz, 2000). Skinfold thickness was measured three to four times at four sites (triceps, biceps, subscapular and suprailiac) on the right side of the body (Durnin & Womersley, 1974) using a skinfold caliper (Lange, Beta, Technology Incorporated, Cambridge, Maryland). The mean of the three closest measurements was used, and the sum (mm) of the four skinfolds (ΣSKF) was taken for analysis. Waist circumference was measured two times in a horizontal plane at the narrowest section between the hips and the bottom

of the rib cage and the mean used for analysis. All anthropometric measurements were taken by the same trained person. For those children who accepted and were able to lay still for 5 minutes (see Figure 1), adiposity was measured via dual energy X-ray absorptiometry, DXA. Based on percentage body fat, the children were classified into fatness categories; low, average, high, or obese using validated norms from Lohman et al. (1997).

## 3.3 Physical activity measurements

PA and sedentary time were assessed with Actigraph accelerometers (Manufacturing Technologies Inc.), model GT1M. Participants wore the monitor on their hips for 7-10 consecutive days from the time they woke up until they went to sleep. Only data from monitors worn minimum 10 hours/day, for at least two weekdays and one weekend day were included in the analysis (Magnusson et al., 2011). If no activity was registered on a monitor for 30 consecutive minutes, it was assumed that the participant had taken it off, and the time was subtracted from the total wear time. Participants who returned monitors with insufficient valid days were given a new period to wear the monitors. All participants or their parents or legal guardians received a text message each morning reminding them to wear the monitors. Actilife 5 software was used to analyze the data, and MVPA was defined as >2296 counts/min and sedentary activity as < 100 counts/min. These thresholds were first established by Evenson et al. (2008) and later independently validated by Trost et al. (2011). The objectively measured sedentary time was standardized as the percentage of the daily wear time, which allows for comparisons regardless of wear time (Melville et al., 2011). The class timetable was used to determine school time separately for every individual. All minutes registered before and after formal school hours was classified as after school time.

## 3.4 Aerobic fitness measures

To evaluate aerobic fitness, maximal oxygen uptake, ($VO_{2max}$) was measured with Parvomedics Trumax2400 unit during a graded maximal test performed on the stationary bike (Monark 828E). Participants pedaled at a constant rate during the test and the load (in watts (W)) was increased every three minutes by the same amount as the initial load. The initial load for children under 30 kg was 20W. Otherwise, the initial load for children younger than 11 years of both sexes was 25W and 30W for 11-12 years old children. Boys 13-14-year-old started the test at 40W whereas girls at the

same age began at 35W. Finally, the initial load for 15-16-year-olds was 50W and 40W for boys and girls, respectively (Arngrimsson, Sveinsson, & Johannsson, 2008). During the test participant's heart rate was measured continuously with heart rate monitor (Polar FT7) and their general well-being was monitored as well. The children were encouraged to keep on pedalling as long as they possibly could but also reminded that they could stop whenever they wanted during the test. A protocol described by Arngrimsson et al. (2008) was used to evaluate whether $VO_{2max}$ had been reached. For those children who did not want to be connected to the Parvomedics Trumax2400 unit and those who were unable to reach the $VO_{2max}$ criteria, the physical work capacity (in W) at a heart rate of 170 bpm (PWC170) was recorded during the graded bicycle test and used to estimate aerobic fitness using the equation from Boreham et al. (1990). The $VO_{2max}$ values (measured and estimated) were used to categorize the children into fitness categories according to established standards (Ruiz, Ortega, et al., 2007; Shvartz & Reibold, 1990).

## 3.5 Metabolic risk factors

Blood pressure was measured three times with an automatic (ADC Advantage 6013) device after participants had been sitting down for a minimum of 10 minutes and established standards (Jolliffe & Janssen, 2007; NIH, 2004) used to determine the presence/absence of elevated BP. Fasting blood sample was acquired from those children who were able to give blood (Figure 1) and high-density lipoprotein (HDL), glucose, triglycerides, insulin were measured and low-density lipoprotein LDL) was calculated from the Friedewald equation (Friedewald, Levy, & Fredrickson, 1972). The number of participants outside recommended levels was determined for total Cholesterol (Chan et al., 2009), HDL (Jolliffe & Janssen, 2007), LDL (Soldin, Bierbower, Choi, Thompson-Hoffman, & Soldin, 2004), Triglycerides (Ghoshal & Soldin, 2003; Jolliffe & Janssen, 2007), insulin (Soldin, Dahlin, Gresham, King, & Soldin, 2008) and Glucose (Jolliffe & Janssen, 2007). Metabolic syndrome was defined as being at risk on any three variables of the following five: Waist circumference, BP, HDL, HDL, Triglycerides and/or Glucose (Jolliffe & Janssen, 2007).

## 3.6 Self-reported physical activity behavior

Data on Tanner stage, commuting to and from school, and several aspects of PA were collected using a questionnaire consisting of closed questions (Magnusson, Sveinsson, Arngrimsson, & Johannsson, 2008). The children

took the questionnaire home and filled it in with the help of their parents or legal guardian, and returned it to the school within 1-5 days in a sealed envelope. Due to limited number of participants in both groups, the many response options for each question were generally collapsed into fewer options for analytical purposes. For questions about frequency and setting of PA and sport participation (e.g. “how often do you take part in organised sports practice with a club every week”), the six response options (“never”, “less than once per week”, “once per week”, “2-3 times per week”, “4-5 times per week”, “almost every day”) were transformed into three categories (<1 times per week, 1-3 times per week, >3 times per week). For questions of the type of PA and sports participations (e.g. “How often do you participate in soccer outside of school”), those who marked participation of at least 1-2 times per week were considered participants in a given sport. For questions about reasons for PA and sports participations, the four response options (“strongly disagree”, “disagree”, “agree”, “strongly agree”) were converted into dichotomous variable (agree, disagree) prior to analysis. For questions regarding the self-evaluation of the quantity of PA (e.g. “I feel that my PA is sufficient”) and own ability in sports, (e.g. “I feel that I am good at sports compared to my peers”) the five response (“strongly disagree”, “disagree”, “neutral”, “agree”, “strongly agree”) options were transformed into three categories (disagree, neutral, agree) during data reduction. Finally, the eight response options (“almost no time”, “0.5-1 hour/day”, “about 1 hour/day”, “about 2 hours/day”, “about 3 hours/day”, “about 4 hours/day”, “about 5 hours/day”, “6 hours or more per day”) for questions concerning time spent in different sedentary activities (e.g. “how many hours, on average, do you spend watching TV/VCR/DVD every weekday”), were converted into the three categories (<1 hour/day, 1-3 hours/day, >3 hours/day) prior to analysis.

## 3.7 Statistical analysis

SPSS 22.0.0 (Chicago, IL) was used for the statistical analyses. All variables were inspected for normality. BMI, triglycerides, and LDL were positively skewed and were log10 transformed to ensure normality. Similarly, for normalization, the square root was taken off weight, insulin, HDL, and all objectively measured PA variables, except sedentary time. Untransformed values are presented in tables and figures for more meaningful comparisons. All statistical analyses were corrected for Tanner stage. Two-way ANOVA was used for all continuous variables to test for main effects and interactions between group and sex and a three-way ANOVA in cases with repeated factor (group X sex X repeated PA or sedentary time). In the

case of interactions, the data were split on the grouping variable. In cases of interactions after such splits, the data were further split on sex. Chi-square was used for categorical variables to investigate proportional differences between groups. The data are presented as means and standard deviation (SD) in tables and as means and SE in figures. Significance was accepted at $\alpha$ level of 0.05.

# 4 Results

## 4.1 Prevelance of health risk factors in children with ID in comparison with TDI children

### 4.1.1 General characteristics and body composition

General characteristics of the participants are given in Table 1. The TDI children were taller ($p<0.001$) and had lower ΣSKF ($p<0.001$) than children with ID, and boys had lower ΣSKF than girls ($p=0.006$). A group by sex interaction was found for waist circumference ($p=0.024$), where boys with ID had significantly larger ($p=0.029$) waist circumference than girls with ID but no sex difference ($p=0.569$) was found in the TDI group.

**Table 1: Characteristics of the participants.**

| | ID boys | TDI boys | ID girls | TDI girls | All ID | All TDI |
|---|---|---|---|---|---|---|
| | n=62 | n=58 | n=29 | n=35 | n=91 | n=93 |
| Age (yr) | 11.8 (2.8) | 11.9 (2.9) | 11.9 (2.6) | 12.0 (2.3) | 11.9 (2.9) | 11.9 (2.7) |
| Tanner stage | 2.3 (1.3) | 2.5 (1.5) | 2.6 (1.3) | 2.9 (1.1) | 2.4 (1.3) | 2.6 (1.3) |
| Weight (kg) | 47.7 (21.0) | 47.1 (16.5) | 43.1 (14.3) | 49.9 (12.0) | 46.2 (19.2) | 48.2 (15.0) |
| Height (cm) | 149.1 (18.4) | 155.7 (20.7) | 144.1 (14.6) | 156.7 (13.9) | 147.5 (17.4) | 156.1 (18.3)* |
| BMI ($kg/m^2$) | 20.6 (5.6) | 18.7(2.8) | 20.3 (4.3) | 20.1 (2.9) | 20.5 (5.2) | 19.2 (2.9) |
| Waist c. (cm) | 71.1 (16.1) | 64.8 (8.3)[a] | 66.1 (9.9) | 67.3 (8.3) | 69.5 (14.6) | 65.7 (8.4) *‡ |
| ΣSKF (mm) | 75.6 (45.1) | 45.9 (29.7) | 83.7 (31.5) | 71.2 (25.7) | 78.2 (41.3) | 55.5 (30.7) *† |
| SBP. (mmHG) | 116.0 (9.5) | 112.2 (7.8) | 114.5 (7.0) | 115.1 (5.3) | 115.5 (8.8) | 113.3 (7.1) |
| DBP. (mmHG) | 75.7 (7.6) | 71.6 (8.2) | 71.8 (6.8) | 69.3 (7.2) | 74.5 (7.6) | 70.7 (7.9)*† |
| | n=48 | n=49 | n=23 | n=32 | n=71 | n=81 |
| Body fat (%) | 28.5 (10.4) | 22.7 (5.8) | 31.5 (8.1) | 29.7 (5.8) | 29.5 (9.8) | 25.5 (7.5)*† |

**ID=Intellectually disabled. TDI=Typically developed individuals. BMI=Body mass index. Waist c.=Waist circumference. ΣSKF=Sum of 4 skinfolds, SBP = systolic blood pressure, DBP = diastolic blood pressure. * = Difference between groups (ID vs. TDI across sex) $p<0.05$, † = difference between sexes (males vs. females across group) $p<0.05$, ‡ = interaction between sex and group $p<0.05$, a = difference between boys with intellectual disability and typically developed boys $p<0.05$.**

Children with ID had higher DBP than TDI children (p=0.006) and boys higher DBP than girls (p=0.007) across groups. Children with ID also had higher percentage body fat (p=0.008) than TDI children and girls higher percentage body fat than boys across groups (p<0.0001). There was no statistical difference in BMI between the groups (p=0.102), but the range in BMI was much larger for children with ID, 13.1 kg/m2 – 40.4 kg/m2 compared to 13.7 kg/m2 – 28.6 kg/m2 for TDI children. Similarly, the range of waist circumference was much larger in the group of children with ID; 46.1 cm – 116.0 cm compared to 50.6 cm – 87.8 cm in the TDI group.

Using BMI cut-offs from Cole et al. (2000), 13% of children with ID were classified as obese, whereas only 2% of TDI children were categorized as such, and a lower proportion of ID children were classified with normal BMI than among TDI children, (p=0.0017, figure 2A). Similarly, a much higher proportion of children with ID were classified as obese (41%) based on body fat percentage (Lohman et al., 1997) than among TDI children (19%) and much lower proportion of children with ID were found with average body fat percentage than among TDI children (p<0.006).

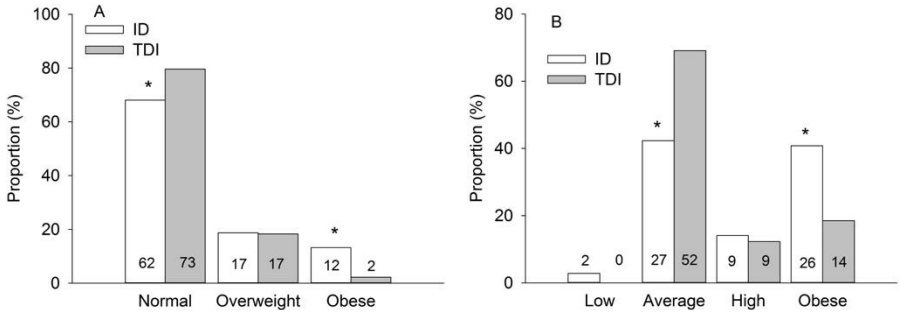


**Figure 2: Classification of participants using BMI (A) and percentages of body fat (B)The values in the bars indicate the number of participants. ID = children with intellectual disability, TDI = typically developed individuals, * = Statistical difference between groups p<0.05.**

### 4.1.2 Aerobic fitness

Aerobic fitness of participants is presented in Table 2. There was a great difference between the groups, regardless of the method used to estimate/measure the fitness. TDI children had higher $VO_{2max}$ ($p<0.001$), PWC170 ($p<0.001$) and estimated $VO_{2max}$ ($p<0.001$) than children with ID. Furthermore, boys had higher $VO_{2max}$ ($p=0.005$), PWC170 ($p=0.001$) and estimated $VO_{2max}$ ($p=0.001$) than girls across groups. Only 26% of children with ID reached recommended level of aerobic fitness (Ruiz, Ortega, et al., 2007; Shvartz & Reibold, 1990), whereas 75% of TDI children do reach the recommended level ($p<0.001$).

**Table 2: Aerobic fitness of participants.**

| | ID boys | TDI boys | ID girls | TDI girls | All ID | All TDI |
|---|---|---|---|---|---|---|
| | n=26 | n=45 | n=12 | n=31 | n=38 | n=76 |
| $VO_{2max}$ (ml/mín/kg) | 36.3 (6.2) | 44.82 (5.85) | 35.39 (3.74) | 39.55 (4.01) | 36.02 (5.34) | 42.67 (5.77)*† |
| | n=55 | n=58 | n=26 | n=35 | n=81 | n=93 |
| PWC170 (w/kg) | 1.46 (0.43) | 1.93 (0.37) | 1.38 (0.40) | 1.66 (0.32) | 1.43 (0.42) | 1.83 (0.38)*† |
| Est $VO_{2max}$ (ml/mín/kg) (Boreham et al., 1990) | 35.28 (6.2) | 42.06 (5.35) | 34.07 (5.77) | 38.13 (4.60) | 34.89 (6.03) | 40.58 (5.41)*† |

**ID = children with intellectual disability, TDI = typically developed individuals, Est. = estimated, * = Difference between groups (ID vs. TDI across sex) $p<0.05$, † = difference between sexes (males vs females across group) $p<0$**.05.

### 4.1.3 Metabolic risk factors

There was little difference in blood lipids and glycemic control of the participants (Table 3). Only in insulin was interaction detected where boys with ID had higher values ($p=0.026$) than TDI boys but no difference ($p=0.457$) was found among the girls.

**Table 3: Blood lipids and glycemic control of the participants.**

| | ID boys n=43 | TDI boys n=45 | ID girls n=20 | TDI girls n=30 | All ID n=63 | All TDI n=75 |
|---|---|---|---|---|---|---|
| Total Cholesterol (mmol/L) | 4.24 (0.81) | 4.21 (0.63) | 4.38 (1.09) | 4.31 (0.20) | 4.29 (0.90) | 4.25 (0.63) |
| HDL (mmol/L) | 1.49 (0.42) | 1.66 (0.32) | 1.56 (0.34) | 1.56 (0.29) | 1.51 (0.39) | 1.62 (0.31) |
| LDL (mmol/L) | 2.47 (0.81) | 2.30 (0.56) | 2.53 (1.01) | 2.41 (0.64) | 2.49 (0.87) | 2.35 (0.59) |
| Triglycerides (mmol/L) | 0.64 (0.23) | 0.56 (0.22) | 0.67 (0.31) | 0.74 (0.20) | 0.65 (0.26) | 0.63 (0.23) |
| Glucose (mmol/L) | 5.10 (0.46) | 5.07 (0.39) | 5.12 (0.48) | 4.95 (0.33) | 5.10 (0.47) | 5.02 (0.37) |
| Insulin(μU/mL) | 9.57 (5.95) | 7.13 (3.99)[a] | 9.07 (4.44) | 10.29 (5.15) | 9.42 (5.49) | 8.39 (4.72)‡ |

**ID = children with intellectual disability, TDI = typically developed individuals, HDL = high-density lipoproteins, LDL = low-density lipoproteins, ‡ = interaction between group and sex p<0.05, a = difference between boys with intellectual disability and typically developed boys p<0.05.**

Figure 3 depicts the proportion of participants outside recommended levels for various metabolic risk factors. With the exception of triglycerides (Ghoshal & Soldin, 2003; Jolliffe & Janssen, 2007) and insulin (Soldin et al., 2008) where no participants were found outside recommended levels, (not depicted in figure 3) more children with ID were found to be outside the recommended levels. Over 20% of children with ID had elevated waist circumference (Fernandez, Redden, Pietrobelli, & Allison, 2004; Jolliffe & Janssen, 2007), whereas only 8% of TDI children were outside the norms (p<0.019) and 34% of children with ID had elevated BP (either SDP or DBP) (Jolliffe & Janssen, 2007; NIH, 2004), whereas 16% of TDI children were classified as such. Twenty-one percent of children with ID had HDL below recommended levels (Jolliffe & Janssen, 2007) compared to 6% of TDI children (p=0.015) and 16% of children with ID had raised LDL (Soldin et al., 2004) but only 4% of the TDI children (p=0.021). Although a few children had raised blood glucose (Jolliffe & Janssen, 2007), there was no statistical difference between the groups (p=0.227). One child with ID had elevated total cholesterol but none of the TDI children showed this. Finally, 7% of the children with ID were diagnosed with metabolic syndrome (Jolliffe & Janssen, 2007) but no TDI children were diagnosed as such (p<0.001).

**Overall PA and sedentary time**

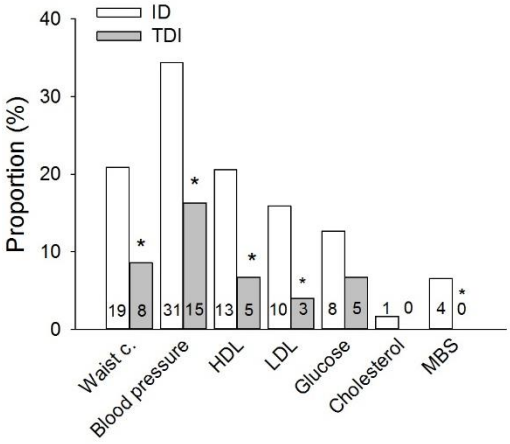


**Figure 3: The proportion of participants outside recommended levels for various metabolic risk factors. The values in the bars indicate the number of participants. ID = children with intellectual disability, TDI = typically developed individuals, Waist c. = waist circumference, HDL = high-density lipoproteins, LDL = low-density lipoproteins, MBS = metabolic syndrome, * = Statistical difference between groups p<0.05.**

Figure 4 demonstrates mean daily PA and time spent sedentary for the entire measurement period. Interaction in PA was observed between sex and group (p=0.004), where TDI boys were significantly more physically active than TDI girls (p<0.001) but no statistical difference between the sexes was found in the ID group (p=0.776, Figure 4A). Similarly, an interaction in sedentary time was observed between sex and group (p=0.019), where TDI girls were more sedentary than TDI boys (p=0.034) but no statistical difference between the sexes was found in the ID group (p=0.278, Figure 4B).

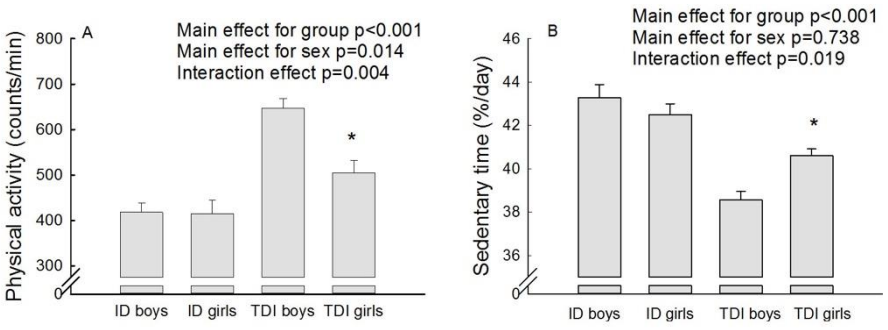


**Figure 4: Physical activity (A) and time spent sedentary (B) among all participants for the entire measurement period. ID=Intellectually disabled, TDI=Typically developed individuals. * = Statistical difference between sex within groups p<0.05.**

## 4.2 Weekday and weekend PA, MVPA and sedentary time

In Figure 5, weekday physical activity (wPA) and weekend physical activity (wePA) are demonstrated. No three-way interaction was found between group, sex, and repeated PA (wPA vs. wePA, p=0.187). Nevertheless, two-way interactions between group and repeated PA (p=0.002) and between group and sex (p=0.007) were observed. In the ID group, no statistical differences were found between the sexes (p=0.982) or between wPA and wePA (p=0.573, Figure 5A). In the TDI group, boys were significantly more active than girls (p<0.001) and PA was higher during weekdays (p<0.001, Figure 5B).

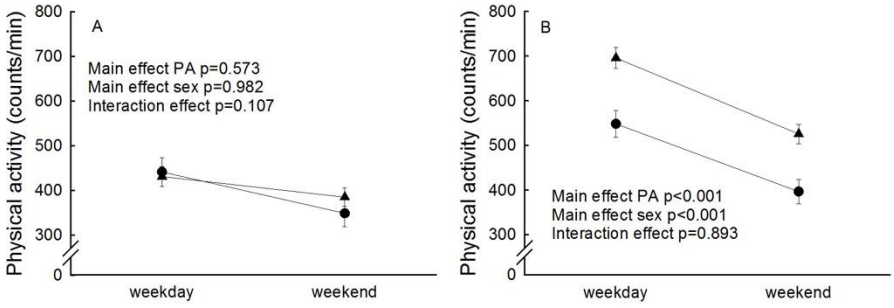


**Figure 5: Physical activity during weekdays and weekends among (A) intellectually disabled children and (B) typically developed children. PA=Physical activity. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated PA) p=0.187, interaction effect (group X repeated PA) p=0.002, interaction effect (sex X repeated PA) p=0.248, interaction effect (group X sex) p=0.007.**

Time spent in MVPA during weekdays and weekends is presented in Figure 6. No three-way interaction (p=0.982) was found between group, sex and time spent in MVPA during weekdays and weekends (repeated MVPA). However, two-way interactions were detected between group and repeated MVPA (p<0.001), between sex and repeated MVPA (p=0.001), and between group and sex (p=0.001). For the ID group (Figure 6A), there was an interaction (p=0.002) between sex and repeated MVPA. Once the data had been split on sex, no statistical differences between time spent in MVPA during weekdays vs. weekends were found among boys (p=0.13) or girls (p=0.077), probably due to the low number of girl participants with ID. Likewise, there was an interaction (p=0.042) between sex and repeated MVPA in the TDI group (Figure 6B). TDI boys spent more time in MVPA during weekdays than weekends (p<0.001), and although a similar trend was observed among the girls, the difference was not significant (p=0.052).

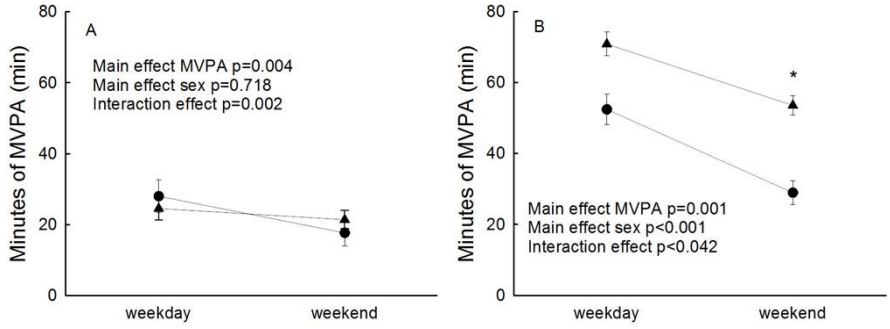


**Figure 6: Time spent in moderate-to-vigorous physical activity during weekdays and weekends among (A) intellectually disabled children and (B) typically developed children. MVPA= Moderate-to-vigorous physical activity. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated PA) p=0.982, interaction effect (group X repeated PA) p<0.001, interaction effect (sex X repeated PA) p=0.001, interaction effect (group X sex) p=0.001. * = Statistical difference between weekday and weekend within sex p<0.05.**

None of the children with ID met the recommendation of 60 minutes of daily MVPA (Riddoch et al., 2004) on average over an entire week, whereas 40% of the TDI children met the recommendation (p<0.001). During weekdays, 49% of TDI boys and 29% of TDI girls met the recommendations for MVPA, whereas only 7% and 0% of children with ID did so, respectively (p<0.001). During the weekend, no children with ID met the MVPA recommendation but 33% of the TDI boys did so and 3% of TDI girls (p<0.001).

Objectively measured time spent sedentary during weekdays and weekends is displayed in Figure 7. No three-way interaction (p=0.159) was found between group, sex and time spent sedentary during weekdays and weekends (repeated sedentary time). However, two-way interactions were detected between sex and repeated sedentary time (p=0.022). For the ID group (Figure 7A), there was an interaction (p=0.047) between sex and repeated sedentary time. Splitting the data on sex revealed that boys with ID were more sedentary on the weekends than weekdays (p=0.018) but no difference was found among girls (p=0.190). No such interaction of sex and repeated sedentary time (p=0.742) was found in the TDI group (Figure 7B), but girls were more sedentary than boys (p=0.023) and more time was spent sedentary on the weekends (p<0.001).

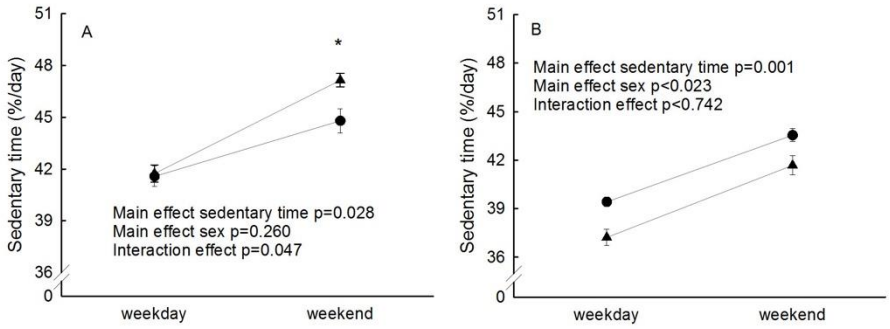


**Figure 7: Time spent sedentary during weekdays and weekends among (A) intellectually disabled children and (B) typically developed children. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated sedentary time) p=0.159, interaction effect (group X repeated sedentary time) p=0.919, interaction effect (sex X repeated sedentary time) p=0.390, interaction effect (group X sex) p=0.022. * = Statistical difference between weekday and weekend within sex p<0.05.**

## 4.3 School and after school PA, MVPA and sedentary time

Figure 8 demonstrates PA during and after school hours. No three-way interaction was found between the group, sex, and repeated PA (school PA vs. after school PA, p=0.312). Nevertheless, two-way interactions between group and repeated PA (p=0.004) and between group and sex (p=0.004) were found. In the ID group, no statistical differences were found between the sexes (p=0.566) but children with ID were more active during school than after school (p=0.002, Figure 8A). In the TDI group, boys were significantly more active than girls (p<0.001) but there was no statistical difference in PA during school vs. after school (p=0.914, Figure 8B).

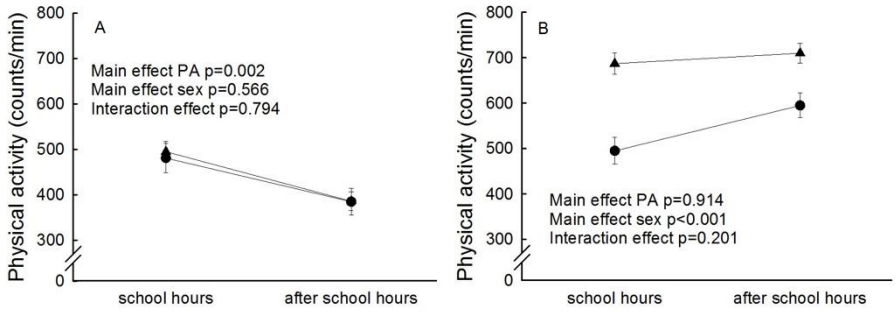


**Figure 8: Physical activity during and after school hours among (A) children with intellectual disability and (B) typically developed children. PA=Physical activity. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated PA) p=0.312, interaction effect (group X repeated PA) p=0.004, interaction effect (sex X repeated PA) p=0.238, interaction effect (group X sex) p=0.004.**

Time spent in MVPA during and after school hours is presented in Figure 9. No three-way interaction (p=0.899) was found between group, sex and time spent in MVPA during school and after school (repeated MVPA). However, two-way interactions were detected between the group and repeated MVPA (p<0.001), and between group and sex (p=0.005) but not between sex and repeated MVPA (p=0.336). For the ID group (Figure 9A), children with ID accumulated more minutes of MVPA during school than after school (p<0.001) but no statistical difference was found between boys and girls (p=0.324). In the TDI group (Figure 9B), boys accumulated more minutes in MVPA over the whole weekday than girls (p<0.008), but no difference was found between time spent in MVPA during school compared to after school (p=0.312).

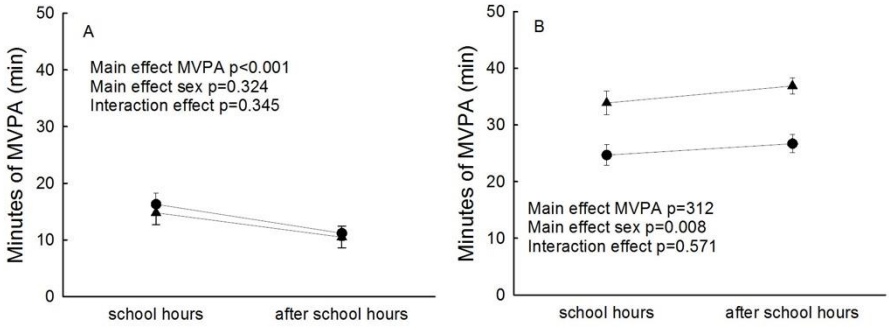


**Figure 9: Time spent in moderate-to-vigorous physical activity during and after school hours among (A) intellectually disabled children and (B) typically developed children. MVPA= Moderate-to-vigorous physical activity. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated MVPA) p=0.899, interaction effect (group X repeated MVPA) p<0.001, interaction effect (sex X repeated MVPA) p=0.336, interaction effect (group X sex) p=0.005.**

Objectively measured time spent sedentary during school hours and after school hours is displayed in Figure 10. No three-way interaction (p=0.314) was found between group, sex and time spent sedentary during school vs. after school (repeated sedentary time). However, a two-way interaction was detected between the group and repeated sedentary time during- and after-school (p<0.001). In the ID group (Figure 10A), children were more sedentary after school than during school time (p=0.001), but no statistical difference was found between the sexes (p=0.424). Among the TDI children, girls were more sedentary than boys (p=0.002), and children were more sedentary during school than after school (p<0.001, Figure 10B).

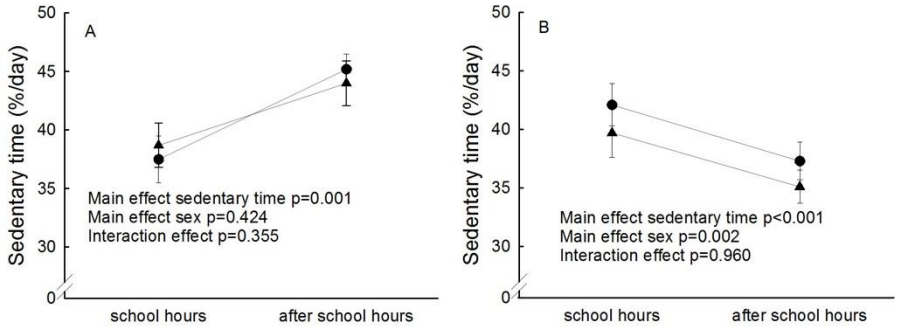


**Figure 10: Time spent sedentary during school and after school hours among (A) intellectually disabled children and (B) typically developed children. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated sedentary time) p=0.314, interaction effect (group X repeated sedentary time) p<0.001, interaction effect (sex X repeated sedentary time) p=0.380, interaction effect (group X sex) p=0.063.**

## 4.4 Reasons for participations in sport and PA

More (~95%) of TDI children took part in sports or PA "to stay fit" and "to improve their performance" or "skill level" in the sport compared with ~50 – 70% of children with ID (p<0.001). Children with ID were more likely to name "weight loss" or "weight control" (~60 – 70%) as a reason to be physically active compared to ~35 - 50% of TDI children (p<0.001) (Table 4). There was no statistical difference between the groups when it came to social factors such as "being with friends" (p=0.627) or "having fun" (p=0.077) as a reason for participation in sports or PA.

**Table 4: Participants' reasons for participation in sports or physical activity and self-perception of their physical activity level.**

| | ID<br>n=90 | TDI<br>n=93 |
|---|---|---|
| To stay fit (%) | 71 | 95* |
| To improve in sport (%) | 50 | 96* |
| To not gain weight (%) | 72 | 52* |
| To lose weight (%) | 60 | 34* |
| To be with friends (%) | 90 | 87 |
| To have fun (%) | 88 | 97 |

*** = Statistical difference between groups p<0.05.**

A significantly lower proportion of children with ID used active commuting (walking or biking) to school compared to TDI children (p<0.001, Table 5). There was also a statistical difference between the groups in organized sports participation where 33% of children with ID participated in sports for 2 hours per week or more, whereas 76% of the TDI children spent that time in sports (p<0.001). Sports like Boccia and swimming were most popular for persons with ID, but team handball and soccer were most often played by TDI children. There was no statistical difference between the groups (p=0.885) during school recess, where approximately half of all children were physically active (i.e. run, walk, take part in games). Fifty-five percent of children with ID took part in low-intensity activities like Boccia, walking or dancing once or more times per week, whereas 67% of TDI children reportedly did the same (p=0.119). Only 15% of children with ID took part in high-intensity sports like soccer, team handball or athletics once or more a week compared to 72% of the TDI children (p<0.001). Only 66% of children with ID reported "to be out of breath" or "to sweat" more than once per week, whereas all of TDI children did so (p<0.001). However, there was no statistical difference between the groups in their perception of being sufficiently physically active (children with ID = 55.7%, TDI children = 71.3, p=0.083).

**Table 5: Self-reported PA patterns and recess behavior of the participants**

| | All ID<br>n=90 | All TDI<br>n=93 |
|---|---|---|
| Active commute to school | 16% | 74%* |
| PA during recess in school | 53% | 52% |
| Sports practice ≤1 hr/week | 67% | 24%* |
| Sports practice 2-3 hr/week | 24% | 38%* |
| Sports practice >3 hr/week | 9% | 38%* |
| Low intensity PA > once/week | 55% | 67%* |
| High intensity PA > once/week | 15% | 72%* |
| Sweat < 1 once/week | 33% | 0%* |
| Sweat (1 – 3)/week | 52% | 38%* |
| Sweat > 3/week | 14% | 62%* |
| I feel my PA is sufficient | 55% | 71% |

**ID=Intellectually disabled, TDI=Typically developed individuals, PA=Physical activity. * = Statistical difference between groups p<0.05.**

No statistical difference was found between the groups in any self-reported time spent during the entire weekday or the whole week in a computer or TV-based activities (p=0.092 – 0.667). Both groups spent the most time playing computer games, watching TV and surfing the internet, but much less time in word processing. More children with ID (46%) listened to music between 1 and 3 hours/day than TDI children (21%, p=0.005), who on the other hand, were more likely (23%) to read books between 1 – 3 hours/day compared with 7% of children with ID (p=0.004).

# 5 Discussion

The main findings of this research project were that children with ID were in many ways different from TDI children in the physical characteristic. By definition, the cognitive functions of children with ID are considerably lower than that of TDI children as well as having significant limitations in both intellectual functioning and adaptive behaviour in many everyday social and practical skills. There were very few comorbidities among the participants in this study, and therefore, children with ID should not have had any physical impairments that could potentially have increased the difference between the two groups. Thus any difference found in the physical variables is likely to stem from the difference in lifestyle and understanding of the environment rather than being of biological reasons.

## 5.1 Physical health and condition

We have confirmed the findings of previous studies for the general population of individuals with ID (Beange et al., 1995; Draheim, 2006; Rimmer & Yamaki, 2006; Stanish et al., 2006; Walsh et al., 2003), that children with ID are in many aspects worse off than their TDI peers regarding their aerobic fitness and body composition. We also demonstrated that more children with ID fall outside recommended international levels for blood pressure and metabolic markers.

### 5.1.1 Aerobic fitness

The children with ID in this study had much lower aerobic fitness than TDI children, similar to what other studies have reported (Fernhall, Millar, Tymeson, & Burkett, 1990; Foley & McCubbin, 2009; Gillespie, 2003; MacDonncha et al., 1999; Wallen et al., 2009). The TDI children also had considerably lower aerobic fitness than demonstrated in an Icelandic study conducted among 9 and 15-year-old children 10 years ago that found Icelandic TDI children to have unusually high $VO_{2max}$ compared to their peers in other countries (Arngrimsson, Sveinsson, & Johannsson, 2008).

Children with ID were less willing or able to use the nose clip, mouthpiece, and headgear needed to connect to the metabolic cart used to measure $VO_{2max}$ (Figure 1). That inability was more common among children with a higher level of disability. Those children without direct measures of $VO_{2max}$

had statistically lower estimated aerobic fitness (p=0.013) by the PWC170 test than those who had direct measures. Therefore, a negative correlation between the level of disability and aerobic fitness among children with ID is likely, similar to the findings of Lotan et al. (2004). Only 25% of the children with ID reached recommended level of aerobic fitness compared with 75% of the TDI children. Not much is generally known about aerobic fitness levels in children with ID other than that it is lower than among their TDI peers (Baynard et al., 2008; Fernhall et al., 1998; Foley & McCubbin, 2009; Gillespie, 2003; Golubovic et al., 2012; Hartman et al., 2015; MacDonncha et al., 1999; Salaun & Berthouze-Aranda, 2012; Wallen et al., 2009). However, studies done on athletes with ID have demonstrated that trained individuals with ID can reach high levels of aerobic fitness (Van de Vliet et al., 2006). Another study conducted among individuals with ID also demonstrated that, by taking part in a moderate-to-vigorous PA, like walking, for two months, participants were able to increase their physical fitness considerably (Lotan et al., 2004), demonstrating again that children with ID should be able to have adequate aerobic fitness level to maintain good health.

### 5.1.2 Body composition

We confirmed results from other studies that children with ID have a higher prevalence of overweight and obesity than TDI children (Reinehr et al., 2010; Rimmer et al., 2007; Rimmer & Yamaki, 2006) using age- and sex-specific cut-offs (Cole et al., 2000). In our study, 33% of the children with ID were classified as overweight or obese compared with 22% in the group of TDI children. The greatest difference between groups was in the obese category, where 13% of the children with ID fell within that category compared with only 3% of the TDI children. Using percentage body fat as a classification for body composition, 50% of the children with ID were overweight or obese compared with 27% among the TDI children. Thus, as previously reported (Bandini et al., 2005; De et al., 2008; Marshall et al., 2003; Reinehr et al., 2010), we found children with ID to be approximately twice as likely to be overweight or obese than TDI children.

Similar results were found for waist circumference, where the proportion (15%) of children with an ID with elevated waist circumference (Fernandez et al., 2004; Jolliffe & Janssen, 2007) was three times greater than in the TDI group. The difference in ΣSKF (40%) was the largest anthropometric difference found between the groups, although the range was similar. The mean differences between the groups in BMI on one hand

and percentage body fat on the other indicate that the children with ID have less fat-free mass and more fat mass than TDI children. However, athletes with ID who take part in competitive sports do not differ in body composition from their TDI peers (Van de Vliet et al., 2006), suggesting that the differences observed in this study are not necessarily of biological nature.

### 5.1.3 Blood pressure, blood lipids, glycemic control, and metabolic syndrome

We were able to confirm what others have found among older individuals with an ID that children with ID have a poorer profile when it comes to metabolic syndrome markers. Children with ID had considerably higher DBP than TDI children, and most children who were diagnosed with elevated BP had increased DBP. The mean values for BP in this study were lower than the mean value among 18-year-old Icelandic (Arngrimsson, Richardsson, Jonsson, & Olafsdottir, 2012) and Swedish teenagers (Wallen et al., 2009), but blood pressure is known to increase with age (Jolliffe & Janssen, 2007). However, a much higher ratio of children in this study were found to have elevated BP (34% of children with and ID and 16% of the TDI children) compared with 15% of the children in the Swedish study (Wallen et al., 2009) and 10% in the Icelandic study (Arngrimsson et al., 2012). It needs to be considered that even though this study used age-specific cut-offs for elevated BP, some of the younger children in both groups did not find it comfortable to have their BP measured. This discomfort may have prevented full relaxation, especially among the children with ID, possibly increasing their resting BP.

There does not appear to be much difference between the two groups in blood metabolic markers. Only in insulin was a statistical difference detected between boys with ID and TDI boys, where boys with ID had 34% higher levels than their TDI peers. However, no participants were found outside recommended levels (Soldin et al., 2008) for insulin nor the levels of triglycerides (Ghoshal & Soldin, 2003; Jolliffe & Janssen, 2007). In contrast, 21% of children with ID had HDL below recommended levels, 16% had elevated LDL, 13% increased glucose, 2% elevated cholesterol, and 7% had a total of three or more metabolic markers outside recommended levels and could, therefore, be classified with the metabolic syndrome. None of the TDI children were classified with metabolic syndrome, and much fewer were outside recommended levels.

Direct comparison with other studies on children with ID at this age is difficult as, to our knowledge, such data do not exist. Wallen et al. (2009) found 55% of Swedish teenager with ID (average age 18) to have at least one of the following variables (waist circumference, BP, triglyceride or total cholesterol) outside the recommended levels, whereas this study finds 47% of children with ID outside the recommendations on the same variables. The TDI participants in this study were considerably younger than in an Icelandic study on 18 year- old teenagers, where 9% of participants were found to have values of HDL and LDL outside recommended levels (Arngrimsson et al., 2012) compared to 4-6% among the TDI children in the present study.

## 5.2 Physical activity

None of the children with ID in this study met the recommendations for MVPA, thus confirming the findings of previous studies (Eiholzer et al., 2003; Foley, 2006; Horvat & Franklin, 2001; Kim, 2006; Kozub, 2003; Lorenzi, Horvat, & Pellegrini, 2000; Peterson et al., 2008; Whitt-Glover, O'Neill, & Stettler, 2006). Their PA and sedentary time patterns were also in many ways different from TDI children.

### 5.2.1 Overall PA and sedentary time

We confirmed that what others have reported that children with ID are less physically active than their TDI peers (Lin et al., 2010; Phillips & Holland, 2011; Sit, McManus, McKenzie, & Lian, 2007), although direct comparison with other studies is difficult due to differences in methodology. The amount of difference between the groups varied from 25% to 40% depending on the time of the week (weekday vs. weekend) or the time of the day (school hours vs. after school hours). We also found children with ID to be more sedentary over the whole week, but the difference between the groups varied from +5% to -23%, again depending on the time of the week or the time of the day. The large fluctuations in the difference between the groups demonstrate that the two groups have very different patterns of PA and sedentary time.

### 5.2.2 Physical activity and sedentary time patterns

In our study, we found no difference between wPA and wePA among the children with ID, but like others (Magnusson et al., 2011; Nader et al., 2008), we found wPA to be greater (34%) than wePA in the group of TDI children. Also, children with ID accumulated a much higher percentage of

their PA during school hours than their TDI peers. We suspect that a large portion of the PA differences between the groups, as well as the different patterns in PA, can be explained by centralization of the schools, lack of understanding of the environment, and safety reasons among the children with ID, all factors known to affect PA among children (Kerr et al., 2006; Merom, Tudor-Locke, Bauman, & Rissel, 2006; Veitch, Salmon, & Ball, 2008; Zhu & Lee, 2008). Schools in Reykjavik, like most other metropolitan cities in the world, are distributed as evenly as possible within the city so that children do not have to commute long distances to and from the schools. Over half of the participants with ID in this study attended the only special school in Reykjavik and commuted, therefore, from all over the city every day to attend the school. Most of the children attending the special school were transported with a special shuttle bus provided by Reykjavik city. Further, the inclusion schools also accepted children with ID from a much larger area than they accepted TDI children. The average walking time to and from school was 10 min for TDI children, and 74% of them walked or biked most days to and from the school. On the contrary, only 16% of the children with ID regularly walked to school, but those who did so also had, on average, 10 min of active commuting. Environmental factors such as distance to school are known to deter PA (Hutzler & Korsensky, 2010).

A similar trend was observed regarding participation in organized sports after school hours. In metropolitan Reykjavik, three centralized sports clubs offer programs for children with disability nearly free of charge. Of these, only one focuses specifically on children with ID. Centralization of sports clubs, again, means much longer travel time for the participants with ID to and from practice (Hutzler & Korsensky, 2010), and most of these children depend on their parents for transportation. Such centralization and dependence on parents for commuting are known barriers to sport participation (Hutzler & Korsensky, 2010). This centralization of sport clubs can, therefore, partly explain the considerably lower participation in sports after school among children with ID.

During school hours, the PA level of TDI children was 25% higher than that of the children with ID, but during after school hours the difference was 73%. This much greater difference in PA between the groups during after school hours compared with school hours underscores that a safe and secure environment is a major promotor for PA (Kerr et al., 2006; Merom, Tudor-Locke, Bauman, & Rissel, 2006; Veitch, Salmon, & Ball, 2008; Zhu & Lee, 2008). Schools offer a safe and secure environment to all children. It is apparent from our results that children with ID are more dependent on the

schools for their overall PA, and given the opportunity and means, they can they can reach higher levels of PA than in environments less suited for their needs.

Likewise, children with ID spent 23% more time sedentary during after school hours but 5% less time during school hours than TDI children. Children with ID spent 37-39% of their time sedentary during school hours and 44-46% during after school hours. This pattern of less sedentary time among children with ID during school hours can partly be explained by the typical classroom practices in their schools. Both the special school and the inclusion schools allow students with ID to move during academic lessons, whereas the tolerance for such movement is much lower for TDI students.

### 5.2.3 Moderate-to-vigorous physical activity

As hypothesized, none of the children with ID met, on average, the recommendation of 60 minutes of daily MVPA over an entire week although 5% did so over the weekdays, whereas almost half of the TDI children met the recommendation. Furthermore, children with ID accumulated 59% of their total minutes in MVPA during school hours vs. 47% among TDI children. Given this difference between the groups in MVPA, it is not surprising that sport participation differed between the groups. Children with ID were much more likely to name low-intensity sports like Boccia, swimming and organized walks as their preferred sport, whereas TDI children were more likely to take part in high-intensity activities like soccer, team handball, and athletics that are activities likely to contribute to time spent in MVPA. For the TDI children, the local sports clubs are always situated near their schools and are, therefore, easily accessible to them. There are sports clubs in Reykjavik that offer soccer and athletics to children with ID but they are centralized, and according to their registration, very few or no children or adolescent participate. This lack of participation from younger children and adolescents with ID implies that these individuals cannot bring themselves to and from practices, demonstrating once again that the distance to and from facilities is a barrier to participation (Hutzler & Korsensky, 2010; Veitch et al., 2008).

The two groups also differ in reasons for participating in sports, which in return affects their accumulated MVPA. Similar to most previous studies (Allender et al., 2006), both groups named socialization, for example, “meeting- and making new friends” and “having fun and enjoying themselves” as major reasons for taking part in PA and sports. However, most of the TDI children in this study also named “improving skills” and

"staying fit" as reasons, whereas children with ID were rarely interested in performance. The performance emphasis in the regular sport clubs can also explain the low participation among children with ID since they are less motivated by these performance-driven factors (Hutzler & Korsensky, 2010).

Despite very low PA and no children with ID meeting the recommendations for MVPA over the whole week, 55% of the children (and their families) felt that their PA was sufficient. Somewhat similar results have been reported before, where self-reported subjective evaluation of PA did not differ between children with ID and TDI children, but objective data demonstrated that the TDI groups had a higher level of PA (Foley & McCubbin, 2009). This lack of knowledge and understanding of PA among the children with ID (and their families), especially about the importance of time spent in MVPA, may also play a large role in the low PA and MVPA among the children with ID. Collectively our findings suggest that the differences between the ID and TDI groups in MVPA are much more likely to be of cultural and environmental origin than biological one.

However, it is important to remember that certain daily activities like walking or doing normal household chores are normally considered of mild intensity and are classified as such when analyzing data from the accelerometers. Such classification originates from studies like Evenson et al. (2008) or Treuth et al. (2004) who simultaneously measured oxygen consumption and accelerometers counts while the participating children performed various daily activities. Children in these studies did not have any disability and had an average $VO_{2max}$. It is, therefore, fair to assume that many of the tasks that the children in these studies found to be of mild intensity could be of moderate or higher intensity for children with ID who have much lower$VO_{2max}$. Consequently, the MVPA of children with ID might be underestimated.

### 5.2.4 Sex difference

Previously, males with ID have been shown to be more active than females with ID in a group of mostly adults, and older individuals (Phillips & Holland, 2011). Similarly, most studies on TDI children, agree on boys being more physically active and less sedentary than girls (Magnusson et al., 2011; Nader et al., 2008; Riddoch et al., 2004). Contrary to these reports, we found no sex differences in the group of ID children on any PA or sedentary time variable. The reasons for the lack of sex differences in PA among the ID population in this study are not readily apparent. According to Vu et al.

(2006), TDI boys are more socially accepted by peers if they are aggressive and athletic, whereas TDI girls often perceive more PA as socially unacceptable. Children with an ID may be less aware of sex-related social distinctions in PA and sex identity may be less important for children with ID than TDI children, especially among those with moderate-to-severe ID (Björnsdottir & Traustadottir, 2010). The PA of many children with ID was extremely low, and it can be speculated that in some cases we did not measure much more than the activities of daily living in this group of children, which makes it difficult to differentiate between the sexes. Furthermore, more boys with ID were diagnosed with moderate-to-severe ID than girls with ID and PA is known to decline with an increased level of ID (Hinckson & Curtis, 2013), also explaining the lack of sex difference in PA.

## 5.3 Challenges in retrieving data from children with ID

Retrieving the data from children with ID was not without challenges and proofed to be more troublesome and time-consuming than obtaining data from the TDI children. They needed much more familiarization and personal attention from the data collectors than their TDI peers. However, if given time and with patience, there is hardly a reason to exclude an ambulatory child with ID from participating in measurements such as were conducted in this study.

### 5.3.1 Anthropometric data collection

The anthropometric measurements proved challenging for children with ID most of the time. Measuring weight and waist circumference were simple, and no differences were noticed in measuring those variables between the two groups. It took some children with ID a few trials to stand upright with their spine and neck in good alignment when measuring their height, and the researcher had to look carefully at their posture while conducting the measurement because they seemed in many cases to have much less body awareness. The skinfold caliper initially scared some of the children with ID. To overcome that fear, the children were allowed to examine it for as long as they wanted and try on themselves and others around them before actually allowing the researcher to conduct the measurement. In fact, all children in both groups were offered to play with the caliper before the measurements took place, but only the children with ID were interested in it or needed this time. Although some of the children with ID had attention deficit hyperactivity disorder, ADHD, on top of their ID and looked very restless, all of them were able to lay still long enough during the DXA scan

to yield usable data. A few times the scan had to be stopped and repeated, but by offering the children to listen to a story while the scanner was scanning, all of them were able to lay still long enough to complete the scan. In the more difficult cases, the children were allowed to use headphones after the scanner had passed the head.

### 5.3.2 Physical activity data collection

It was not without difficulty to use accelerometers in children with ID. The children and their families were reminded to put the accelerometer on every morning with a text message. Such reminders were not enough to fulfill the minimum wear time in all cases, so many children, mostly children with ID got additional days to wear the accelerometer. Furthermore, some children with ID saw no reason to wear the small device on their hip and simply disposed of them in the school bus or at the school where they saw fit. To stop the children to disposing of the meters, some parents, who all were very positive and helpful in this study, simply sewed the accelerometer into a small pocket of the trousers right below the waistband, so participants did not really see the accelerometer nor could they in a simple way dispose of it.

### 5.3.3 Blood sampling and blood pressure data collection

Collecting blood samples from children is always challenging. In this study, 78% of the children with ID (and their parents) agreed to blood sampling, and 89% of these participated successfully. Among the TDI children, 91% agreed to give a blood sample with 93% being able to do so. The biggest difference is, therefore, in the proportion of signed agreement to try to give a blood sample. We did not inquire about the reasons for not agreeing to blood sampling, but many parents told us that they did not think that their child could endure such sampling, so they did not want to try and have the child fail. In fact, the success rate was almost the same in the both groups among those who consented to blood sampling.

It is also noteworthy that the measurement of PB turned out to be one of the most difficult for many of the children with ID. To sit still, without standing up or starting to fiddle with something for 10 minutes before the measurements, proved hard for many participants. Further, especially those who had autism along with their ID, the pressure from the cuff was very uncomfortable, and in some cases, the BP was measured many times on many different occasions to familiarise participants with the protocol to get as reliable reading as possible.

### 5.3.4 Aerobic fitness data collection

Retrieving data on aerobic fitness from young children can be problematic, especially when using gas analysis equipment, where the participants have to wear a headgear and a nose clip. Some young TDI children were not willing to use the headgear, but it was significantly harder for many of the children with ID to use the mouthpiece and the nose clip because they found these to be too invasive. To try to overcome this discomfort among the participants, all children were allowed to play with and try out all the items before using them. Many children were able to overcome their discomfort in that way and then felt comfortable enough to perform the test using the headgear and nose clip. It was also clear that many of the children with ID were not used to giving their maximal physical effort. Therefore the rate of perceived exertion (RPE) scale was color-coded and made more visual to ease its use for the children. All the children in the study received similar encouragement to do their best, but often that encouragement had to be implemented much sooner for the children with ID. Other studies have also reported difficulty measuring aerobic fitness in individuals with ID (Wallen et al., 2009) and claiming RPE scales to be inadequate among many individuals with ID.

## 5.4 Strength and limitations

This study is not without limitations. First, the low number of girl participants with ID reduced the statistical power of the study. This low number was due to the fact that fewer girls are diagnosed with ID than boys (Gillberg & Soderstrom, 2003), resulting in fewer potential participants, making it hard to overcome this limitation. Further, fewer children with ID were able to finish the $VO_{2max}$ and fewer children with ID accepted to give blood and undergo DXA measurements. Secondly, since the ID group is more dependent on the social structure and –support than the TDI group, the results may not be directly applicable to children with ID in other societies. We also have little information on parents or legal guardians of the participants and it is possible that the parents of the children with ID are less encouraging of PA, and thereby, increase the PA difference between groups.

We believe that the strengths of the study overcome its limitations. We were able to measure a large number of children with ID compared to most previous studies on this population, and the dropout was less than 5%. Furthermore, we objectively measured PA and PA patterns with accelerometers among children with ID in the same way as in a comparison

group of TDI children. To our knowledge, we are the first to publish objective measurements on PA and sedentary time comparing school hours and after school hours between the two groups. Finally, our sample consisted of almost all ambulatory children with ID in the metropolitan area of Reykjavik, which includes more than 70% of the Icelandic population.

# 6 Conclusion

The first two aims of this dissertation were to study the prevalence of overweight and obesity children with ID as well as to determine the levels of PA, aerobic fitness, and other risk factors for metabolic diseases in this population and to compare them TDI peers. This study has demonstrated that children with ID, who all are able to be physically active are generally in much worse physical condition that their TDI peers. Children with ID have unusually high level of obesity, waist circumference, ΣSKF and very low aerobic fitness compared with their TDI peers. Many children with ID also have elevated BP and blood lipid markers outside of the recommended levels and are therefore, at risk of developing metabolic syndrome despite young age. The PA of children with ID is considerably lower than among their TDI peers and the fact that no children with ID met the recommendation of daily MVPA calls for special PA measures in this group. Furthermore, there appear to be no sex differences in PA and PA patterns among children with ID thus disproving the hypothesis.

Aim III was to compare school and after school PA and sedentary time behaviour among children with ID and with that of children without ID of the same age and sex. The PA level of children with ID is considerably lower than that among their TDI peers and they also depend much more on the school system to accumulate their PA and MVPA. Children with ID are also less sedentary during school hours than after school hours, whereas the vice versa is true for TDI children.

Aim IV was to study reasons for sport participation and PA among children with ID. Children with ID are more likely to participate in low-intensity PA and sport for reasons of losing weight or preventing weight gain demonstrating a negative body image. In contrast, TDI children are more likely to participate in high-intensity PA and sport in order to stay fit or improve their skill level. Furthermore, the children with ID seem to be less aware of their PA level than TDI children.

# 7 Future perspectives

This dissertation has, if nothing else, demonstrated that the vulnerable group of children with ID needs our attention regarding general health and well being. Many studies have demonstrated the importance of a healthy life style, including reasonable amounts of PA and good aerobic fitness, especially at young age. In general, it is known that PA and fitness have been declining and obesity rising among TDI children in Iceland as well in the western world. This is the first large study focusing on children with ID in Iceland and it is, therefore, difficult to speculate whether the health and PA profile is improving or worsening in this population. It would be wise to repeat this study in a few years and to do a follow-up study on the same cohort of children with ID. That way the trend can be investigated and better measures implemented to counteract the unfavourable findings of this study. Studies have demonstrated that direct interventions work well to improve many aspect of people's lifestyle. Much less is known about what works best for children with ID, so a well-planned intervention study is needed. The biggest foreseen challenge with such study is the selection of the reference group of ID children that would not receive the intervention.

It can easily be concluded from the dissertation that a traditional campaign for healthier lifestyle and improved PA might not reach children with ID and their families. It is clear that intensity is not well understood and importance of MVPA is not well known among children with ID and their families. A campaign should be designed, targeting PA with a special emphasis on the importance of MVPA aiming at children with ID and their families. An emphasis should be put on weekends and perhaps to prolong the school time with some kind of extra curricula organised physical activity or recreation.

It is a known fact that the trend in many countries, including Iceland, is to close as many special schools as possible and integrate as many children with ID as possible in the mainstream schools. About half of the children with ID in this study came from the largest special school in Iceland, where there is no shortage of specially trained teachers who are well aware of the importance of PA and health promotion among children with ID. However, more integration creates some new challenges for the elementary school teachers in the mainstream schools, both the physical education (PE)

teachers as well as teachers working in typical classroom settings. The teachers´ training, especially the PE teachers´ training and education, needs to be adjusted to allow them to rise to these new challenges. All teachers need to be educated about the important role of the schools for the children with ID in collecting their PA and MVPA.

The greatest difference in PA between the children with ID and the TDI children occurs after school, especially regarding amount of MVPA. The local sport clubs play a major role in the accumulation of time spent in MVPA among the TDI children. It is known that distance to and from sport opportunities is a major barrier for participations for children in general. It is, therefore, important that as many as possible of the local sport clubs make it easier for children with ID (and all disabilities) to participate in their programs. This can be done either with integration or full inclusion of the children with ID. Such inclusion again requires training for coaches of the sport clubs as well as informing the board members in charge about what is possible to accomplish with rather simple changes. For the children with ID a small change can mean a huge difference.

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**PAPER 1**

# Differences in Physical Activity among Youth with and without Intellectual Disability

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**ABSTRACT**

EINARSSON, I. Þ., Á. ÓLAFSSON, G. HINRIKSDÓTTIR, E. JÓHANNSSON, D. DALY, and S. Á. ARNGRÍMSSON. Differences in Physical Activity among Youth with and without Intellectual Disability. *Med. Sci. Sports Exerc.*, Vol. 47, No. 2, pp. 411–418, 2015. **Introduction**: Very little is known about physical activity (PA) and PA patterns measured with objective methods among children with intellectual disability (ID). **Purpose**: This study aimed to investigate PA and PA patterns among Icelandic school children with mild-to-severe ID. **Methods**: A sample of 91 children with ID and a randomly selected age- and sex-matched group of 93 typically developed individuals (TDI) took part in the study. Basic anthropometric measurements were attained, and PA was assessed with ActiGraph accelerometers for 7–10 consecutive days. A questionnaire was used to collect data on PA behavior. **Results**: Although children with ID were 40% less physically active and spent 9% more time sedentary than their TDI peers, there was interaction between group and sex ($P < 0.05$). TDI boys were more active and less sedentary than TDI girls ($P < 0.05$), but no sex differences were found among children with ID on any PA variable. In addition, there was no difference between workday PA and weekend PA among children with ID. Only 16% of children with ID walked or biked to school, whereas the proportion was 74% among TDI children ($P < 0.001$). Similarly, a lower fraction (33%) of children with ID took part in 2 h·wk$^{-1}$ or more in sports compared with TDI children (76%, $P < 0.001$). No children with ID met the recommendation of 60 min of daily moderate-to-vigorous PA, whereas 40% of the TDI children met the recommendation. **Conclusions**: PA of children with ID is considerably lower than that among their TDI peers, and there seem to be no sex differences in PA and PA patterns among children with ID. The fact that no children with ID met the recommended daily MVPA calls for special PA measures in this group. **Key Words:** ACCELEROMETER, CHILDREN, ADOLESCENT, SEX, SPORT PARTICIPATION, ANTHROPOMETRY

The prevalence of childhood overweight and obesity has risen in the Western world over the past two decades (15). This rise can have serious consequences for health and general well-being (40). Physical activity (PA) has shown negative relationship with obesity, and positive relationship with health and *vice versa* has been demonstrated for sedentary behavior (21). Fewer and fewer young people meet the recommended guidelines of 60 min·d$^{-1}$ of moderate-to-vigorous PA (MVPA) (30) needed to maintain good health (22,30). Correspondingly, sedentary behavior has increased during the past few decades (24), and today children spend 4–8 h·d$^{-1}$ sedentary (24) or approximately 40% of their waking time (35). Furthermore, various studies have shown that PA declines with age (18,22,30), boys are more physically active than girls (22,30), and PA is greater during workdays (wPA) than that on the weekend (wePA) among children (22).

This situation seems to be more dramatic in persons with intellectual disability (ID) than among typically developed individuals (TDI) (4,20,29,31). Children with ID have approximately 40% prevalence of overweight and obesity, and some studies report that they have twice the prevalence of their TDI peers (4,29). In addition, incidence of overweight and obesity has negative relationship with the level of ID (20,25,32). Athletes with ID, on the other hand, have anthropometric measures similar to their TDI peers (37).

Studies of PA in persons with ID generally agree that this population is less physically active than the TDI population (9,13,25) and that PA also declines with increased level of ID (12). Similarly, sedentary time is greater among adults with ID (5). Very few studies on PA and all with low numbers of participants have been conducted on children with ID. Nevertheless, a study using accelerometers showed that nine children with ID were only 50% as active as their TDI peers, although no differences were found in their self-reported sedentary behavior (9). Furthermore, very few or no children with ID reached recommended levels of MVPA estimated via questionnaires (17,32) or accelerometers (25). However, a study using HR monitors to assess PA found that with increased PA classes in school, children with ID

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could achieve the recommended daily 60 min of MVPA (27). Differences in PA between boys and girls with ID are also not clear, but a study on 150 individuals with ID age 12–70 yr found men to be more active than women and a trend for decline in PA with age (26). In addition, little is known on the rate and type of participation in organized sport among children with ID, although the positive benefits of sport participation and increased PA in persons with ID for both health and general well-being have been demonstrated (1,14).

There is incomplete knowledge about PA and PA patterns among the vulnerable group of children with ID. Large quantitative studies on PA and PA patterns of children with ID, with a TDI comparison group, using objective methodology are particularly missing. The purpose of this study was, therefore, to investigate PA and PA patterns with accelerometers among Icelandic school children with ID and to compare them with an age- and sex-matched group of TDI children. A secondary purpose was to investigate potential sex differences in PA and PA patterns among children with ID. We hypothesized that children with ID would be less physically active than their TDI peers, that they would not meet recommended levels of daily MVPA, and that boys with ID would be more active than girls with ID.

## METHODS

**Study design and sampling.** For this study, data were obtained on PA and anthropometric variables from Icelandic primary and secondary schoolchildren (age 6–16 yr) with and without ID. All ($n$ = 120) children with ID from one special school and four inclusion schools were offered participation, and 94 children agreed to take part (78%). Sixty-two percent of the children with ID came from the special school, which only accepts children with moderate-to-severe ID, and 38% came from inclusion schools, which accept children with mild-to-moderate ID. None of the participants had Down syndrome. All the children lived at home with their parents or legal guardians (none were institutionalized). An age- and sex-matched TDI group ($n$ = 124) was randomly selected from the class register from the four inclusion schools and was asked to participate, with 93 children accepting (75%). Before participation in the study, which was approved by the National Bioethics Committee in Iceland (VSNB 2010120007/03.7), a written informed consent was obtained from the children's parents and/or legal guardians along with an assent from the children themselves. Three children with ID dropped out during the study, but all TDI children finished. All children with ID had a diagnosed mild-to-severe ID from the State Diagnostic and Counseling Centre in Iceland, and all participants were able to walk without assistance and did not exhibit motor disabilities, with the exception of three children with ID who had mild cerebral palsy. In addition, four children with ID had epilepsy and took medication (Lamotrin, Abilfy) to control their conditions, which potentially could affect their willingness to be physically active.

**Anthropometric measures.** Standing height was measured three times to the nearest millimeter with a stadiometer (Seca 220; Seca Ltd., Birmingham, United Kingdom), and the mean was used. Body weight was determined to the nearest 0.1 kg using a calibrated scale (Seca 708; Seca Ltd., Birmingham, United Kingdom), with participants in light clothing. Body mass index (BMI) was calculated ($kg \cdot m^{-2}$), and participants were categorized into normal weight, overweight, and obesity using international standards (3). Skinfold thickness was measured three to four times at four sites (triceps, biceps, subscapular, and suprailiac) on the right side of the body (6) using a skinfold caliber (Lange; Beta Technology Incorporated, Cambridge, MD). The mean of the three closest measurements was used, and the sum (mm) of the four skinfolds ($\Sigma$SKF) was used for analysis. Waist circumference was measured two times in a horizontal plane at the narrowest section between the hips and the bottom of the rib cage, and the mean was used for analysis. All measurements were taken by the same trained person.

**PA measurement.** PA was assessed with ActiGraph accelerometers (Manufacturing Technologies, Inc.) model GT1M, which were programmed to record PA every 5 s (5-s epochs). Participants wore the monitor on their hip for 7–10 consecutive days from the time they woke up until they went to sleep. Only data from monitors worn for a minimum of 10 $h \cdot d^{-1}$ for at least two workdays and one weekend day were included in the analysis (18,30). If no activity was registered on the monitor for 30 consecutive minutes, it was assumed that the participants had taken the monitor off and the time was subtracted from the total wear time. Participants who handed in monitors with insufficient valid days were given a new period to wear the monitors. All participants or their parents or legal guardians received a text message each morning, reminding them to wear the monitor. The ActiLife 5 software was used to analyze the data, and MVPA was defined as $\geq$2296 counts per minute, and sedentary activity, as $\leq$100 counts per minute. These thresholds were first established by Evenson et al. (7) and later independently validated by Trost et al. (36). Objectively measured sedentary time was standardized as the percentage of daily wear time, which allows for comparisons regardless of wear time.

**Self-reported sexual maturation and PA.** Data on several aspects of PA and Tanner stage were collected with a questionnaire that was completed at home by the participants together with their parents or legal guardian (19). The questionnaire consisted of closed questions about the time the children spent in PA in school (excluding physical education classes), in sport clubs, out of school (excluding sport clubs), and how often they took part in PA that causes them to be out of breath or to start to sweat. They were also asked how they commuted to and from school.

**Statistical analysis.** SPSS 22.0.0 (Chicago, IL) was used for the statistical analyzes. All variables were inspected for normality. BMI was positively skewed and

TABLE 1. Characteristics of the participants.

| | Boys with ID, $n = 62$ | TDI Boys, $n = 58$ | Girls with ID, $n = 29$ | TDI Girls, $n = 35$ | All with ID, $n = 91$ | All TDI, $n = 93$ |
|---|---|---|---|---|---|---|
| Age (yr) | 11.8 (2.8) | 11.9 (2.9) | 11.9 (2.6) | 12.0 (2.3) | 11.9 (2.9) | 11.9 (2.7) |
| Weight (kg) | 47.7 (21.0) | 47.1 (16.5) | 43.1 (14.3) | 49.9 (12.0) | 46.2 (19.2) | 48.2 (15.0) |
| Height (cm) | 149.1 (18.4) | 155.7 (20.7) | 144.1 (14.6) | 156.7 (13.9) | 147.5 (17.4) | 156.1 (18.3)* |
| BMI ($kg \cdot m^{-2}$) | 20.6 (5.6) | 18.7 (2.8) | 20.3 (4.3) | 20.1 (2.9) | 20.5 (5.2) | 19.2 (2.9) |
| Normal weight (%) | 67.7 | 84.5 | 69.0 | 71.4 | 68.1 | 79.6 |
| Overweight (%) | 17.7 | 13.8 | 20.7 | 25.7 | 18.7 | 18.3 |
| Obese (%) | 14.5 | 1.7 | 10.3 | 2.9 | 13.2 | 2.2 |
| Waist c. (cm) | 71.1 (16.1) | 64.8 (8.3) | 66.1 (9.9) | 67.3 (8.3) | 69.5 (14.6) | 65.7 (8.4)*,** |
| Normal (%) | 83.9 | 98.3 | 86.2 | 88.6 | 84.6 | 94.6 |
| Elevated (%) | 16.1 | 1.7 | 13.8 | 11.4 | 15.4 | 5.4 |
| ΣSKF (mm) | 75.6 (45.1) | 45.9 (29.7) | 83.7 (31.5) | 71.2 (25.7) | 78.2 (41.3) | 55.5 (30.7)*,*** |
| Tanner stage | 2.3 (1.3) | 2.5 (1.5) | 2.6 (1.3) | 2.9 (1.1) | 2.4 (1.3) | 2.6 (1.3) |

*Difference between groups (ID vs TDI across sex) ($P < 0.05$).
**Interaction between sex and group ($P < 0.05$).
***Difference between sex (males vs females across groups) ($P < 0.05$).
Waist c., waist circumference.

was log10-transformed to ensure normality. Similarly, the square root was taken of weight and all PA variables, except sedentary time, for normalization. Untransformed values are presented in tables and figures for more meaningful comparisons. All statistical analyses were corrected for Tanner stage. Two-way ANOVA was used to test for main effects and interactions between group and sex, and a three-way ANOVA, in cases with repeated factor (group–sex–repeated PA or sedentary time). In case of interactions, the data were split on the grouping variable. In cases of interactions after such splits, the data were further split on sex. Chi-square test was used to investigate proportional differences between groups. The data are presented as means and SD in tables and as means and SE in figures. Significance was accepted at $\alpha$ level of 0.05.

## RESULTS

The general characteristics of the participants are given in Table 1. The TDI children were taller ($P < 0.001$) and had lower ΣSKF ($P < 0.001$) than that of children with ID, and boys had lower ΣSKF than girls ($P = 0.006$). A group–sex interaction was found for waist circumference ($P = 0.024$), where boys with ID had significantly larger ($P = 0.029$) waist circumference than girls with ID, but no sex difference ($P = 0.569$) was found in the TDI group. There was no statistical difference in BMI between the groups ($P = 0.102$), but the range in BMI was much larger for children with ID at 13.1–40.4 $kg \cdot m^{-2}$ compared with 13.7–28.6 $kg \cdot m^{-2}$ for TDI children. However, there were more (13%) children with ID (3) than TDI children (2%, $P = 0.017$) in the obese category. Similarly, the range for waist circumference was much larger in the group of children with ID at 46.1–116.0 cm compared with 50.6–87.8 cm in the TDI group. In the group of children with ID, 15% had elevated waist circumference values, whereas the proportion was only 5% among the TDI children ($P = 0.026$) (8,16).

A significantly lower proportion of children with ID used active commuting (walking or biking) to school compared with TDI children ($P < 0.001$) (Table 2). There was also a statistical difference between the groups in organized sport participation where 33% of children with ID participated in sports for 2 $h \cdot wk^{-1}$ or more, whereas 76% of the TDI children spent that time in sports ($P < 0.001$). Sports like Boccia and swimming were most popular for persons with ID, but team handball and soccer were most often played by TDI children. There was no statistical difference between the groups ($P = 0.885$) during school recess, where approximately half of all children were physically active (i.e., run, walk, and take part in games).

Figure 1 depicts mean daily PA and time spent sedentary for the entire measurement period. Interaction in PA was observed between sex and group ($P = 0.004$), where TDI boys were significantly more physically active than TDI girls ($P < 0.001$), but no statistical difference between the sexes was found in the ID group ($P = 0.776$) (Fig. 1A). Similarly, interaction in sedentary time was observed between sex and group ($P = 0.019$), where TDI girls were more sedentary than TDI boys ($P = 0.034$), but no statistical difference between the sexes was found in the ID group ($P = 0.278$) (Fig. 1B).

In Figure 2, wPA and wePA are demonstrated. No three-way interaction was found among group, sex, and repeated PA (wPA vs wePA, $P = 0.187$). Nevertheless, two-way interactions between group and repeated PA ($P = 0.002$) and between group and sex ($P = 0.007$) were observed. In the ID group, no statistical differences were found between the sexes ($P = 0.982$) or between wPA and wePA ($P = 0.573$) (Fig. 2A). In the TDI group, boys were significantly more

TABLE 2. Self-reported PA patterns and recess behavior of the participants.

| | Boys with ID, $n = 62$ | Girls with ID, $n = 28$ | TDI Boys, $n = 58$ | TDI Girls, $n = 35$ | All with ID, $n = 90$ | All TDI, $n = 93$ |
|---|---|---|---|---|---|---|
| Active commute to school (%) | 11 | 25 | 72 | 77 | 16 | 74 |
| PA during recess in school (%) | 52 | 55 | 60 | 38 | 53 | 52 |
| Sport practice ≤1 $h \cdot wk^{-1}$ (%) | 74 | 52 | 26 | 21 | 67 | 24 |
| Sport practice 2–3 $h \cdot wk^{-1}$ (%) | 21 | 31 | 38 | 38 | 24 | 38 |
| Sport practice >3 $h \cdot wk^{-1}$ (%) | 5 | 17 | 36 | 41 | 9 | 38 |

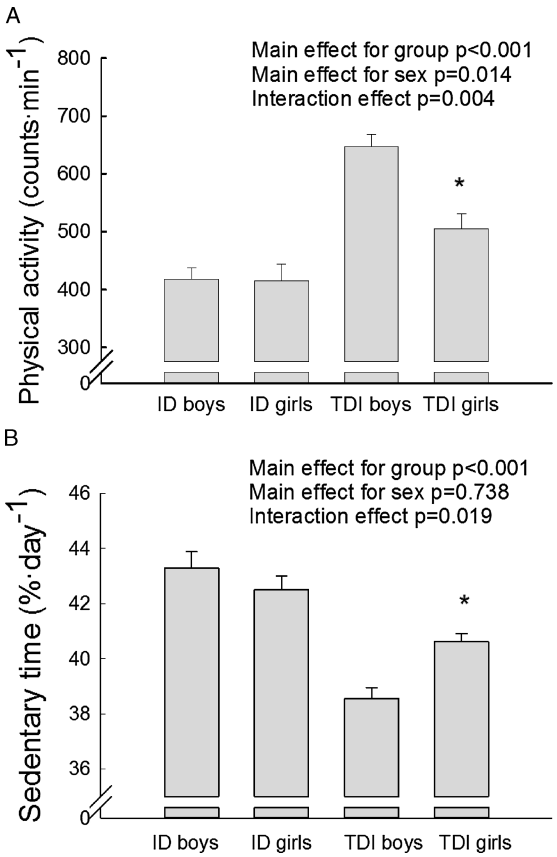


**FIGURE 1—PA (A) and time spent sedentary (B) among all participants for the entire measurement period. Values are adjusted for Tanner stage. *Statistical difference between sex within groups, $P < 0.05$.**

active than girls ($P < 0.001$) and PA was higher during workdays ($P < 0.001$) (Fig. 2B).

Time spent in MVPA is presented in Figure 3. No three-way interaction ($P = 0.982$) was found among group, sex, and time spent in MVPA during workdays and weekends (repeated MVPA). However, two-way interactions were detected between group and repeated MVPA ($P < 0.001$), between sex and repeated MVPA ($P = 0.001$), and between group and sex ($P = 0.001$). For the ID group (Fig. 3A), there was interaction ($P = 0.002$) between sex and repeated MVPA. Once the data had been split on sex, no statistical differences between time spent in MVPA during workdays versus weekends were found among boys ($P = 0.13$) or among girls ($P = 0.077$) probably because of the low number of girl participants with ID. Likewise, there was interaction ($P = 0.042$) between sex and repeated MVPA in the TDI group (Fig. 3B). TDI boys spent more time in MVPA during workdays than that during weekends ($P < 0.001$), and although a similar trend was observed among the girls, the difference was not significant ($P = 0.052$).

None of the children with ID met the recommendation of 60 min of daily MVPA on average over an entire week, whereas 40% of the TDI children met the recommendation ($P < 0.001$). During workdays, 49% of TDI boys and 29% of TDI girls met the recommendations for MVPA, whereas only 7% and 0% of children with ID did so, respectively ($P < 0.001$). During the weekend, no children with ID met the MVPA recommendation but 33% of the TDI boys and 3% of TDI girls did so ($P < 0.001$).

Objectively measured time spent sedentary is displayed in Figure 4. No three-way interaction ($P = 0.159$) was found among group, sex, and time spent sedentary during workdays and weekends (repeated sedentary time). However, two-way interactions were detected between sex and repeated sedentary time ($P = 0.022$). For the ID group (Fig. 4A), there was interaction ($P = 0.047$) between sex and repeated sedentary time. Splitting the data on sex revealed that boys with ID were more sedentary on the weekends than on workdays ($P = 0.018$), but no difference was found among

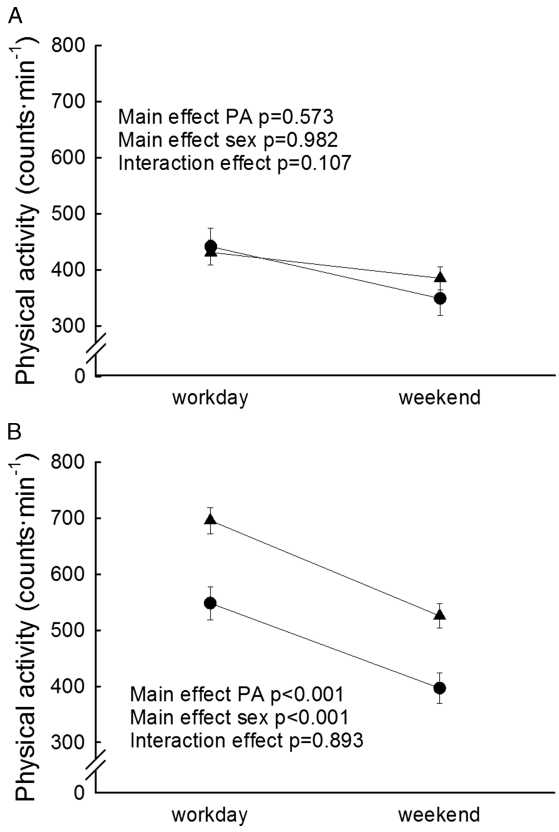


**FIGURE 2—PA during workdays and weekends among children with ID (A) and TDI children (B). Values are adjusted for Tanner stage. *Triangles*, boys; *circles*, girls. Interaction effect (group–sex–repeated PA), $P = 0.187$; interaction effect (group–repeated PA), $P = 0.002$; interaction effect (sex–repeated PA), $P = 0.248$; interaction effect (group–sex), $P = 0.007$.**

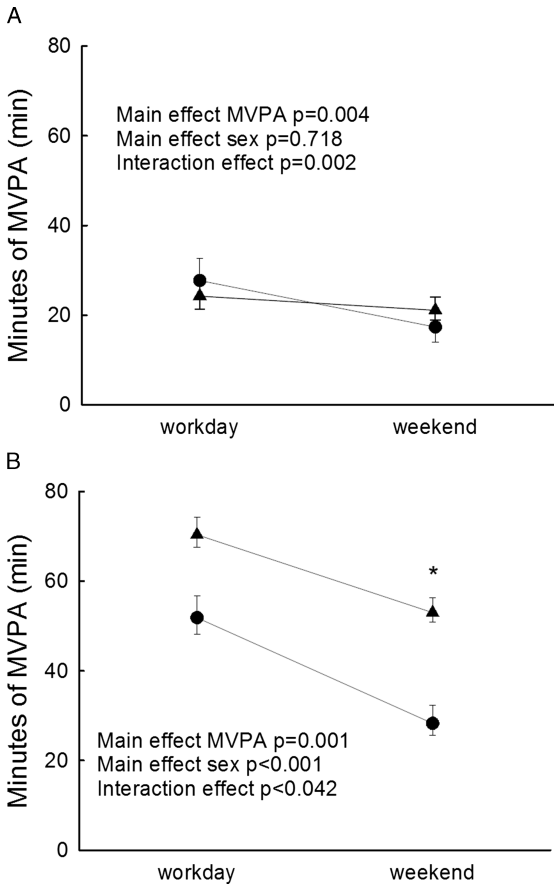


**FIGURE 3—Time spent in MVPA during workdays and weekends among children with ID (A) and TDI children (B). Values are adjusted for Tanner stage. *Triangles*, boys; *circles*, girls. Interaction effect (group–sex–repeated PA), $P = 0.982$; interaction effect (group–repeated PA), $P < 0.001$; interaction effect (sex–repeated PA), $P = 0.001$; interaction effect (group–sex), $P = 0.001$. *Statistical difference between workday and weekend within sex, $P < 0.05$.**

girls ($P = 0.190$). No such interaction of sex and repeated sedentary time ($P = 0.742$) was found in the TDI group (Fig. 4B), but girls were more sedentary than boys ($P = 0.023$) and more time was spent sedentary on the weekends ($P < 0.001$).

## DISCUSSION

The main finding of this study was that children with ID are considerably less physically active than TDI children. In addition, no difference between wPA and wePA was observed among the children with ID, but like others (18,22), we found wPA to be greater (34%) than wePA in the group of TDI children. As hypothesized, none of the children with ID met the recommendations for daily MVPA whereas 40% of the TDI children did so. However, contrary to our hypothesis, no sex differences were found in the group of children with ID on any PA variable, whereas most studies (18,22,30) on TDI children agree on boys being 15%–30% more physically active than girls. Compared with that in other studies on similar groups, a larger sample of children with ID was included here, and almost all children with ID that met the inclusion criteria in the metropolitan area of Reykjavík took part.

With objective measurements on PA, we confirmed that children with ID are less physically active than their TDI peers (17,26,33), although direct comparison with other studies is difficult because of differences in methodology. Most studies on children with ID have used more subjective measures of PA (13,17,32), and studies using accelerometers or HR monitors have been limited by very small sample sizes (9,26). We found TDI children to be 40% more active over the entire week, 44% are more active during workdays, and 25% are more active during weekends, and their activity

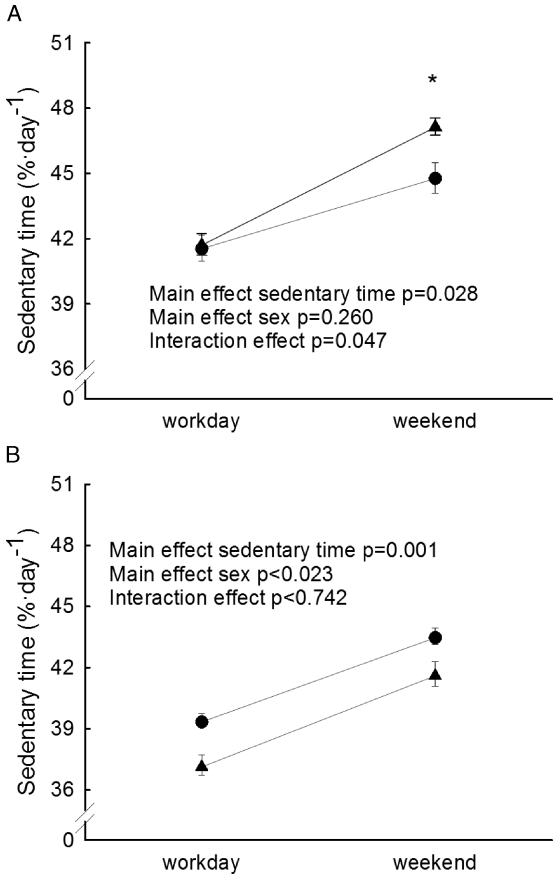


**FIGURE 4—Time spent sedentary during workdays and weekends among children with ID (A) and TDI children (B). Values are adjusted for Tanner stage. *Triangles*, boys; *circles*, girls. Interaction effect (group–sex–repeated sedentary time), $P = 0.159$; interaction effect (group–repeated sedentary time), $P = 0.919$; interaction effect (sex–repeated sedentary time), $P = 0.390$; interaction effect (group–sex), $P = 0.022$. *Statistical difference between workday and weekend within sex, $P < 0.05$.**

level was similar to previous reports on Icelandic children (18). None of the children with ID met the recommendation of 60 min of daily MVPA on average over an entire week. In contrast, 40% of TDI children met the recommendation on average over the entire week, which is a much higher proportion than that previously reported in this age group in Iceland (18). The present study used 2296 activity counts per minute to define MVPA (7,35,36), whereas the previous Icelandic study of TDI children used 3400 counts per minute (18). The differences between the studies are, thus, not surprising.

There are several probable explanations for the difference in PA between ID and TDI children. Inactive commuting to school, possibly because of safety reasons and their lack of understanding of the environment as well as longer travel distance to the centralized special school, plays a role in the low PA among the children with ID. Environmental factors such as distance to school are known to deter PA (14). In addition, fewer children with ID took part in organized sports after school than TDI children, and most of those doing so participated in low-intensity sport like Boccia. In metropolitan Reykjavík, there are three centralized sports clubs that offer programs for children with disability, which are nearly free of charge. Of these, only one focuses specifically on children with ID. Centralization means much longer travel time for the participants with ID to and from practice (14), and most of these children depend on their parents for commuting. Such centralization and dependence on parents for commuting are known barriers for sports participation (14). All these reasons play a role in the low PA among the children with ID, and although the same portion of children with ID and TDI children claim via self-reporting to be physically active during recess, it is apparent that when measured directly, the activity of children with ID is of much lower intensity. The differences in PA between the ID and TDI groups are much more likely to be of cultural and environmental origin than biological origin because athletes with ID, who have the opportunity to take part in sports, can reach the same fitness levels as TDI athletes (37).

Longer travel distance to centralized school and sport clubs could result in more time spent sedentary among the children with ID. Our findings indeed indicate that children with ID were more sedentary than their TDI peers, although the difference between the groups is lower (9%) than the difference in PA. Few studies have objectively assessed sedentary time in persons with ID, but our results support the findings of Dixon-Ibarra et al. (5), showing that adults with ID were 16%–20% more sedentary than TDI adults. We are not aware of any study comparing objectively measured sedentary time between children with and without ID; however, Foley and McCubbin (9) found, in contrast with our findings, no difference in subjectively reported sedentary time in their sample of nine children with ID compared with their TDI peers. To our knowledge, no studies have been published that compare time spent sedentary on workdays versus that on weekends among children with ID, and studies on TDI children find the sedentary time to be the same (28) or slightly less during the weekend (23), again in contrast with our findings. Although the differences were small, both groups of children in our study increased their sedentary time on the weekends compared with that on the workday.

Previously, males with ID have been shown to be more active than females with ID in a group of mostly adult and older individuals (26), but studies on sex differences in the ID population are scarce, especially among children. Our findings suggest that the patterns of PA and sex differences in PA are not the same among children with ID, as typically observed among their TDI peers. The reasons for the lack of sex differences in PA among the ID population are not readily apparent. According to Vu et al. (38), TDI boys are more socially accepted by peers if they are aggressive and athletic whereas TDI girls often perceive more PA as socially unacceptable. Children with ID may be less aware of sex-related social distinctions in PA, and sex identity may be less important among children with ID than among TDI children, especially among those with moderate-to-severe ID (2). The PA of children with ID was extremely low, and it can be speculated that we did not measure much more than the activities of daily living in this group of children, which makes it difficult to differentiate between the sexes. Indeed, far fewer bursts of high-intensity PA were observed in the ID group than that observed in the TDI group. Furthermore, more boys with ID were diagnosed with moderate-to-severe ID than girls with ID and PA is known to decline with increased level of ID (12), also explaining the lack of sex difference in PA.

This study also verifies that children with ID have higher prevalence of overweight and obesity (9,29,31) using age- and sex-specific cutoffs (3). The difference in BMI between the ID and TDI groups was not significant, which can be explained by much higher variability among children with ID. Similar results were found for waist circumference, where there was a small difference in the mean value, but more extreme values were observed for children with ID at both ends of the spectrum. In fact, the proportion (15%) of children with ID with elevated waist circumference (8,16) was three times greater than that in the TDI group. Nonetheless, much greater prevalence (48%) of elevated waist circumference was reported among 16- to 21-yr-old adolescents with ID (39). This higher prevalence can be explained partly by inclusion of participants with Down syndrome who experience greater levels of adiposity (11) and older participants because the prevalence of elevated waist circumference is known to increase with age (34). The differences in ΣSKF were the largest anthropometric differences found between the groups, although the range was similar. The group differences in BMI and ΣSKF indicate that the children with ID have less lean mass and more fat mass than TDI children. In contrast, athletes with ID who take part in competitive sports do not differ in body composition from their TDI peers (37), again suggesting that the differences are not necessarily biological. Such potential lack of biological difference demonstrates

the need to promote PA and healthy lifestyle for this population among the children themselves, parents, schools, and sport clubs. Children with ID need to have the opportunity to participate in PA (that fulfils their own potential) regardless of the level of their disability.

This study is not without limitations. First, the low number of girl participants with ID reduced the statistical power of the study. This low number was due to the fact that fewer girls are diagnosed with ID than boys (10), resulting in much fewer potential participants among girls with ID, making it hard to overcome this limitation. Secondly, because the ID group is more dependent on the social structure and support than the TDI group, the results may not be directly applicable to children with ID in other societies. We also have little information about parents or legal guardians of the participants, and it is possible that the parents of the children with ID are less encouraging of PA and thereby increase the PA difference between groups. We believe that the strengths of the study overcome its limitations. We were able to measure a much larger number of children with ID compared with previous studies on this population, and the dropout was less than 5%. Furthermore, we objectively measured PA and PA patterns including sedentary time with accelerometers among children with ID in the same way as that in a comparison group of TDI children. Finally, our sample consisted of almost all ambulatory children with ID in the metropolitan area of Reykjavík, which is inhabited by more than 70% of the Icelandic population.

In conclusion, the PA of children with ID is considerably lower than that among their TDI peers, and the fact that no children with ID meet the recommendation of daily MVPA calls for special PA measures in this group. Furthermore, there seem to be no sex differences in PA and PA patterns among children with ID. The extremely low PA among children with ID, which might only represent activity of daily living, may explain the lack of difference between wPA and wePA or between the sexes in this group. Further studies on promoting PA among children with ID are needed.

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# PAPER 2

# Hreyfing og líkamlegt ástand íslenskra grunnskólabarna með þroskahömlun

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## ÁGRIP

**Inngangur:** Lítið er vitað um hreyfingu, holdafar og áhættuþætti fyrir ýmsum hjarta-, æða- og efnaskiptasjúkdómum á meðal barna með þroskahömlun. Tilgangur þessarar rannsóknar var að kanna líkamlegt ástand grunnskólabarna með þroskahömlun.
**Efniviður og aðferðir:** Úrtak barna með þroskahömlun (n=91) og aldurs- og kynjajafnaður samanburðarhópur almennra skólabarna (n=93) voru mæld á hlutlægan hátt á hreyfingu, úthaldi, líkamssamsetningu, blóðþrýstingi, blóðfitum og blóðsykurstjórnun.
**Niðurstöður:** Börn með þroskahömlun voru lágvaxnari (-8,6 cm, p<0,001) en með hærri summu húðfellinga (22,7 mm, p<0,001), þanþrýsting (3,8 mmHG, p=0,006) og hlutfall líkamsfitu (4,0 prósentustig, p=0,008) en almenn skólabörn. Drengir með þroskahömlun voru með meira mittismál en almennir skóladrengir (6,3 cm, p=0,009) en enginn munur fannst á stúlknahópunum. Samkvæmt hlutfalli líkamsfitu greindist hærra hlutfall (41%) barna með þroskahömlun með offitu en almennra skólabarna (19%, p=0,006). Börn með þroskahömlun hreyfðu sig aðeins 24 mínútur á dag af miðlungs- til erfiðri ákefð en almenn skólabörn tæplega 60 mínútur. Ekkert barn með þroskahömlun náði ráðlagðri daglegri hreyfingu, á móti 40% hjá almennum skólabörnum. Einungis 25% barna með þroskahömlun náðu úthaldsviðmiðum, á móti 75% (p<0,001) almennra skólabarna. Rúmlega 20% barna með þroskahömlun voru með of hátt mittismál, 34% með of háan blóðþrýsting, á milli 13 og 21% greindust með áhættuþætti í blóði og tæplega 7% með efnaskiptavillu, sem var í öllum tilvikum mun hærra algengi en hjá almennum skólabörnum.
**Ályktanir:** Líkamlegt ástand barna með þroskahömlun er alls ekki gott og koma þau oftast verr út en jafnaldrar þeirra án þroskahömlunar. Það þarf að kanna vel hvaða ástæður liggja að baki þessari slæmu útkomu hjá þessum hópi og hvað er hægt að gera til að bæta ástandið.

## Inngangur

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Höfundar hafa útfyllt eyðublað um hagsmunatengsl.

Minnkandi hreyfing er eitt helsta heilbrigðisvandamál iðnríkja í dag, því hægt er að tengja hana við ýmsa áhættuþætti fyrir hjarta-, æða- og efnaskiptasjúkdóma, svo sem sykursýki 2 og kransæðavandamál.[1] Samhliða minnkandi hreyfingu eru ofþyngd og offita vaxandi alheimsvandamál og hafa Íslendingar ekki farið varhluta af þessari miklu aukningu undanfarna áratugi þó vissulega hafi dregið úr aukningunni allra síðustu ár.[2] Á milli 17 og 23% 9 og 15 ára íslenskra barna voru yfir kjörþyngd á árunum 2003 og 2004[3] og hafa rannsóknir auk þess sýnt að offita á unglingsárum eykur dánartíðni meira en ofþyngd á fullorðinsárum.[4]

Á sama tíma og gögnum er skipulega safnað um lýðheilsu hjá almennu þýði, hefur hingað til ekki verið unnið sérstaklega með gögn um börn með þroskahömlun. Þær fáu erlendu rannsóknir sem gerðar hafa verið hafa sýnt að meðal þessa hóps einstaklinga er staðan mun verri hvað varðar hreyfingu, holdafar og almennt heilsufar.[5,6] Að sama skapi hafa fáar rannsóknir verið gerðar á hreyfingu meðal barna og unglinga með þroskahömlun með hlutlægum mælingum. Flestar þeirra hafa verið með lítil úrtök (n<20) og sýna fram á allt að helmingi minni hreyfingu en hjá almennum skólabörnum.[7] Íslensk rannsókn á stóru úrtaki (n=91) barna með þroskahömlun sýndi fram á að þau hreyfa sig um 33% minna en almenn skólabörn og að hinn hefðbundni hreyfingarmunur á milli kynja og á milli virkra daga og helga fannst ekki hjá börnum með þroskahömlun.[8] Mjög fá börn með þroskahömlun virðast ná ráðlögðum viðmiðum um lágmarkstíma hreyfingar á miðlungs- til erfiðri ákefð (*moderate-to-vigorous physical activity*, MVPA).[8,9,10] Þó hefur verið sýnt fram á að með því að auka íþróttakennslu og virkni í frímínútum hjá börnum með þroskahömlun á skólatíma náðu allir þátttakendur ráðlögðum viðmiðum um MVPA á virkum dögum.[11]

Ungmenni með þroskahömlun hafa mælst með tvöfalt hærri tíðni ofþyngdar/offitu en almenn skólabörn[5,6] og hefur tíðnin farið yfir 40%. Minna er vitað um aðra áhættuþætti hjarta-, æða- og efnaskiptasjúkdóma hjá þessum hópi en sænsk rannsókn á 16-21 árs einstaklingum með þroskahömlun sýndi að sá hópur hafði mun hærri tíðni áhættuþátta fyrir hjarta-, æða- og efnaskiptasjúkdóma og var með lægra úthald en almenningur á sama aldri.[12] Það er einnig nokkuð vel þekkt að hátt hlutfall fullorðinna einstaklinga með þroskahömlun þjáist af hjarta-, æða- og efnaskiptasjúkdómum.[13]

Tilgangur þessarar rannsóknar var að kanna líkamlega heilsu grunnskólabarna með þroskahömlun með því að mæla beint helstu áhættuþætti hjarta-, æða- og efnaskiptasjúkdóma. Holdafar, úthald, hreyfing, blóðþrýstingur, blóðfita og blóðsykur voru mæld hjá börnunum og á sama tíma var aldurs- og kynjajafnaður samanburðarhópur almennra skólabarna mældur með sömu aðferðum. Tilgáta okkar var sú að börn með


**Mynd 1.** *Þátttaka og brottfall. ÞH = börn með þroskahömlun, ASB = almenn skólabörn, DXA = tvíorku-röntgengeislagleypnimæling, PWC170 = áreynslupróf neðan hámarks, $VO_{2max}$ hámarkssúrefnisupptaka. * = almennar líkamsmælingar, hreyfing og blóðþrýstingur.*

þroskahömlun á Íslandi hefðu meiri áhættu á að þróa með sér hjarta-, æða- og efnaskiptasjúkdóma en almenn skólabörn.

### Efniviður og aðferðir

Öllum börnum með þroskahömlun, sem uppfylltu skilyrði til þátttöku, frá einum sérskóla fyrir börn með þroskahamlanir og fjórum grunnskólum þar sem ýmist voru blandaðir bekkir og/eða sérdeildir var boðin þátttaka (mynd 1). Þátttökuskilyrði voru þau að börnin væru með greiningu um þroskahömlun frá Greiningarstöð ríkisins og væru fær um að hjóla á þrekhjóli. Sextíu og tvö prósent barnanna komu frá sérskóla þar sem einungis börn með meðalmikla til mikla þroskahömlun fá inngöngu og 38% frá almennum grunnskólum og voru með milda til meðalmikla þroskahömlun. Þrjú barnanna með þroskahömlun voru með milda heilalömun (*cerebral palsy*) en gátu vel hjólað á þrekhjóli og að auki tóku fjögur börn lyf, (Lamotrin, Abilfy) til að vinna gegn flogaveiki, sem hugsanlega gátu haft áhrif á vilja þeirra til almennrar hreyfingar. Handahófsvöldum aldurs- og kynjajöfnuðum viðmiðunarhópi af almennum skólabörnum var einnig boðin þátttaka (mynd 1). Allir þátttakendur og/eða forráðamenn skrifuðu undir upplýst samþykki. Rannsóknin var tilkynnt til Persónuverndar og samþykkt af Vísindasiðanefnd (VSNB 2010120007/03.7)

Mælingarnar fóru fram í skólunum sjálfum, nema mæling á líkamssamsetningu (*body composition*) sem fór fram í Hjartavernd, sem og blóðtaka. Hæð var mæld þrívegis með nákvæmni upp á einn millimetra með hæðarmæli (Seca206) og þyngd var einnig mæld þrívegis með vog (Seca703) með 100g nákvæmni. Líkamsþyngdarstuðull (*body mass index*, BMI) var reiknaður út og börnunum svo skipt í holdafarsflokka eftir alþjóðlegum viðmiðum.[14] Börnin voru léttklædd og skólaus við holdafarsmælingarnar. Mittismál var mælt þrisvar í láréttu plani með óteygjanlegu málbandi (Gulick) með nákvæmni upp á einn millimetra þar sem mittið er grennst á milli neðstu rifja og mjaðmarkambs og þeim skipt í áhættuflokka eftir alþjóðlegum viðmiðum.[15,16] Húðfellingar voru mældar þrisvar sinnum að næsta mm á fjórum stöðum (þríhöfða, tvíhöfða, neðan herðablaðs og ofan mjaðmarkambs) hægra megin á líkamanum og meðaltal hvers mælistaðar reiknað og þau svo lögð saman til að finna út heildarsummu húðfellinganna. Líkamssamsetning var mæld með tvíorku-röntgengeislagleypnimælingu (*dual energy X-ray absorptiometry*, DXA) með Lunar beinþéttnimæli. Út frá hlutfalli líkamsfitu var börnunum einnig skipt í holdafarsflokka.[17]

Til að meta úthald var hámarkssúrefnisupptaka (*maximal oxygen uptake*, $VO_{2max}$) mæld (Parvomedics Trumax2400) með stigvaxandi hámarksáreynsluprófi á þrekhjóli. Börnin hjóluðu á stöðugum pedalasnúningshraða og var álagið í wöttum (W) aukið um byrjunarálagið á þriggja mínútna fresti. Börn undir 30 kg fengu 20W í byrjunarálag en annars fengu 10 ára og yngri 25W í byrjun og 11-12 ára 30W. Drengir 13-14 ára fengu 40W í byrjun á meðan stúlkur á sama aldri fengu 35W og 15-16 ára drengir fengu 50W en stúlkur á sama aldri 40W í byrjun. Á meðan á prófinu stóð var hjartsláttur barnanna mældur með hjartsláttarmæli (Polar FT7) og fylgst með líðan barnanna, þau hvött til að gera sitt besta en jafnframt minnt á að þau gætu hætt hvenær sem var. Til að ákvarða hvort $VO_{2max}$ væri náð var beitt aðferð sem áður hefur verið lýst.[18] Til að tryggja að hægt væri að bera saman úthald allra (líka þeirra sem ekki vildu tengjast súrefnisupptökutækinu eða uppfylltu ekki skilyrði um $VO_{2max}$, (mynd 1)) var álagið við 170 slög á mínútu jafnframt skráð og notað sem áreynsluprófneðan hámarks (Physical Work Capacity at heart rate 170 beats/min, PWC170). Niðurstöður úr PWC170 voru svo notaðar til að áætla $VO_{2max}$ samkvæmt þekktri jöfnu[19] og börnunum var skipt í flokka eftir alþjóðlegum viðmiðum.[20,21] Við flokkunina var mæld $VO_{2max}$ notuð hjá þeim sem henni náðu en áætluð $VO_{2max}$[19] notuð fyrir þau börn sem einungis náðu að ljúka PWC170 prófinu.

Hreyfing var mæld með Actigraph hröðunarmælum (GT1M) í 7-10 daga allan daginn, nema þegar þátttakendur sváfu eða fóru í sturtu/bað eða í sund og þurftu að minnsta kosti að vera þrír virkir dagar og einn helgardagur með að minnsta kosti 8 klukkustundir af gögnum á mælunum til að gögnin yrðu notuð við tölfræðilega úrvinnslu. Til að meta neðri mörk MVPA var notast við 2296 slög/mín.[22] Allar mínútur sem börnin voru yfir þessum mörkum voru svo lagðar saman fyrir hvern dag og að lokum var meðaltal allra daganna reiknað. Þannig var metið hvort börnin uppfylltu hreyfiráðleggingar Embættis landlæknis sem miðast við klukkustund á dag af MVPA.

Blóðþrýstingur var mældur þrívegis með blóðþrýstingsmæli (ADC Advantage 6013) eftir að þátttakandi hafði setið rólegur í 10 mínútur og börnunum var skipt í flokka eftir alþjóðlegum viðmiðum.[15,23] Tekin var fastandi blóðprufa og heildarkólesteról, háþéttnifituprótein (*high-density lipoprotein* (HDL), þríglýseríð, blóðsykur og insúlín mæld og lágþéttnifituprótein (*low-density lipoprotein* LDL) voru svo reiknuð út samkvæmt jöfnu Friedewald.[24] Börnunum var síðan skipt í áhættuflokka eftir alþjóðlegum viðmiðum um heildarkólesteról,[25] HDL,[15] LDL,[26] þríglýseríð[15, 27] og blóðsykur.[15] Þátttakendur töldust vera með efnaskiptavillu (*metabolic syndrome*) ef þrjár af eftirtöldum fimm breytum voru utan viðmiða: mittismál, blóðþrýstingur, HDL, þríglýseríð og blóðsykur.[15]

Unnið var úr gögnunum með tölfræðiforritinu SPSS (Statistical Package for the Social Sciences, útgáfa 15.0). Fyrst voru gögnin skoðuð með tilliti til normaldreifingar og breytunum þyngd, MVPA, insúlíni og HDL var kvaðratvarpað en lógaritminn tekinn af BMI, þríglýseríðum og LDL til að uppfylla skilyrði um normaldreifingu. Tvíbreytudreifigreining (*Two-Way ANOVA*) var notuð

**Tafla I.** *Líkamlegir eiginleikar þátttakenda.*

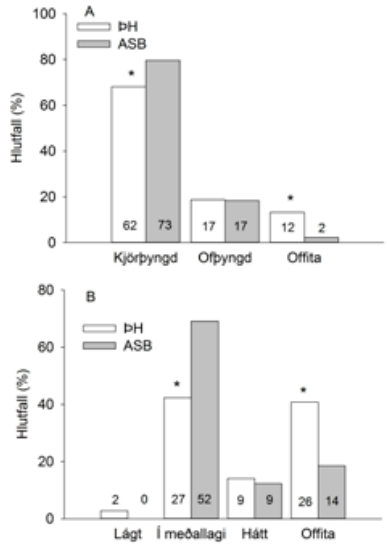
| | ÞH drengir n=62 | ASB drengir n=58 | ÞH stúlkur n=29 | ASB stúlkur n=35 | Allir ÞH n=91 | Öll ASB n=93 |
|---|---|---|---|---|---|---|
| Aldur (ár) | 11,8 (2,8) | 11,9 (2,9) | 11,9 (2,6) | 12,0 (2,3) | 11,9 (2,9) | 11,9 (2,7) |
| Þyngd (kg) | 47,7(21,0) | 47,1 (16,5) | 43,1 (14,3) | 49,9 (12,0) | 46,2 (19,2) | 48,2 (15,0) |
| Hæð (cm) | 149,1 (18,4) | 155,7 (20,7) | 144,1 (14,6) | 156,7 (13,9) | 147,5 (17,4) | 156,1 (18,3)* |
| BMI (kg/m$^2$) | 20,6 (5,6) | 18,7(2,8) | 20,3 (4,3) | 20,1 (2,9) | 20,5 (5,2) | 19,2 (2,9) |
| Húðf. (mm) | 75,6 (45,1) | 45,9 (29,7) | 83,7 (31,5) | 71,2 (25,7) | 78,2 (41.3) | 55.5 (30.7)*† |
| Mittismál (cm) | 71,1 (16,1) | 64,8 (8,3)a | 66,1 (9,9) | 67,3 (8,3) | 69,5 (14,6) | 65,7 (8,4)*‡ |
| Slagþr. (mmHG) | 116,0 (9,5) | 112,2 (7,8) | 114,5 (7,0) | 115,1 (5,3) | 115,5 (8,8) | 113,3 (7,1) |
| Þanþr. (mmHG) | 75,7 (7,6) | 71,6 (8,2) | 71,8 (6,8) | 69,3 (7,2) | 74,5 (7,6) | 70,7 (7,9)*† |
| | n=48 | n=49 | n=23 | n=32 | n=71 | n=81 |
| Líkamsfita (%) | 28,5 (10,4) | 22,7 (5,8) | 31,5 (8,1) | 29,7 (5,8) | 29,5 (9,8) | 25,5 (7,5)*† |

ÞH = börn með þroskahömlun, ASB = almenn skólabörn, BMI = líkamsþyngdarstuðull, ΣHúðf. = summa húðfellinga, Slagþr. = efri mörk blóðþrýstings, Þanþr. = neðri mörk blóðþrýstings, * = Munur á milli hópa p<0,05, † = munur á milli kynja p<0,05, ‡ = víxlverkun milli hópa og kynja p<0,05, a = munur á drengjum með þroskahömlun og almennum skóladrengjum p<0,05.

til að bera saman hópa og kyn og til að meta víxlverkun (*interaction*) á milli þessara breyta. Þegar víxlverkun fannst var munur á hópum innan kyns skoðaður. Krosstöflur (*crosstabs*) voru notaðar til að skoða dreifingu hópanna í flokka viðmiðunargildanna og kí-kvaðrat (*chi-square*) notað til að meta hvort marktækur munur væri á milli hópanna. Gögnin eru birt sem óvörpuð meðaltöl og staðalfrávik og tölfræðileg marktækni var sett við p<0,05.

## Niðurstöður

Niðurstöður almennra líkamsmælinga, blóðþrýstings og hlutfalls líkamsfitu má sjá í töflu I. Almenn skólabörn voru hávaxnari (8,6 cm, p<0,001) en höfðu lægri summu húðfellinga (-22,7 mm, p<0,001), neðri mörk blóðþrýstings (-6,3 mmHG, p=0,006) og hlutfall af líkamsfitu (-4,0 prósentustig, p=0,008) en börn með þroskahömlun. Þvert á hópa höfðu drengir lægri summu húðfellinga (-15,7 mm, p=0,006), hærri neðri mörk blóðþrýstings (3,3 mmHG, p=0,007) og lægra hlutfall líkamsfitu (-4,9 prósentustig, p<0,001) en stúlkur. Víxlverkun fannst á mittismáli (p=0,024) þar sem drengir með þroskahömlun voru með hærra mittismál en almennir skóladrengir (6,3 cm, p=0,009) en enginn marktækur munur fannst hjá stúlkunum (p=0,601). Samkvæmt BMI flokkuðust marktækt fleiri börn með þroskahömlun of feit, eða 13% á móti 2% hjá almennum skólabörnum, og færri í kjörþyngd (p=0,017, mynd 2A). Á mynd 2B sést flokkun barnanna eftir hlutfalli líkamsfitu (mælt með DXA) en mun fleiri börn með þroskahömlun flokkuðust of feit (41% á móti 19% hjá almennum skólabörnum) og mun færri flokkuðust í meðallagi (43% á móti 69% hjá almennum skólabörnum, p=0,006).



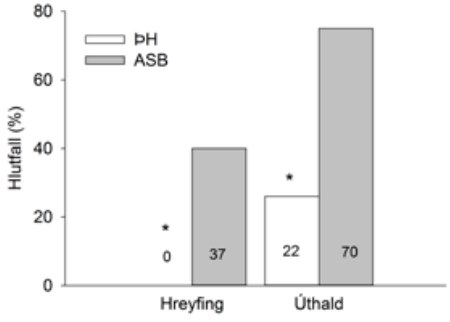

**Mynd 2.** *Holdafarsflokkun þátttakenda samkvæmt líkamsþyngdarstuðli (A) og hlutfalli líkamsfitu (B). Tölurnar í súlunum sýna fjölda einstaklinga. ÞH = börn með þroskahömlun, ASB = almenn skólabörn, * = munur á milli hópa p<0,05.*

Í töflu II má sjá mælda hreyfingu og úthald þátttakenda. Víxlverkun kom fram í MVPA (p=0,002) sem fólst í að munurinn

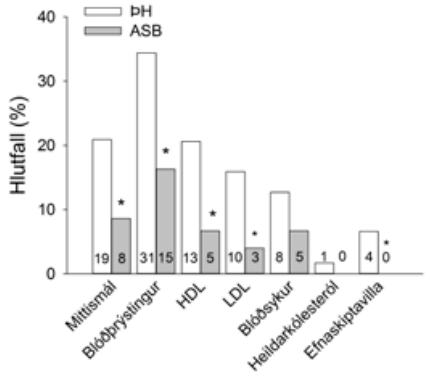
**Tafla II.** *Hreyfing og úthald þátttakenda.*

| | ÞH drengir n=62 | ASB drengir n=58 | ÞH stúlkur n=29 | ASB stúlkur n=35 | Allir ÞH n=91 | Öll ASB n=93 |
|---|---|---|---|---|---|---|
| MVPA (mín) | 24,3 (15,9) | 65,9 (28,6)a | 24,7 (12,8) | 44,9 (22,9)b | 24,4 (14,9) | 57,9 (28,4)*‡† |
| | n=26 | n=45 | n=12 | n=31 | n=38 | n=76 |
| $VO_{2max}$ (ml/mín/kg) | 36,3 (6,2) | 44,82 (5,85) | 35,39 (3,74) | 39,55 (4,01) | 36,02 (5,34) | 42,67 (5,77)*† |
| | n=55 | n=58 | n=26 | n=35 | n=81 | n=93 |
| PWC170 (w/kg) | 1,46 (0,43) | 1,93 (0,37) | 1,38 (0,40) | 1,66 (0,32) | 1,43 (0,42) | 1,83 (0,38)*† |
| Áætlað[19] $VO_{2max}$ (ml/mín/kg) | 35,28 (6,2) | 42,06 (5,35) | 34,07 (5,77) | 38,13 (4,60) | 34,89 (6,03) | 40,58 (5,41)*† |

ÞH = börn með þroskahömlun, ASB = almenn skólabörn, MVPA = hreyfing af miðlungs- til erfiðri ákefð * = Munur á milli hópa p<0,05, † = munur á milli kynja p<0,05, ‡ = víxlverkun milli hópa og kynja p<0,05, a = munur á drengjum með þroskahömlun og almennum skóladrengjum p<0,05, b = munur á stúlkum með þroskahömlun og almennum skólastúlkum p<0,05.




**Mynd 3.** *Hlutfall þátttakenda sem náðu ráðlagðri hreyfingu MVPA og viðmiðum um úthald. Tölurnar í súlunum sýna fjölda einstaklinga.*
*ÞH = börn með þroskahömlun, ASB = almenn skólabörn, * = munur á milli hópa p<0,05.*




**Mynd 4.** *Hlutfall þátttakenda yfir/undir ráðlögðum mörkum fyrir ýmsa áhættuþætti hjarta, æða- og efnaskiptasjúkdóma. Tölurnar í súlunum sýna fjölda einstaklinga.*
*ÞH = börn með þroskahömlun, ASB = almenn skólabörn, HDL = háþéttnifituprótein, LDL = lágþéttnifituprótein, *= munur á milli hópa p<0,05.*

á drengjahópunum var tvöfalt meiri (42 mínútur) en munurinn á stúlknahópunum (20 mínútur). Mikill munur var á úthaldi þátttakenda eftir því hvorum hópnum þeir tilheyrðu, sama hvaða mæliaðferð var notuð. Almenn skólabörn voru með marktækt betra úthald samkvæmt $VO_{2max}$ (6,65 ml/mín/kg, p<0,001), PWC170 (0,40 W/kg, p<0,001) og áætlaðri $VO_{2max}$ (5,69 ml/mín/kg, p<0,001) en börn með þroskahömlun. Eins voru drengir með betra úthald en stúlkur samkvæmt $VO_{2max}$ (3,31 ml/mín/kg, p=0,005), PWC170 (0,16 w/kg, p=0,001) og áætlaðri $VO_{2max}$ (2,36 ml/mín/kg, p=0,001) þvert á hópa.

Á mynd 3 má sjá hve hátt hlutfall þátttakenda frá hvorum hópi fyrir sig náði ráðlagðri hreyfingu dag hvern og viðmiði um úthald. Ekkert barn með þroskahömlun náði ráðlagðri hreyfingu að meðaltali yfir alla vikuna á meðan um 40% almennra skólabarna gerði það (p<0,001) og einungis tæplega 26% barna með þroskahömlun náði viðmiði um úthald á meðan um 75% almennra skólabarna náði því viðmiði (p<0,001).

Lítill munur var á blóðsýnum þátttakenda (tafla III). Aðeins á insúlíni fannst víxlverkun þar sem drengir með þroskahömlun voru marktækt hærri (2,44 µU/mL, p=0,026) en almennir skóladrengir en enginn munur var á milli hópanna hjá stúlkunum (p=0,457).

Hlutfall þátttakenda sem voru yfir/undir ráðlögðum mörkum ýmissa áhættuþátta hjarta-, æða- og efnaskiptasjúkdóma má sjá á mynd 4. Fyrir utan þríglýseríð og insúlín þar sem engir þátttakendur greindust með of há gildi, greindust oftast mun fleiri börn með þroskahömlun með of há/lág gildi en almenn skólabörn. Rúmlega 20% þroskahamlaðra barna mældist með of mikið mittismál en einungis um 8% almennra skólabarna (p=0,019), 34% barna með þroskahömlun voru með of háan blóðþrýsting á móti 16% almennra skólabarna (p=0,004), 21% barna með þroskahömlun var með of lágt HDL á móti 6% almennra skólabarna (p=0,015) og 16% barna með þroskahömlun mældust með of hátt LDL en 4% almennra skólabarna (p=0,021) en ekki reyndist marktækur munur (p=0,227) á blóðsykri á milli hópanna. Eitt barn með þroskahömlun greindist svo með of hátt gildi heildarkólesteróls en ekkert almennu skólabarnanna. Að sama skapi greindist ekkert almennu skólabarnanna með efnaskiptavillu en tæplega 7% barna með þroskahömlun (p<0,001).

## Umræður

Helstu niðurstöður þessarar rannsóknar voru þær að íslensk grunnskólabörn með þroskahömlun komu mun verr út en almenn skólabörn hvað holdafar, hreyfingu og úthald varðar og nokkuð verr hvað blóðsýni varðar. Tæplega 33% barna með þroskahömlun voru of þung eða of feit samkvæmt BMI en um 55% sömu barna voru með of hátt hlutfall líkamsfitu eða of feit samkvæmt DXA. Ekkert barn með þroskahömlun náði ráðlagðri hreyfingu að meðaltali yfir vikuna og einungis um 25% náðu viðmiðum fyrir úthald. Rúmlega 20% barna með þroskahömlun voru með of mikið mittismál, 34% með of háan blóðþrýsting, 21% með of lágt HDL, 16% með of hátt LDL, 13% með of háan blóðsykur, 2% með of hátt kólesteról og tæplega 7% barna greindist svo með efnaskiptavillu.

**Tafla III.** *Blóðfitur og blóðsykurstjórnun þátttakenda.*

| | ÞH drengir n=43 | ASB drengir n=45 | ÞH stúlkur n=20 | ASB stúlkur n=30 | Allir ÞH n=63 | Öll ASB n=75 |
|---|---|---|---|---|---|---|
| Kólesteról (mmol/L) | 4,24 (0,81) | 4,21 (0,63) | 4,38 (1,09) | 4,31 (0,20) | 4,29 (0,90) | 4,25 (0,63) |
| HDL (mmol/L) | 1,49 (0,42) | 1,66 (0,32) | 1,56 (0,34) | 1,56 (0,29) | 1,51 (0,39) | 1,62 (0,31) |
| LDL (mmol/L) | 2,47 (0,81) | 2,30 (0,56) | 2,53 (1,01) | 2,41 (0,64) | 2,49 (0,87) | 2,35 (0,59) |
| Þríglýseríð (mmol/L) | 0,64 (0,23) | 0,56 (0,22) | 0,67 (0,31) | 0,74 (0,20) | 0,65 (0,26) | 0,63 (0,23) |
| Blóðsykur (mmol/L) | 5,10 (0,46) | 5,07 (0,39) | 5,12 (0,48) | 4,95 (0,33) | 5,10 (0,47) | 5,02 (0,37) |
| Insúlín (µU/mL) | 9,57 (5,95) | 7,13 (3,99)[a] | 9,07 (4,44) | 10,29 (5,15) | 9,42 (5,49) | 8,39 (4,72)‡ |

ÞH = börn þroskahömlun, ASB = almenn skólabörn, Kólesteról = heildarkólesteról, HDL = háþéttnifituprótein, LDL = lágþéttnifituprótein, ‡ = víxlverkun milli hópa og kynja p<0,05, a = munur á drengjum með þroskahömlun og almennum skóladrengjum p<0,05.

Mikill munur var á holdafari milli hópanna. Börn með þroskahömlun voru með 20% hærra hlutfall af líkamsfitu og um 40% hærri summu húðfellinga. Nærri helmingi fleiri börn með þroskahömlun greindust með offitu en almenn skólabörn, sé miðað við hlutfall líkamsfitu og ef BMI-stuðullinn var notaður voru þriðjungi fleiri börn með þroskahömlun flokkuð í ofþyngd eða offitu. Óvenju lágt hlutfall almennra skólabarna greindist með offitu samkvæmt BMI og eru tölur í þessari rannsókn áþekkar því sem mældust hjá börnum á þessum aldri fyrir 10-30 árum síðan.[2,3] Ekki er ljóst hvort þessar niðurstöður gefa til kynna að tíðni offitu fari lækkandi eða hvort þetta úrtak hafi verið óvenju grannt en munurinn á hópunum væri samt mikill þótt um 5% samanburðarhópsins hefði flokkast of feitur eins og nýjustu tíðnitölur á höfuðborgarsvæðinu gefa til kynna.[2] Niðurstöðurnar hjá börnum með þroskahömlun eru sambærilegar þeim sem fundist hafa í erlendum rannsóknum en þar voru 40% barna með þroskahömlun flokkuð í ofþyngd eða offitu og voru allt að helmingi líklegri til að vera í þessum flokkum en almenn skólabörn.[5,6] Lítið er vitað um þróun þessara mála á meðal þroskahamlaðra á Íslandi undanfarin ár, en nýjar rannsóknir á almennum skólabörnum benda til að nokkuð sé að draga úr fjölgun barna með offitu eftir mikla aukningu síðustu áratugi.[2]

Hreyfiráðleggingar Embættis landlæknis segja til um 60 mínútur á dag af MVPA, en börn með þroskahömlun ná aðeins um 24 mínútum á dag á meðan almenn skólabörn ná tæplega 60 mínútum. Það er erfitt að bera þessar tölur saman við aðrar rannsóknir þar sem viðmiðin um hvernig skuli meta MVPA eru nokkuð breytileg á milli landa og tímaskeiða en þessi rannsókn staðfestir það sem margar aðrar rannsóknir á minni þýðum hafa sýnt, að sá tími sem börn með þroskahömlun ná af MVPA er oftast minni en hjá almennum skólabörnum.[7] Áður birtar niðurstöður á sama úrtaki þroskahamlaðra barna sýndi að hreyfing þeirra var almennt mjög lítil, lítið var um lotur af miklu álagi og ályktanir dregnar um að hreyfingin hafi að mestu verið til að sinna daglegum þörfum.[8] Ekkert barn náði ráðlagðri hreyfingu að meðaltali á dag, miðað við rúmlega 40% almennra skólabarna, sem er í samræmi við rannsóknir Foley og McCubbin.[7] Að hluta til má skýra minni hreyfingu barna með þroskahömlun með því að þau eru mun oftar keyrð til og frá skóla meðan algengara er að almenn skólabörn gangi eða hjóli í skólann.[8]

Börn með þroskahömlun mældust með mun minna úthald en almenn skólabörn. Almennu skólabörnin mældust þó með tölurvert minna úthald en í íslenskri rannsókn sem gerð var fyrir 10 árum síðan á 9 og 15 ára börnum.[18] Börnin með þroskahömlun vildu einnig síður tengjast við súrefnisupptökutækið og voru það oftar börn með sýnilega meiri fötlun en hin. Þau börn sem ekki náðu að uppfylla skilyrðin fyrir $VO_{2max}$ voru marktækt verri (p=0,013) á PWC170 en þau sem náðu að uppfylla skilyrðin. Því er líklegt að neikvæð tengsl séu á milli stigs þroskahömlunar og úthalds á svipaðan hátt og Lotan og félagar [28] fundu í sinni rannsókn. Einungis 25% barna með þroskahömlun náðu svo viðmiðum um æskilegt úthald á meðan 75% almennra skólabarna náðu því. Það hefur áður verið sýnt fram á að íslensk ungmenni séu almennt með gott úthald[29] og ekki verra en gengur og gerist hjá nágrannaþjóðunum[18] en miklu minna hefur verið vitað um úthald barna með þroskahömlun. Árangur íþróttamanna með þroskahömlun í keppnisíþróttum sýnir samt að þeir virðast geta náð góðu úthaldi. Jafnframt hefur verið sýnt að einstaklingar með þroskahömlun sem byrja að stunda meðalerfiða líkamsrækt eins og göngu, bæta úthald sitt marktækt á tveim mánuðum.[28]

Þanþrýstingur barna með þroskahömlun mældist hærri en hjá almennum skólabörnum og flest börnin með þroskahömlun sem flokkuðust með blóðþrýsting yfir viðmiðum greindust á þanþrýstingi. Meðalgildin fyrir blóðþrýsting í þessari rannsókn voru nokkru lægri en í sænskri rannsókn á unglingum með þroskahömlun[12] og í íslenskri rannsókn á ungmennum[29] en einstaklingarnir í þeim rannsóknum voru talsvert eldri, eða um 18 ára gamlir. Hins vegar greindist mun hærra hlutfall þátttakenda í þessari rannsókn með hækkaðan blóðþrýsting (34% barna með þroskahömlun og 16% almennra skólabarna). Innan við 15% sænskra unglinga með þroskahömlun greindust með hækkaðan blóðþrýsting[12] og um 10% íslenskra ungmenna.[29] Hafa verður í huga að þrátt fyrir að viðmiðin sem notuð voru fyrir hækkaðan blóðþrýsting hafi verið kynja- og aldursstöðluð, þótti sumum börnunum með þroskahömlun ekki þægilegt að láta mæla blóðþrýstinginn. Það gæti hugsanlega hafa valdið því að þau slökuðu ekki nægjanlega vel á og þess vegna hafi blóðþrýstingur mælst hærri en ella.

Þótt ekki hafi mælst marktækur munur á meðalgildum barna með þroskahömlun og almennra skólabarna á neinni af blóðbreytunum, voru mun fleiri börn með þroskahömlun greind með gildi utan viðmiða en gerðist hjá almennu skólabörnunum. Almenn skólabörn í þessari rannsókn voru mun yngri en í rannsókn þar sem um 9% greindust með HDL og LDL utan viðmiða[29] sem er heldur hærra en í þessari rannsókn. Hins vegar greindust 16 og 21% barna með þroskahömlun í þessari rannsókn með HDL og LDL utan viðmiða sem meðal annars eykur líkurnar á æðakölkun.[29] Sænsk rannsókn[12] á unglingum með þroskahömlun greindi 64% einstaklinga með að minnsta kosti eitt af þeim gildum sem skilgreina efnaskiptavillu utan marka en þessi rannsókn greinir 57% barna með þroskahömlun á sama hátt og 7% barna með þroskahömlun í þessari rannsókn greindust með efnaskiptavillu.

Þessi rannsókn er ekki án veikleika. Fáar stúlkur voru í hópi þroskahamlaðra, sem skýra má með almennt færri greiningum á þroskahömlun meðal stúlkna,[30] og gerði það að verkum að stundum vantaði afl í tölfræðina. Einnig luku færri börn með þroskahömlun $VO_{2max}$ og blóðtökunni en almenn skólabörn, sökum fötlunar þeirra. Börn með þroskahömlun eru líka oft mun háðari umhverfi sínu en almenn skólabörn, svo ekki er víst að þessar niðurstöður séu yfirfæranlegar á þroskahömluð börn sem lifa við annarskonar samfélagsgerð. Við teljum þó að styrkleikarnir vegi þyngra. Úrtak barna með þroskahömlun var stórt samanborið við aðrar rannsóknir, allar mælingar voru gerðar á hlutlægan hátt á sama tíma og á sama hátt fyrir báða hópana og mjög lítið brottfall var úr rannsókninni.

## Ályktanir

Niðurstöður þessarar rannsóknar benda til þess að líkamlegt ástand, svo sem holdafar, úthald, hreyfing og flestir áhættuþættir

hjarta-, æða- og efnaskiptasjúkdóma hjá börnum með þroskahömlun sé alls ekki gott þrátt fyrir ungan aldur. Börn með þroskahömlun hafa fleiri áhættuþætti hjarta-, æða- og efnaskiptasjúkdóma en jafnaldrar þeirra án þroskahömlunar, sem getur leitt til slæmrar heilsu síðar á lífsleiðinni. Það þarf að kanna betur orsakirnar sem liggja að baki þessari slæmu útkomu hjá þessum hópi svo hægt sé að veita ráðgjöf og meðferð til að fyrirbyggja óhagstæða áhættuþætti, til dæmis með markvissum íhlutunum. Það má því álykta að skóla- og heilbrigðiskerfið þurfi að taka höndum saman til að auka hreyfingu og bæta úthald, holdafar og almennt líkamlegt ástand hjá þessum börnum með þroskahömlun.

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## ENGLISH SUMMARY

### Physical activity and physical condition of Icelandic primary and secondary school children with intellectual disability

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**Introduction:** Little is known about physical activity, body composition and metabolic risk factors among children with intellectual disability (ID). The purpose of this study was to investigate their physical condition.
**Material and methods:** Children with ID (n=91) and a randomly selected age-and-gender matched group of 93 typically developed individuals (TDI) participated and the groups were compared on physical activity, fitness, body composition, blood pressure, blood lipids, and glycemic control.
**Results:** Children with ID were shorter (-8.6 cm, p<0.001), had greater skinfolds (p<0.001), diastolic blood pressure (22.7 mm, p=0,006), and body fat percentage (4.0 percentage points, p=0.008) than TDI children. Boys with ID had larger waist circumference than TDI boys (6.3 cm, p=0.009) but no difference was found among the girls. Higher proportion (41%) of children with ID than TDI children (19%) were categorized as obese (p=0.006) based on body fat percentage. No children with ID reached the recommended daily 60 minutes of moderate- to vigorous physical activity compared to 40% of the TDI children. Only 25% of children with ID achieved the recommended levels for fitness, whereas the same proportion was 75% among TDI children. Over 20% of the children with ID had elevated waist circumference, 34% elevated blood pressure, 13-21% elevated metabolic risk factors in the blood, and 7% were diagnosed with metabolic syndrome. These prevalences were lower among the TDI children.
**Conclusion:** Physical condition of children with ID is poor and inferior to their TDI peers. Further studies are needed to investigate the reasons underlying the poor physical health among children with ID and how it can most effectively be enhanced.

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**Key words:** *children, intellectual disability, MVPA, body composition, aerobic fitness, metabolic risk factors.*

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# PAPER 3

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# Physical activity during school and after school among youth with and without intellectual disability

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ABSTRACT

*Background:* Little is known about physical activity (PA) among children with intellectual disability (ID) or their reasons to take part in PA and sport.
*Aims:* To investigate PA and PA patterns during school and after school among Icelandic children with mild-to-severe ID.
*Methods and procedures:* Ninety-one children with ID and a matched group of 93 typically developed individuals (TDI) took part. PA was assessed with accelerometers and a questionnaire was used to collect data on PA behavior.
*Results and outcomes:* TDI children were more active and less sedentary than children with ID ($p < 0.001$). Both sexes with ID were more active and less sedentary during school than after school ($p < 0.003$) but no difference was found among TDI children. Children with ID (60%) were more likely to name weight loss as a reason to participate in PA than TDI children (34%, $p = 0.002$) but a higher proportion (96%) of TDI children than children with ID (50%) participated in PA to improve skills ($p < 0.001$).
*Conclusion and implications:* Children with ID depend more on schools to accumulate their PA and their reasons for PA participation differ from TDI children. This needs to be considered when designing and implementing PA promotion campaigns for children with ID.



## What this paper adds

This paper includes a large sample of children with intellectual disability (ID) and a randomly selected age- and sex-matched comparison group of typically developed individuals (TDI). All participants were objectively assessed at the same time with the same protocols by the same persons. The different patterns observed between the two groups during- and after school hours have to our knowledge not been reported before. Children with ID depend more on the schools to accumulate their physical activity (PA) and moderate-to-vigorous PA (MVPA) than their TDI peers. Further, children with ID are less sedentary during school hours than after school hours but the opposite is observed among TDI children. Children with ID were more likely to name factors related to negative body image such as losing- or not gaining weight as reasons for PA and sport participation, whereas a much higher proportion of TDI children named sport performance or improvement-related

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factors. Despite a large difference in measured PA, no statistical difference was found between the two groups in self-assessed PA. These findings indicate that children with ID and their families are less aware of their level of PA and its importance, especially MVPA and thus overestimate their PA. Our results need to be considered when PA promotion campaigns are designed and implemented for this vulnerable group of children.

## 1. Introduction

Physical activity (PA) has shown a positive relationship with health, and a negative relationship with obesity and the opposite has been found for sedentary behavior (Mitchell et al., 2009). Fewer and fewer typically developed individuals (TDI) meet the recommended guidelines of 60 min/day of moderate to vigorous PA (MVPA) (Ortega et al., 2013; Riddoch et al., 2004) needed to maintain good health (Nader, Bradley, Houts, McRitchie, & O'Brien, 2008; Riddoch et al., 2004). Correspondingly, sedentary behavior has increased during the past few decades (Pate, Mitchell, Byun, & Dowda, 2011) and today children spend 4–8 h every day sedentary (Pate et al., 2011) or around 40% of their waking time (Syvaoja et al., 2013). Children and adolescents 6–16 years old spend a large amount of their waking time on weekdays at school, and although they accumulate 5–61% of their MVPA during school hours, they spend 65–71% of their day sedentary (Bailey et al., 2012; Guinhouya et al., 2009; Taylor et al., 2011; Li et al., 2013).

Studies of PA among persons with intellectual disability (ID) generally concur that this population is less physically active (Foley & McCubbin, 2009; Hinckson, Dickinson, Water, Sands, & Penman, 2013; Peterson, Janz, & Lowe, 2008) and is more obese (De, Small, & Baur, 2008; Einarsson, Olafsson et al., 2015; Melville, Hamilton, Hankey, Miller, & Boyle, 2007; Reinehr, Dobe, Winkel, Schaefer, & Hoffmann, 2010) than the TDI population and that PA declines with increased level of ID (Hinckson & Curtis, 2013). Similarly, sedentary time is greater among adults with ID than TDI adults (Dixon-Ibarra, Lee, & Dugala, 2013). Recently, in a sample of ~90 children with ID and ~90 TDI children, we found that objectively measured PA of TDI children was 40% greater than that of children with ID and none of the latter reached the recommended 60 min of MVPA per day whereas 40% of the TDI children met the recommendations. Studies with smaller samples have found children with ID to be 50% less active than their TDI peers although no differences were found in their self-reported sedentary behavior (Foley & McCubbin, 2009). Very few or no children with ID reached recommended levels of MVPA estimated via self-reported questionnaires (Rimmer & Yamaki, 2006; Lin et al., 2010) or accelerometers (Peterson et al., 2008). This low PA and MVPA frequently found in studies among children and adolescents with ID has partly been explained with a lack of safe environment in their residential area and potentially unsafe routs for active commuting to and from schools (Einarsson, Olafsson et al., 2015), as safety is an important factor for PA for all children (Hutzler & Korsensky, 2010; Kerr et al., 2006; Merom, Tudor-Locke, Bauman, & Rissel, 2006; Veitch, Salmon, & Ball, 2008; Zhu & Lee, 2008).

Furthermore, little is known about the reasons for PA or sport participation, or the frequency and type in which children with ID take part. Nevertheless, one study on young teens with ID reported "meeting friends", "having fun" and "learning new skills" as the main reasons for taking part in every-day PA (Pozerine, Adomaitiene, Ostaseviciene, Reklaitiene, & Kragniene, 2008). Similarly, it is well documented that TDI children and adolescents take part in sports "to be with friends" and "have fun" as well as "to improve skills" and, among adolescents, "for weight control" (Allender, Cowburn, & Foster, 2006). The positive benefits of sports participation and increased PA in persons with ID for both health and general well-being have been demonstrated in many studies (Bartlo & Klein, 2011; Hutzler & Korsensky, 2010).

Finally, sex differences in PA among individuals with ID have not been well examined. A study on 150 individuals with ID aged 12–70 years found men to be more active than women with a trend for a decline in PA with age (Phillips & Holland, 2011), whereas we found no sex difference in PA or sedentary behavior among 6–16 year old children and adolescents (Einarsson, Olafsson et al., 2015).

There is a particular lack of knowledge about the role of schools in determining PA and sedentary time among children with ID as this is a place where all children spend a large part of their day. The purpose of this study was, therefore, to investigate PA and sedentary time during school hours vs. after school hours among Icelandic school children with ID and to compare them to an age- and sex-matched group of TDI children, as well as to investigate any potential sex differences in PA and sedentary time. A secondary purpose was to investigate the reasons for PA and sport participation in both groups. We hypothesized that children with ID would depend more on schools for PA than TDI children, but there would be no differences in the reasons for taking part in sports and PA. We also hypothesized that there would be no sex differences in PA and sedentary time among children with ID, whereas among TDI children, boys would be more active and spend less time sedentary than girls.

## 2. Materials and methods

### 2.1. Subjects

For this study, data were obtained on PA and PA behavior as well as basic anthropometric variables in Icelandic primary and secondary school children (aged 6–16 years) with and without ID. All (n = 120) children with ID from one special school and four inclusion schools were offered participation, and 94 children agreed to take part (78%). Sixty-two percent of the children with ID came from the special school, which only accepts children with moderate-to-severe ID, and 38% came from inclusion schools, which accept children with mild-to-moderate ID. All children lived at home with their parents or legal

guardians (none was institutionalized), and none of the participants had Down syndrome. An age- and sex-matched TDI group (n = 124) was randomly selected from the class registers from the four inclusion schools and offered to participate with 93 children accepting (75%). Prior to participation in the study, which was approved by the National Bioethics Committee in Iceland (VSNB 2010120007/03.7), a written informed consent was obtained from the children's parents and/or legal guardians along with an assent from the children themselves. Three children with ID dropped out during the study but all TDI children finished. All children with ID had a diagnosed mild-to-severe ID from the State Diagnostic and Counseling Centre in Iceland. All participants were able to walk unassisted and did not exhibit motor disabilities with the exception of three children with ID who had mild Cerebral Palsy. In addition, four children with ID had epilepsy and took medication to control their conditions, which potentially could have affected their willingness to be physically active.

### 2.2. Anthropometric measurements

Standing height was measured three times to the nearest mm with a stadiometer (Seca 220, Seca Ltd., Birmingham UK), and the mean was used. Body weight was determined to the nearest 0.1 kg using a calibrated scale (Seca 708, Seca Ltd., Birmingham UK) with participants in light clothing. Body mass index (BMI) was calculated ($kg/m^2$), and participants were categorized into normal weight, overweight and obesity using international standards (Cole, Bellizzi, Flegal, & Dietz, 2000). The same trained person took all measurements.

### 2.3. Physical activity measurements

PA and sedentary time were assessed with Actigraph accelerometers (Manufacturing Technologies Inc.), model GT1 M. Participants wore the monitor on their hips for 7–10 consecutive days from the time they woke up until they went to sleep. Only data from monitors worn minimum 10 h $day^{-1}$, for at least two weekdays were included in the analysis. If no activity was registered on a monitor for 30 consecutive minutes, it was assumed that the participant had taken it off, and the time was subtracted from the total wear time. Participants who returned monitors with insufficient valid days were given a new period to wear the monitors. All participants or their parents or legal guardians received a text message each morning reminding them to wear the monitors. Actilife 5 software was used to analyze the data, and MVPA was defined as $\geq$2296 counts/min and sedentary activity as $\leq$100 counts/min. These thresholds were first established by Evenson, Catellier, Gill, Ondrak, and McMurray (2008) and later independently validated by Trost, Loprinzi, Moore, and Pfeiffer (2011). The objectively measured sedentary time was standardized as the percentage of the daily wear time, which allows for comparisons regardless of wear time (Einarsson, Olafsson et al., 2015). The class timetable was used to determine school time separately for every individual. All minutes registered before and after formal school hours was classified as after school time.

### 2.4. Self-reported physical activity behavior

Data on Tanner stage, commuting to and from school, and several aspects of PA were collected using a questionnaire consisting of closed questions (Magnusson, Sveinsson, Arngrimsson, & Johannsson, 2008). The children took the questionnaire home and filled it in with the help their parents or legal guardian, and returned it to the school within 1–5 days in a sealed envelope. For questions of frequency and setting of PA and sport participation (e.g. "how often do you take part in organized sports practice with a club every week"), the six response options ("never", "less than once per week", "once per week", "2–3 times per week", "4–5 times per week", "almost every day") were transformed into three categories (<1 times per week, 1–3 times per week, >3 times per week) for analytical purposes. For questions of type of PA and sport participations (e.g. "How often do you participate in soccer outside of school"), those who marked participation of at least 1–2 times per week were considered particpants in a given sport. For questions about reasons for PA and sports participations, the four response options ("strongly disagree", "disagree", "agree", "strongly agree") were converted into dichotomous variable (agree, disagree) prior to analysis. For questions regarding the self-evaluation of the quantity of PA (e.g. "I feel that my PA is sufficient") and own ability in sports, (e.g. "I feel that I am good in sports compared to my peers") the five response ("strongly disagree", "disagree", "neutral", "agree", "strongly agree") options were transformed into three categories (disagree, neutral, agree) during data reduction. Finally, the eight response options ("almost no time", "0.5–1 h/day", "about 1 h/day", "about 2 h/day", "about 3 h/day", "about 4 h/day", "about 5 h/day", "6 h or more per day") for questions concerning time spent in different sedentary activities (e.g. "how many hours, on average, do you spend watching TV/VCR/DVD every weekday"), were converted into the three categories (<1 h/day, 1–3 h/day, >3 h/day) prior to analysis.

## 3. Calculation

SPSS 22.0.0 (Chicago, IL) was used for the statistical analyzes. All variables were inspected for normality. BMI was positively skewed and was log10 transformed to ensure normality. Similarly, for normalization, square root was taken of weight, and all objectively measured PA variables, with the exception of sedentary time. Untransformed values are presented in tables and tables and figures for more meaningful comparisons. All statistical analyzes were corrected for Tanner stage. For objectively measured PA variables, two-way ANOVA was used to test for main effects and interactions between group and sex, and a three-way ANOVA in cases with repeated factor (group X sex X repeated PA or sedentary time). When interaction was

**Table 1**
Characteristics of the participants.

| | All ID n = 91 | All TDI n = 93 | P-value | Effect size[a] |
|---|---|---|---|---|
| Age (yr) | 11.9 (2.9) | 11.9 (2.7) | 0.190 | >0.001 |
| Weight (kg) | 46.2 (19.2) | 48.2 (15.0) | 0.383 | 0.116 |
| Height (cm) | 147.5 (17.4) | 156.1 (18.3) | **>0.001** | 0.482 |
| BMI (kg/m$^2$) | 20.5 (5.2) | 19.2 (2.9) | 0.102 | 0.309 |
| Normal weight (%) | 68 | 32 | | |
| Overweight/obese (%) | 82 | 18 | **0.033** | 0.157 |
| Tanner stage | 2.4 (1.3) | 2.6 (1.3) | 0.273 | 0.021 |

ID = Intellectual disability. TDI = Typically developed individuals. BMI = Body mass index. Numbers are mean and (standard deviation).
[a] Cohen's d for continuous variables and Cramer's v for categorical variables.

significant, the data were split on sex. Chi-square was used to investigate proportional differences between groups for all questionnaire variables with the exception of travel distance to-and-from school where two-way ANOVA was used. Cohen's D was used to calculate effect sizes for continuous variables and Cramer's V (C′V) for categorical variables. The data are presented as means and SD in tables and as means and SE in figures. Significance was accepted at $\alpha$ level of 0.050.

## 4. Results

General characteristics of the participants are presented in Table 1 and have been reported elsewhere (Einarsson, Olafsson et al., 2015) but are given here for descriptive purposes. Briefly, the TDI children were taller but there were no statistical differences in age, weight, or BMI between the groups. However higher proportion of children with ID were classified as overweight or obese than TDI children.

Fig. 1 depicts mean PA and time spent sedentary during a regular weekday. We found TDI children to be 44% more active and 24% less sedentary than children with ID during the entire weekday. However, an interaction in PA was observed between sex and group ($p = 0.003$), where TDI boys were significantly more active than TDI girls ($p < 0.001$), but no statistical difference for sex was found in the ID group ($p = 0.583$, Fig. 1A). Similarly, interaction was found between sex and group for sedentary time ($p = 0.029$), where TDI girls were more sedentary than TDI boys ($p < 0.006$), but no statistical difference was found in the ID group ($p = 0.683$, Fig. 1B).

Fig. 2 demonstrates PA during and after school hours. We found the TDI children to be 25% more active during school hours and 73% more active after school than children with ID. Even though no three-way interaction was found between the group, sex, and repeated PA (school PA vs. after school PA, $p = 0.312$), two-way interactions between group and repeated PA ($p = 0.004$) and between group and sex ($p = 0.004$) were found. In the ID group, no statistical differences were found between the sexes ($p = 0.566$) but children with ID were more active during school than after school ($p = 0.002$, Fig. 2A). In the TDI group, boys were significantly more active than girls ($p < 0.001$) but there was no statistical difference in PA during school vs. after school ($p = 0.914$, Fig. 2B).

Time spent in MVPA during and after school hours is presented in Fig. 3. TDI children accumulated 15.1 more minutes of MVPA during school hours and 22.3 more minutes after school than children with ID. Despite no three-way interaction ($p = 0.899$) between group, sex and time spent in MVPA during school and after school (repeated MVPA), two-way interactions were detected between group and repeated MVPA ($p < 0.001$) and between group and sex ($p = 0.005$), but not between sex and repeated MVPA ($p = 0.336$). For the ID group (Fig. 3A), children with ID accumulated more minutes of MVPA during school than after school ($p < 0.001$) but no statistical difference was found between boys and girls ($p = 0.324$). In the TDI group (Fig. 3B), boys accumulated more minutes than girls in MVPA over the entire weekday ($p < 0.008$), but no difference was found between time spent in MVPA during school compared to after school ($p = 0.312$). Over the entire weekday, only 5% of children with ID reached the recommended 60 min of MVPA, whereas 42% of TDI children did so.

Objectively measured time spent sedentary during school hours and after school hours is displayed in Fig. 4. Children with ID were found to be 6% less sedentary during school hours but 24% more sedentary after school. Even though no three-way interaction ($p = 0.314$) was found between group, sex and time spent sedentary during school vs. after school (repeated sedentary time), a two-way interaction was detected between the group and repeated sedentary time during- and after school ($p < 0.001$). In the ID group (Fig. 4A), children were more sedentary after school than during school time ($p = 0.001$) but no statistical difference was found between the sexes ($p = 0.424$). Among the TDI children, girls were more sedentary than boys ($p = 0.002$), and these children were more sedentary during school than after school ($p < 0.001$, Fig. 4B).

No statistical difference was found between the groups in any self-reported time spent during the entire weekday in front of computers ($p = 0.092$, $C'V = 0.141$) or TV based activities ($p = 0.667$, $C'V = 0.071$). Both groups spent the most time playing computer games, watching TV and surfing the internet, but much less time in word processing. More children with ID (46%) listened to music between 1 and 3 h/day than TDI children (21%, $p = 0.005$, $C'V = 0.244$), who on the other hand, were more likely (23%) to read books between 1 and 3 h/day compared with only 7% among children with ID ($p = 0.004$, $C'V = 0.223$).

Eight percent of children with ID participated in sport or PA, more than three times per week during school hours, whereas 32% of the TDI children did the same ($p < 0.001$, $C'V = 0.429$). Similar values were found for sports or PA participation more than three times per week during after school hours (7% and 37%, $p < 0.001$, $C'V = 0.471$). Forty-four percent of children

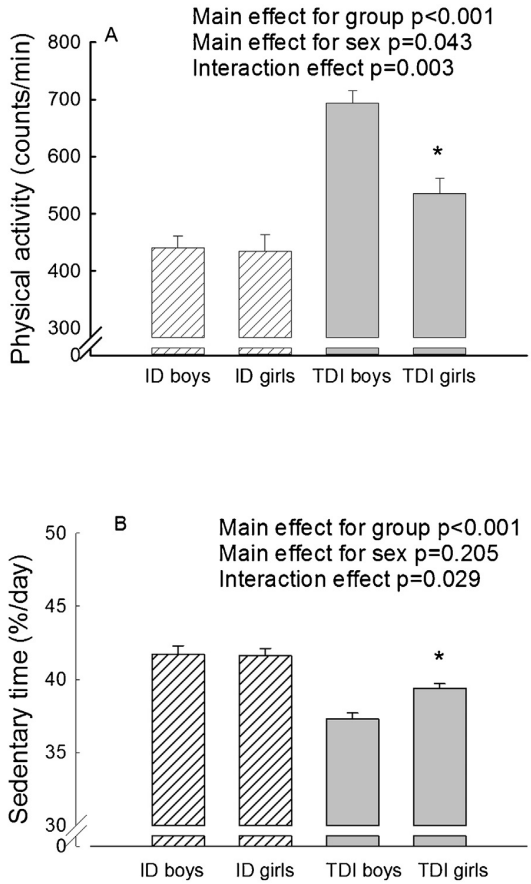


**Fig. 1.** (A) Average PA and (B) time spent sedentary among all participants during a regular weekday. * = Statistical difference between sex within groups ($p < 0.050$).

**Table 2**
Participants' reasons for participation in sports or physical activity and self-perception of their physical activity level.

| | ID n = 90 | TDI n = 93 | P-value | Cramer's v |
|---|---|---|---|---|
| To stay fit (%) | 71 | 95 | **>0.001** | 0.313 |
| To improve in sport (%) | 50 | 96 | **>0.001** | 0.516 |
| To not gain weight (%) | 72 | 52 | **0.015** | 0.202 |
| To lose weight (%) | 60 | 34 | **0.002** | 0.256 |
| To be with friends (%) | 90 | 87 | 0.627 | 0.046 |
| To have fun (%) | 88 | 97 | 0.057 | 0.169 |
| I feel my PA is sufficient (%) | 55 | 71 | 0.083 | 0.160 |

ID = Intellectual disability TDI = Typically developed individuals, PA = physical activity.

with ID never took part in organized PA or sport during after school hours, whereas only 15% of the TDI children never participated ($p < 0.001$, $C'V = 0.419$). Fifty-five percent of children with ID took part in low-intensity activities like Boccia, walking or dancing one or more times per week, whereas 67% of TDI children reportedly did the same ($p = 0.119$, $C'V = 0.203$). Only 15% of children with ID took part in high-intensity sports such as soccer, team handball or athletics more than once a week compared to 72% of the TDI children ($p < 0.001$, $C'V = 0.549$). Only half of the children with ID reported "to be out of breath" or "to sweat" more than once per week, whereas 91% of TDI children did so ($p < 0.001$, $C'V = 0.448$).

More (~95%) of TDI children took part in sports or PA "to stay fit" and "to improve their performance" or "skill level" in the sport compared with ~50–70% of children with ID, whereas children with ID were more likely to name "weight loss" or "weight control" (~60–70%) as a reason to be physically active compared with ~35–50% of TDI children (Table 2). There was no statistical difference between the groups in social factors such as "being with friends" as a reason for participation

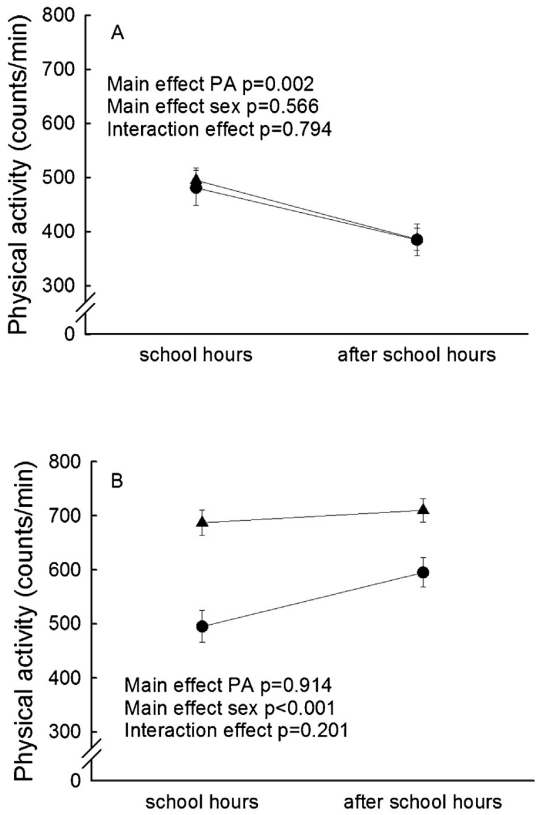


**Fig. 2.** Physical activity during and after school hours among (A) children with intellectual disability and (B) typically developed children. PA = Physical activity. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated PA) p = 0.312, interaction effect (group X repeated PA) p = 0.004, interaction effect (sex X repeated PA) p = 0.238, interaction effect (group X sex) p = 0.004.

in sports or PA. There was no statistical difference between the groups in their perception of being sufficiently physically active (children with ID = 55.7%, TDI children = 71.3%).

## 5. Discussion

The main findings of this study were that the children with ID had considerably lower PA and were more sedentary during weekdays than TDI children. However, interactions were detected where no sex difference was found among children with ID but in the group of TDI children, boys were significantly more physically active and less sedentary than girls. In addition, different patterns were observed between school hours and after school hours among the groups. Children with ID were much more dependent on their schools for their PA compared to TDI children. This confirmed our hypothesis. We also found no difference between the sexes among children with ID on any PA variable or in sedentary time during school hours or after school hours. Compared to other studies on similar groups, a much larger sample of children with ID was included here, and almost all children with ID that met the inclusion criteria in the metropolitan area of Reykjavík took part.

Using objective measurements of PA, we confirmed that children with ID are less physically active than their TDI peers (Einarsson, Olafsson et al., 2015; Phillips & Holland, 2011; Sit, McManus, McKenzie, & Lian, 2007; Lin et al., 2010) and extended these findings to the weekday, both during and after school hours. Furthermore, the time spent in MVPA among children with ID was only 41%, 50%, and 32% of that of TDI children during entire weekday, school hours, and after school hours, respectively. Children with ID accumulated 59% of their total minutes in MVPA during school hours vs. 47% among TDI children. Overall, only 5% of the children with ID met the recommendation of 60 min of daily MVPA on average over the weekday whereas 43% of TDI children met the recommendation. Similarly, children with ID spent 9% more time sedentary over the whole weekday, 23% more time after school hours, but 5% less time during school hours than TDI children. Few studies have objectively assessed sedentary time in persons with ID, but our results support the findings of Dixon-Ibarra et al. (2013) showing that adults with ID were 16–20% more sedentary than TDI adults. The children with ID spent 37–39% of their time sedentary during school hours and 44–46% during after school hours. To our knowledge, no studies have been published comparing time spent sedentary during school hours vs. after school hours among children with ID. The TDI children spent

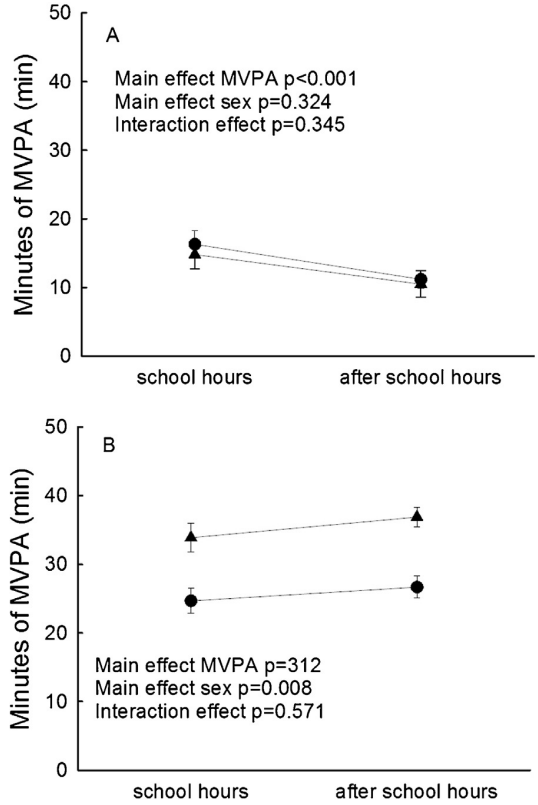


**Fig. 3.** Time spent in moderate-to-vigorous physical activity during and after school hours among (A) intellectually disabled children and (B) typically developed children. MVPA = Moderate-to-vigorous physical activity. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated MVPA) p = 0.899, interaction effect (group X repeated MVPA) p < 0.001, interaction effect (sex X repeated MVPA) p = 0.336, interaction effect (group X sex) p = 0.005.

between 40 and 43% of their time sedentary during school hours and 35–37% during after school hours, which are similar or slightly lower findings than other studies have reported previously but direct comparison is difficult due to different methodology (Bailey et al., 2012; Guinhouya et al., 2009; Taylor et al., 2011). A large proportion (62%) of the children with ID in this study, came from a special school that only accept children with moderate- to severe ID. Incresed level of ID is known to contrubute to low PA (Hinckson & Curtis, 2013), which can partly explain the relativetly large difference between the groups in this study. It also needs to be considered that the cut-offs used in this study (and in most studies) for sedentary behavior and MVPA were established and validated on TDI children and adolescents (Evenson et al., 2008; Trost et al., 2011). These cut-offs are based on oxygen consumption and since children, adolescents and adults with ID have lower aerobic fitness than their TDI peers (Einarsson, Johannsson, Daly, & Arngrimsson, 2015; Wallen et al., 2009), it can be argued that the cut-off for MVPA should be lower for children with ID. Therefore the difference in MVPA between children with ID and TDI children could potentially be smaller than depicted here.

The much greater difference in PA between the groups during after school hours as compared to during school hours underscores that a safe and secure environment is a major promotor for PA (Kerr et al., 2006; Merom et al., 2006; Veitch et al., 2008; Zhu & Lee, 2008). Over half of the children with ID in this study attended the only special school for this population in the Reykjavik metropolitan area and the inclusion schools accepted children with ID from a much larger area than TDI children. The larger area leads to longer travel distances for the ID children, which in turn results in inactive commuting to school, possibly because of safety reasons and/or their lack of understanding of the environment in addition to the time factor (Hutzler & Korsensky, 2010). Travel time to and from schools was categorized as after school hours in this study, which again plays a role in the very low PA among the children with ID during this period of the day. Similarly, even though there are specialized sport and activity clubs for children with ID in Reykjavík, they are also centralized. Thus, the travel distances to sports practices are in general much longer for children with ID, which is a known barrier for participation in PA (Hutzler & Korsensky, 2010; Veitch et al., 2008). Fewer safe opportunities to be physically active close to home can accordingly explain part of the difference in after school hours PA participation between the groups. Furthermore, most children with ID who took part in organized sports after school participated in low-intensity sports such as Boccia, walking or dancing. This all plays a role in the very low PA during after school hours among children with ID.

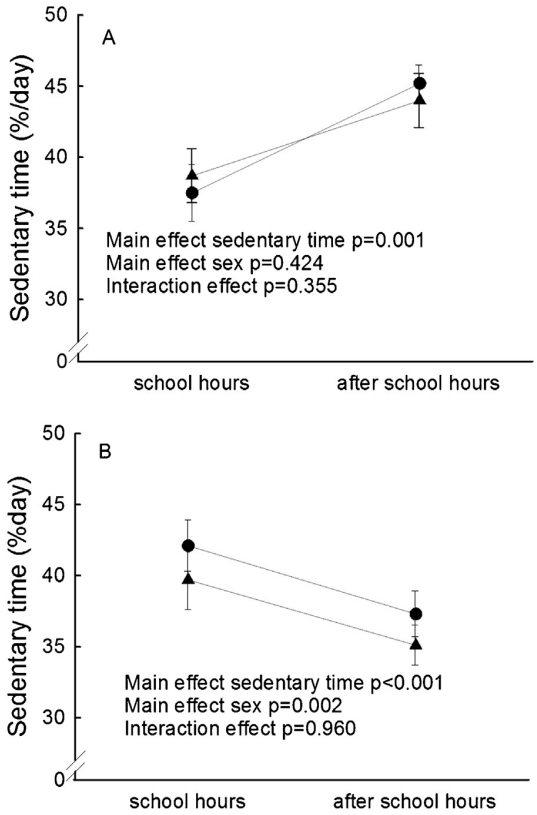


**Fig. 4.** Time spent sedentary during school and after school hours among (A) intellectually disabled children and (B) typically developed children. Triangles = boys, circles = girls. Interaction effect (group X sex X repeated sedentary time) p = 0.314, interaction effect (group X repeated sedentary time) p < 0.001, interaction effect (sex X repeated sedentary time) p = 0.380, interaction effect (group X sex) p = 0.063.

During school hours the difference between children with ID and TDI children in PA and MVPA was much smaller than during after school hours and, if anything, children with ID were actually less sedentary than TDI children during school hours. Schools provide a safe environment where children are secure to be physically active if they are allowed and encouraged to be. We found children with ID to be less sedentary, despite being less physically active and with many fewer minutes in MVPA during school hours, demonstrating that their activity is at a very low intensity. This pattern of lower PA and sedentary time among children with ID can partly be explained by the typical classroom practices. Both the special school and the inclusion schools allow students with ID to move during academic lessons, whereas the tolerance for such movement is much lower for TDI students. The apparent lack of sex difference in the ID group has been previously discussed for this cohort (Einarsson, Olafsson et al., 2015). In contrast, TDI children were more active and less-sedentary during after school hours than during school hours. There is more emphasis on academic subjects during school hours for this group, resulting in more sedentary time, and this group has many more opportunities to participate in organized sport and PA close to their home during after school hours.

The main difference between the two groups in self-reported PA and sports activities is participation in high-intensity activities like soccer, team handball and athletics that are activities likely to contribute to time spent in MVPA. Low participation in high-intensity activities was also confirmed by the fact that only half of the children with ID reported to be out of breath or to sweat more than once a week. This proportion was considerably lower than that of the TDI children (91%), which is similar to previously reported values for Icelandic children (Magnusson, Arngrimsson, Sveinsson, & Johannsson, 2011). There are in fact centralized sports clubs in Reykjavik that offer soccer and athletics to children with ID, but according to their registration, very few or no children in this age group participated. The average age of the individuals taking part in these sports is around 30 years. This implies that these individuals can bring themselves to and from practices, demonstrating once again that the distance to and from facilities is a barrier for participation (Hutzler & Korsensky, 2010; Veitch et al., 2008).

The only difference observed in self-reported sedentary behavior is in reading books and listening to music. The difference in reading is not surprising since some of the children with ID cannot read and many of them are very slow readers. However, both groups spent similar time in front of a screen. Most of the screen time for both groups was allocated to computer games,

watching TV, and browsing the net. Foley and McCubbin (2009) also reported that there was no or little difference between the children with ID and TDI children in sedentary behavior. The screen time findings in our study are also consistent with results from a large nationwide questionnaire survey conducted among TDI children in the same age group in Iceland (Pálsdóttir et al., 2014).

Our hypothesis was that children in both groups would have similar reasons for taking part in PA and sports as suggested in the literature (Allender et al., 2006; Pozerine et al., 2008). Similar to most previous studies (Allender et al., 2006), both groups designated socialization, for example "meeting- and making new friends" and "having fun and enjoying themselves" as major reasons for taking part in PA. However, the two groups deviated when it came to goals and performance as reasons for PA and sport participation. Most of the TDI children in this study named "improving skills" and "staying fit" as reasons for taking part in PA and sport. This high percentage differs from what most other studies have reported (Allender et al., 2006; Pozerine et al., 2008), and is much higher than among children with ID. Such high goal and performance reasons among the TDI children can partly be due to the fact that most after school PA and sport programs are run and organized by local sports clubs. Often competition is introduced early and the children learn to perform at a young age in informal competition against other local sports clubs. This performance emphasis can also explain the low participation among children with ID in regular sport clubs since they are less motivated by these performance-driven factors (Hutzler & Korsensky, 2010). More children with ID than TDI children in this study participated in PA or sport either "to lose-" or "-not gain weight". Children with ID are known to have more negative body image than TDI children (Hutzler & Korsensky, 2010) and the children with ID in this study (Einarsson, Olafsson et al., 2015) like most other studies (Melville et al., 2007; Reinehr et al., 2010) are more likely to be overweight or obese. Such increased prevalence of overweight/obesity can also explain the differences between the groups in reasons regarding body image for PA and sport participation.

Despite very low PA and few children with ID (5%) reaching recommended time in MVPA, 55% of the children felt that their PA was sufficient. This large difference between objectively- and subjectively measured PA indicates that children with ID (and their families) overestimate their PA. This lack of knowledge and understanding of PA among the children with ID, especially about the importance of time spent in MVPA, may also play a large role in the low PA among the children with ID. Our findings suggest that at least part of the low PA among the children with ID was due to lack of knowledge about the importance of PA and what type of PA leads to MVPA. Children and adolescents with mild-to-moderate ID who have the opportunity to fully participate in sports either with special clubs for ID or integrated sport clubs, can reach high level of fitness (van de Vliet et al., 2006). The differences in PA between the ID and TDI groups are, therefore, much more likely to be of social and environmental than biological origin.

This study is not without limitations. First, the low number of girl participants with ID reduced the statistical power of the study. This low number was due to the fact that fewer girls are diagnosed with ID than boys (Gillberg & Soderstrom, 2003), resulting in fewer potential participants, making it hard to overcome this limitation. Second, as mentioned, the cut-off used for MVPA was established and validated on TDI children and adolescents, which may exaggerate the differences between the groups, but to the best of our knowledge, no cut-offs have been established or validated for individuals with ID. Third, since the ID group is more dependent on social structure and −support than the TDI group, the results may not be directly applicable to children with ID in other societies. We also have little information on parents or legal guardians of the participants. It is possible that parents of children with ID are less encouraging of physical activity, and thereby, increase the PA difference between groups.

We believe that the strengths of the study outweigh its limitations. We were able to measure a large number of children with ID compared to most previous studies on this population, and the dropout was less than 5%. Furthermore, we objectively measured PA and PA patterns with accelerometers among children with ID in the same way as in a comparison group of TDI children. To our knowledge, we are the first to publish objective measurements on PA and sedentary time comparing school hours and after school hours between the two groups. Finally, our sample consisted of almost all ambulatory children with ID in the metropolitan area of Reykjavík, which includes more than 70% of the Icelandic population.

## 6. Conclusions

Not only is the PA level of children considerably lower than that among their TDI peers, but they also depend much more on the school system to accumulate their PA and MVPA. Children with ID are also less sedentary during school hours than after school hours, whereas the opposite was found for TDI children. Children with ID are more likely to participate in low-intensity PA and sport for reasons of losing weight or preventing weight gain. In contrast, TDI children are more likely to participate in high-intensity PA and sport in order to stay fit or improve their skill level, which results in more MVPA. Furthermore, the children with ID seem to be less aware of their PA level than TDI children. During the design and implementation of PA promotion campaigns, children with ID and their families need to be specifically targeted with a special emphasis on the description and importance of MVPA.

## Conflict of interest

The authors have no conflict of interest.

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# Appendix 1

Written consent

HÁSKÓLI ÍSLANDS

# Hreyfing og heilsa íslenskra grunnskólabarna með þroskafrávik

**Kæru foreldrar/forráðamenn**

Undanfarin ár hafa verið gerðar rannsóknir við Háskóla Íslands á börnum, hreyfingu, mataræði, líkamssamsetningu og lífsstílssjúkdómum tengdum þessum þáttum. Nú er komið að því að skoða grunnskólabörn með sérþarfir. Rannsóknin er unnin við rannsóknarstofu í íþrótta- og heilsufræðum við Háskóla Íslands og að henni munu koma sérfræðingur í þjálfunarlífeðlisfræði Dr. Sigurbjörn Árni Arngrímsson, doktorsnemi hans Ingi Þór Einarsson auk meistaranemanna Sigurlínar Garðarsdóttir, Mörtu Ólafsdóttur, Barböru Drafnar Fischer og Ágústs Ólafssonar.

Í þessari rannsókn ætlum við að einbeita okkur að langstærsta hópnum sem rúmast innan þeirrar skilgreiningar að teljast vera með sérþarfir en það eru börn með ýmis vitsmunaleg þroskafrávik (ID). Erlendar rannsóknir sýna að þessi hópur sé oft í verra líkamlegu ásigkomulagi en ófatlaðir jafnaldrar þeirra, þeim er hættara við offitu og kyrrsetu og þar af leiðandi ýmsum lífsstílstengdum sjúkdómum tengdum þessum þáttum, eins og sykursýki, hjartasjúkdómum og fleiru. Það er þó nýlega búið að sýna fram á það hér á landi sem annars staðar að ófötluð börn á grunnskólaaldri eru alls ekki í góðu líkamlegu ástandi og ástandið fer síversandi. Það getur bent til þess að börn með sérþarfir á Íslandi séu í talsvert mjög mikilli hættu hvað þessa áhættuþætti varðar.

Samkvæmt þessum sömu rannsóknum eru ástæður fyrir þessu verra ástandi einstaklinga með sérþarfir fyrst og fremst mun minni og jafnvel engin hreyfing og verri næring. Erlendar rannsóknir sýna að oft virðist lítið vera lagt upp úr hreyfingu og heilsusamlegu líferni, bæði innan skólakerfisins og á heimilunum. Það eru samt litlar sem engar lífeðlisfræðilegar ástæður fyrir því að ID börn þurfi að vera í verra líkamlegu ásigkomulagi en önnur börn, það þarf bara að skapa þeim rétt umhverfi og aðstæður þar sem þau eiga möguleika á að hreyfa sig, borða vel og lifa heilbrigðu lífi.

**Markmið rannsóknarinnar eru því:**

<u>Markmið I:</u> Að rannsaka algengi ofþyngdar og offitu á meðal barna og unglinga með þroskahömlum ásamt því að ákvarða þol, magn hreyfingar og styrk áhættuþátta efnaskiptasjúkdóma hjá þessum þjóðfélagshóp.

*Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444*

**Markmið II:** Að bera saman líkamssamsetningu, þol, hreyfingu og aðra áhættuþætti efnaskiptasjúkdóma barna og unglinga með þroskahömlum við sömu þætti hjá börnum og unglingum án þroskahömlunnar.

**Markmið III:** Að bera saman hugsanlegan mun á líkamssamsetningu, þoli, hreyfingu og öðrum áhættuþáttum efnaskiptasjúkdóma á milli barna og unglinga með þroskahömlum sem ganga í sérstaka skóla fyrir börn og unglinga með slíka þroskahömlum og barna og unglinga með þroskahömlum sem ganga í blandaða (venjulega) skóla. Við þennan samanburð verður leiðrétt fyrir stig þroskahömlunnar.

**Markmið IV:** Að rannsaka víxlverkandi tengsl á milli líkamssamsetningar, þols og hreyfingar annars vegar við áhættuþætti efnaskiptasjúkdóma hins vegar á meðal barna og unglinga með þroskahömlun.

*Þeim börnum sem boðin er þátttaka í rannsókninni eru bæði börn sem þurfa sérstaka aðstoð í skólakerfinu vegna einhvers konar þroskafrávika og börn sem á engan hátt þurfa neina aðstoð. Báðir hóparnir gefa mikilvægar upplýsingar um stöðu mála í viðkomandi skólum og hverfum.*

Gert er ráð fyrir því að undirbúningur rannsóknarinnar fari fram vor og haust 2011 og gagnaöflun fari fram á vormánuðum 2012 þegar skólar hefjast eftir jólaleyfi og klárist á haustmánuðum 2011. Fyrstu niðurstöður ættu að liggja fyrir á vormánuðum 2012.

**Væntanlegur ávinningur og næstu skref:**

Það er von okkar að geta varpað ljósi á hver staðan hjá börnum með sérþarfir er í dag og út frá því sett fram leiðbeiningar handa þeim sem koma almennt að hreyfingu, mataræði og lífsstíl þessara barna. Þjálfun íþróttakennara er í mörgum tilvikum ábótavant þegar að kemur að því að vinna með hreyfingu hjá þessum hópi barna og viljum við undirritaðir sem kennarar við Íþróttafræðasetur HÍ bæta úr því sérstaklega ef í ljós kemur að þessi hópur barna er í sérstakri hættu.

Það er einskær von okkar að þau börn sem fá boð um að mæta sjái sér fært að taka þátt í öllum verkþáttum rannsóknarinnar. Þannig yrði best stuðlað að marktækum niðurstöðum rannsóknarinnar. Áhætta vegna þátttöku er ekki meiri en við hefðbundna læknisskoðun, áreynslu í íþróttatíma og blóðsýnatöku.

Vísindasiðanefnd, Persónuvernd, Geislavarnir ríkisins og Menntasvið Reykjavíkur hafa samþykkt framkvæmd rannsóknarinnar. **Þið getið samþykkt þátttöku án þess að barnið fari í alla verkþætti rannsóknarinnar. Þið getið ákveðið hvenær sem er og fyrirvaralaust að hætta við þátttöku í rannsókninni, að hluta eða öllu leyti.**

***Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444***

Ef þið hafið einhverjar spurningar eða athugasemdir er ykkur velkomið að hafa samband við einhvern undirritaðra. Þau börn sem ekki skila inn samþykkisyfirlýsingu verða ekki með í rannsókninni. Undirritaðir vilja einnig biðja foreldra að hafa í huga að samkvæmt alþjóða viðmiðum er talið að börn geti sjálf látið í ljós vilja til þátttöku um 10 ára aldur. Mat Vísindasiðanefndar er að hér er um viðkvæman hóp að ræða og eru foreldrar hvattir til að fara varlega í að samþykkja þátttöku barna undir 10 ára án þess að ræða fyrst við þau um fyrirhugaða þátttöku og kanna vel hvort raunverulegur vilji er til þess að taka þátt.

Þátttaka í rannsókninni felst í eftirfarandi sjö þáttum:

1. **Spurningalistinn:** Ætlast verður til að foreldrar og börn svari honum saman heima hjá sér þegar þeim hentar. Spurningalistanum er ætlað að varpa ljósi á ýmislegt sem viðkemur mataræði, hreyfingu og íþróttaþátttöku þátttakenda.
2. **Þroskaprófið:** Til að geta séð hvort stig þroskafrávika hefur áhrif á aðrar niðurstöður og ef svo er að hversu miklu leiti svo sé verður þroskapróf (cognitive test) lagt fyrir börnin. Þetta er nýlegt próf hannað í Englandi er notað af Alþjóða Ólympíunefnd Fatlaðra til að meta að hversu miklu leiti þroskaskerðingar hamla íþróttagetu barna.
3. **Þrekprófið:** Til að meta þrek verða börnin beðin um hjóla á þrekhjóli með stigvaxandi ákefð og fylgst verður með hjartslætti og súrefnisupptöku hjá þeim. Prófið er hámarkspróf þar sem þátttakendur hjóla þar til þeir geta ekki (eða vilja ekki) meira. Börnin þurfa því að vera í íþróttaklæðnaði við það og helst að komast í sturtu á eftir.
4. **Líkamssamsetningarmælingar, blóðþrýstingur:** Ummál, húðþykkt, blóðþrýstingur, hæð og þyngd verða mæld hjá öllum. Börnin þurfa bara að vera í léttum klæðnaði.
5. **Hreyfimælingarnar:** Hreyfingamælarnir eru litlir kubbar á stærð við eldspýtnastokk. Mælikubbarnir eru hafðir í belti við hægri mjöðm í sex daga samfellt nema þegar farið er í sund eða bað eða þegar sofið er.

6. **Blóðtakan:** Börnin verða keyrð niður í Hjartavernd (eða mæta þangað) þar sem hjúkrunarfræðingur tekur lítið blóðsýni. Framkvæmd blóðprufu verður þannig að stungið er í bláæð einni stungu í olnbogabót og teknir samtals 10 ml í 3 glös. Fyrir stungu verður búið að deyfa húð með kremi (emla). Blóðfita, kólesteról, insúlín og blóðsykur verða mæld. Ef blóðprufur eru ekki eðlilegar verður haft samband við forráðamenn. Strax að lokinni blóðprufu fá þau næringu (ávaxtasafa og brauð) eða nesti sem þau taka með sér ef þau vilja það frekar. Börnin fá sérstaka tilkynningu daginn fyrir blóðprufuna og þau minnt á að mæta fastandi í skólann (eða í Hjartavernd).

7. **Beinþéttnimæling:** Verður einnig framkvæmd í húsnæði Hjartaverndar. DXA-mæling segir bæði til um beinþéttni og fitudreifingu í líkamanum. Gera má ráð

***Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444***

fyrir að mælingin taki u.þ.b. 5 mínútur á barn og barnið liggur á bekk á meðan rannsóknin fer fram og líkaminn er skannaður. Við beinþéttnimælinguna er notaður röntgengeisli, en geislun vegna þátttöku í rannsókninni er sambærileg við 2–3 daga náttúrlega bakgrunnsgeislun á Íslandi. Náttúruleg bakgrunnsgeislun er í öllu okkar umhverfi. Hún kemur frá himingeimnum, jarðskorpunni og geislavirkum efnum í líkama okkar. Þessi geislun er mjög lítil á Íslandi og mun minni en annarsstaðar á Norðurlöndum. Miðað við þá geislun sem hér um ræðir er það mat Geislavarna ríkisins að áhætta vegna þátttöku í rannsókninni sé hverfandi, sbr. það sem að ofan segir.

**Verkþættir 6 og 7 verða framkvæmdir í Húsnæði Hjartaverndar í sömu ferðinni**

**Virðingarfyllst,**

Dr. Sigurbjörn Árni Arngrímsson, prófessor HÍ ,ábyrgðarmaður rannsóknarinnar

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***Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444***

HÁSKÓLI ÍSLANDS

## Samþykkisyfirlýsing um þátttöku í rannsókninni

## Hreyfing og Heilsa íslenskra grunnskólabarna með þroskafrávik

**Nafn barns:**_____

**Kennitala barns:**_____

**Athugið** að undirrita þarf bæði atriðin ef samþykkt er þátttaka í öllum þáttum rannsóknarinnar!

*Ég, forráðamaður ofangreinds barns, samþykki þátttöku þess í fyrstu 5 þáttum ofangreindrar rannsóknar.*

***Samþykki forráðamanns:***

*Dags:*_____;_____

***Samþykki barns:***

*Dags:*_____, _____

*Ég, forráðamaður ofangreinds barns, samþykki að það fari í DXA-mælingu og blóðmælinguna sem er 6 og 7 hluti ofangreindrar rannsóknar.*

***Samþykki forráðamanns:***

*Dags:*_____;_____

***Samþykki barns:***

*Dags:*_____, _____

Hefur barnið einhvern tíma leitað lækninga eða verið á lyfjum vegna heilsufarsvandamála er tengjast lungum, hjarta, blóðrásarkerfi eða efnaskiptum eða öðrum sjúkdómum sem gætu haft áhrif á þrek þess?

**Já** ☐ **Nei** ☐ **(Ef já, vinsamlega gefið upplýsingar á bakhlið blaðsins)**

Undirskrift rannsakanda sem leggur yfirlýsinguna fyrir:

Dags.:_____ Nafn:_____

***Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444***

# Appendix 2

Questionnaire

HÁSKÓLI ÍSLANDS

# Hreyfing og heilsa íslenskra grunnskólabarna með þroskafrávik spurningalisti

## Trúnaðarmál

**Spurningar til barnsins sem það svarar með hjálp forráðamanna heima hjá sér**

*Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444*

Til nemenda og forráðamanna

Í þessu hefti eru nokkrar spurningar sem þið eruð beðin að svara saman. Þær fjalla um hreyfingu og kyrrsetu barnins, mataræði og skoðanir þess ýmsum félags-, tómstunda-, íþrótta- og heilsufarlegum þáttum sem tengjast líðheilsu ásamt spurningum og fjölskylduhagi. Svör ykkar skipta miklu máli og við vonum að þið svarir af samviskusemi. Flestum spurningum er beint til barnsins og þar sem það er kostur ættu svörin að endurspegla viðhorf barnsins sem allra mest. Þetta er ekki próf og því er ekkert svar réttara en annað. Það eina sem skiptir máli er að skoðanir og lífsmunstur barnanna komi fram.

Við flestum spurningum eru nokkrir svarmöguleikar og þið þurfið aðeins að velja einn þeirra. Setjið kross í reitinn við það svar sem þið hafið valið. Við biðjum ykkur um að svara öllum spurningum eftir bestu getu. Ef að ykkur finnst enginn svarmöguleiki í einhverri spurningu eiga nákvæmlega við um ykkur merkið þá við þann svarmöguleika sem að ykkur finnst komast næst sannleikanum.

Þegar þið hafið lokið við að svara öllum spurningunum, setjið þá listann í frímerkta umslagið sem honum fylgir og komið honum í póst. Nafn barnsins kemur hvergi fram á listanum svo enginn mun vita hvernig þið svarið.

Ef þið hafið einhverjar spurningar varðandi spurningalistann hikið ekki við að hafa samband Inga Þór Einarsson (issi@hi.is, 694-7323).

Með fyrirfram þökk fyrir þátttökuna,
Aðstandendur verkefnisins

1. **Ertu strákur eða stelpa**

   ☐ Strákur ☐ Stelpa

2. **Hvaða ár ertu fædd(ur)?** _____

3. **Hvernig býrð þú núna?**
   **(Merktu aðeins í EINN reit)**

   a) Hjá báðum foreldrum ☐

   b) Hjá móður ☐

   c) Hjá föður ☐

   d) Hjá móður og sambýlismanni hennar ☐

   e) Hjá föður og sambýliskonu hans ☐

   f) Hjá afa og/eða ömmu ☐

   g) Hjá öðrum ættingjum ☐

   h) Annað fyrirkomulag ☐

4. **Hversu gott teljið þið fjölskyldu ykkar hafa það fjárhagslega?**

   a) Mjög gott ☐

   b) Gott ☐

   c) Miðlungs ☐

   d) Slæmt ☐

   e) Mjög slæmt ☐

**5. Er faðir þinn með vinnu?**

a) Já ☐

b) Nei ☐

c) Ég á ekki/hef ekki samband við föður ☐

**Ef JÁ, við hvað vinnur hann? (merktu í þann reit sem lýsir því best)**

a) Ófaglærð störf s.s. verkamaður, fiskvinnsla, ræsting, o.þ.h. ☐

b) Einföld þjónustustörf s.s. afgreiðslustörf o.þ.h. ☐

c) Ófaglærð umönnunarstörf s.s. dagforeldri, heimilishjálp, skólaliði o.þ.h. ☐

d) Sjómennsku, sjómaður ☐

e) Búmennsku, bóndi ☐

f) Faglærð iðnaðarstörf s.s. rafvirki, húsasmiður, pípari ☐

g) Þjónustustörf s.s. skrifstofustörf, bankamaður, sölumaður, fulltrúi o.þ.h. ☐

h) Menningartengd störf s.s. listamaður, fjölmiðlamaður, íþróttaþjálfari o.þ.h. ☐

i) Faglærð störf í opinberri þjónustu s.s. kennari, sjúkraliði, hjúkrunarfr., lögreglumaður o.þ.h. ☐

j) Sérfræðistörf í einkageira s.s. lögfr., viðskiptafr., verkfr., flugmaður o.þ.h. ☐

k) Sérfræðistörf í ríkisgeira s.s. háskólakennari, læknir lögfræðingur o.þ.h. ☐

l) Æðstu stjórnunarstörf s.s. kjörinn fulltrúi, embættismaður, framkvæmdastjóri, forstjóri o.þ.h. ☐

m) Önnur stjórnunarstörf s.s. deildarstjóri, sölustjóri, verslunarstjóri o.þ.h. ☐

n) Eigin atvinnurekstur ☐

**Ef NEI, hversvegna hefur hann ekki vinnu? (merktu í þann reit sem lýsir því best)**

a) Hann hefur ekki heilsu ☐

b) Hann er á eftirlaunum ☐

c) Hann er í námi ☐

d) Hann er að leit að vinnu ☐

e) Hann sér um heimilið ☐

f) Ég veit það ekki ☐

**6. Er móðir þín með vinnu?**

a) Já ☐

b) Nei ☐

c) Ég á ekki/hef ekki samband við móður ☐

**Ef JÁ, við hvað vinnur hún? (merktu í þann reit sem lýsir því best)**

a) Ófaglærð störf s.s. verkakona, fiskvinnsla, ræsting, o.þ.h. ☐

b) Einföld þjónustustörf s.s. afgreiðslustörf o.þ.h. ☐

c) Ófaglærð umönnunarstörf s.s. dagforeldri, heimilishjálp, skólaliði o.þ.h. ☐

d) Sjómennsku, sjómaður ☐

e) Búmennsku, bóndi ☐

f) Faglærð iðnaðarstörf s.s. rafvirki, húsasmiður, pípari ☐

g) Þjónustustörf s.s. skrifstofustörf, bankakona, sölukona, fulltrúi o.þ.h. ☐

h) Menningartengd störf s.s. listakona, fjölmiðlakona, íþróttaþjálfari o.þ.h. ☐

i) Faglærð störf í opinberri þjónustu s.s. kennari, sjúkraliði, hjúkrunarfr., lögreglukona o.þ.h. ☐

j) Sérfræðistörf í einkageira s.s. lögfr., viðskiptafr., verkfr., flugmaður o.þ.h. ☐

k) Sérfræðistörf í ríkisgeira s.s. háskólakennari, læknir lögfræðingur o.þ.h. ☐

l) Æðstu stjórnunarstörf s.s. kjörinn fulltrúi, embættismaður, framkvæmdastjóri, forstjóri o.þ.h. ☐

m) Önnur stjórnunarstörf s.s. deildarstjóri, sölustjóri, verslunarstjóri o.þ.h. ☐

n) Eigin atvinnurekstur ☐

**Ef NEI, hversvegna hefur hún ekki vinnu? (merktu í þann reit sem lýsir því best)**

a) Hún hefur ekki heilsu ☐

b) Hún er á eftirlaunum ☐

c) Hún er í námi ☐

d) Hún er að leit að vinnu ☐

e) Hún sér um heimilið ☐

f) Ég veit það ekki ☐

**7. Hver er menntun foreldra þinna (ef þú ert alin/n upp hjá fósturföður eða fósturmóður svarið þið fyrir hann/hana). Merkið aðeins í einn reit í hverri línu**

| | Lauk grunnskóla eða minna | Hóf nám í framhalds-skóla | Lauk námi í framhalds-skóla | Hóf nám í háskóla | Lauk námi í háskóla | Veit ekki | Á ekki við |
|---|---|---|---|---|---|---|---|
| **a) Menntun föður** | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| **b) Menntun móður** | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**8. Eftirfarandi spurningar eru um íþróttir og líkamsrækt?**
**(Merktu aðeins í EINN reit í HVERJUM lið)**

| | Aldrei | Sjaldnar en 1 sinni í viku | 1 sinni í viku | 2-3 sinnum í viku | 4-5 sinnum í viku | Svo til á hverjum degi |
|---|---|---|---|---|---|---|
| a) Hversu oft tekur þú þátt í íþróttum og líkamsþjálfun í skólanum, fyrir utan skyldutíma (leikfimitíma)? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Hve oft stundar þú íþróttir (æfingar eða keppnir) með íþróttafélagi? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Hve oft stundar þú íþróttir eða æfingar, sem ekki er á vegum skólans eða íþróttafélaga? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) Hve oft reynir þú á sig líkamlega þannig að þú mæðist verulega eða svitnir? | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**EF ÞÚ STUNDAR EKKI ÍÞRÓTTIR SLEPPTU ÞÁ SPURNINGUM NR. 9 OG 10 OG SVARAÐU NÆST SPURNINGU NR. 11.**

**9. Ef þú stundar íþróttir hversu sammála eða ósammála ertu eftirfarandi fullyrðingu? Ég stunda íþróttir til að...**

**(Merktu aðeins í EINN reit í HVERJUM lið)**

| | Mjög ósammála | Fremur ósammála | Fremur sammála | Mjög sammála |
|---|---|---|---|---|
| a) halda mér í góðu formi | ☐ | ☐ | ☐ | ☐ |
| b) bæta færni mína í íþróttinni | ☐ | ☐ | ☐ | ☐ |
| c) hafa það skemmtilegt | ☐ | ☐ | ☐ | ☐ |
| d) bæta heilsuna | ☐ | ☐ | ☐ | ☐ |
| e) til að fitna ekki | ☐ | ☐ | ☐ | ☐ |
| f) gefa mér kraft og orku | ☐ | ☐ | ☐ | ☐ |
| g) til að eignast vini | ☐ | ☐ | ☐ | ☐ |
| h) til að vera með vinum mínum | ☐ | ☐ | ☐ | ☐ |
| i) til að létta mig | ☐ | ☐ | ☐ | ☐ |

**10. Hjá hverjum stundarðu íþróttina (merktu í eins marga reiti og við á)**

a) Sjálf/sjálfur ☐

b) Skólanum ☐

c) Íþróttafélagi fyrir fatlaða ☐

d) Öðru íþróttafélagi ☐

**11. Hversu sammála eða ósammála ertu eftirfarandi fullyrðingum?**

**(Merktu aðeins í EINN reit í HVERJUM lið)**

| | Mjög ósammála | Fremur ósammála | Hvorki né | Fremur sammála | Mjög sammála |
|---|---|---|---|---|---|
| a) Mér finnst ég hreyfa mig nógu mikið | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Mér finnst ég heilsuhraust(ur) | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Mér líður illa í skólanum | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) Ég er góð(ur) í íþróttum miðað við jafnaldra mína | ☐ | ☐ | ☐ | ☐ | ☐ |
| e) Mér finnst skipta miklu máli að borða hollan mat | ☐ | ☐ | ☐ | ☐ | ☐ |

**12. Hvað býrðu langt frá skólanum?**

**(Merktu í ANNAN eða BÁÐA reitina)**

_____ km. frá skólanum

_____ mínútna göngufjarlægð frá skólanum

**13. Hvernig ferðu vanalega í skólann?**

**(Merktu aðeins í EINN reit)**

| Keyrð(ur) í einkabíl | Með ferðaþjónustunni | Með strætó | Á hjóli | Geng eða hleyp |
|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ |

**14. Hversu margar klukkustundir notar þú, að jafnaði, í eftirtalið <u>um helgar</u>?**
**(Merktu aðeins í EINN reit í HVERJUM lið)**

| | Nær engum tíma | ½-1 klst. | Um 1 klst. | Um 2 klst. | Um 3 klst. | Um 4 klst. | Um 5 klst. | 6 klst. eða fleiri |
|---|---|---|---|---|---|---|---|---|
| a) Spila tölvuleiki (s.s. á heimilis-tölvu, Gameboy, nintendo ofl.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Horfa á sjónvarp eða videó/dvd | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Vera á netinu (Veraldarvef eða spjallrásum) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) Skrifa eða lesa tölvupóst | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| e) Nota tölvur í annað en vera á netinu eða spila tölvuleiki | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| f) Hlusta á tónlist | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| g) Lesa bækur (aðrar en skólabækur) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**15. Hversu margar klukkustundir notar þú, að jafnaði, í eftirtalið <u>á virkum dögum</u>?**
**(Merktu aðeins í EINN reit í HVERJUM lið)**

| | Nær engum tíma | ½-1 klst. | Um 1 klst. | Um 2 klst. | Um 3 klst. | Um 4 klst. | Um 5 klst. | 6 klst. eða fleiri |
|---|---|---|---|---|---|---|---|---|
| a) Spila tölvuleiki (s.s. á heimilis-tölvu, Gameboy, nintendo ofl.) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Horfa á sjónvarp eða videó/dvd | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Vera á netinu (Veraldarvef eða spjallrásum) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) Skrifa eða lesa tölvupóst | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| e) Nota tölvur í annað en vera á netinu eða spila tölvuleiki | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| f) Hlusta á tónlist | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| g) Lesa bækur (aðrar en skólabækur) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**16. Hversu oft stundar þú eitthvað af eftirtöldu (utan skólatíma)?**
**(Merktu aðeins í EINN reit í HVERJUM lið**

| | Nær aldrei | Nokkrum sinnum á ári | Nokkrum sinnum í mánuði | 1-2 sinnum í viku | 3 sinnum í viku eða oftar |
|---|---|---|---|---|---|
| a) Félagsstarf í skóla að undanskildum böllum og diskóum (t.d. námskeið eða klúbbur) | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Tónlistarnám | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Listnám (leiklist, myndlist, o.fl.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) Dans (jassballett, ballett, samkvæmisdansar) | ☐ | ☐ | ☐ | ☐ | ☐ |
| e) Félagsstarf utan skóla (skátar, æskulýðsstarf trúfélaga, K.F.U.M eða K.F.U.K. eða annað) | ☐ | ☐ | ☐ | ☐ | ☐ |
| f) Hestamennsku eða göngur | ☐ | ☐ | ☐ | ☐ | ☐ |
| g) Handbolta | ☐ | ☐ | ☐ | ☐ | ☐ |
| h) Fótbolta | ☐ | ☐ | ☐ | ☐ | ☐ |
| i) Körfubolta | ☐ | ☐ | ☐ | ☐ | ☐ |
| j) Fimleika | ☐ | ☐ | ☐ | ☐ | ☐ |
| k) Frjálsar íþróttir eða hlaup | ☐ | ☐ | ☐ | ☐ | ☐ |
| l) Tennis, badminton, borðtennis eða veggtennis | ☐ | ☐ | ☐ | ☐ | ☐ |
| m) Sund | ☐ | ☐ | ☐ | ☐ | ☐ |
| n) Skíði, gönguskíði, snjóbretti eða skauta | ☐ | ☐ | ☐ | ☐ | ☐ |
| o) Sjálfsvarnaríþróttir (júdó, karate, jujitsu, glímu eða annað) | ☐ | ☐ | ☐ | ☐ | ☐ |
| p) Golf | ☐ | ☐ | ☐ | ☐ | ☐ |
| q) Hjólabretti eða línuskauta (hjólaskauta) | ☐ | ☐ | ☐ | ☐ | ☐ |
| r) Annað | ☐ | ☐ | ☐ | ☐ | ☐ |

hvað? _____

**17. Hve oft getur þú fengið þér hvað sem þú vilt að borða úr eldhúsinu heima hjá þér?**

**(Merktu aðeins í EINN reit)**

| Aldrei | Stundum | Oft | Alltaf |
|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ |

**18. Hversu oft borðar þú þessar máltíðir að jafnaði á viku ?**

**(Merktu í EINN reit í HVERJUM lið)**

| | Nær aldrei | 1-2 sinnum í viku | 3-4 sinnum í viku | 5-6 sinnum í viku | Nánast á hverjum degi |
|---|---|---|---|---|---|
| a) Morgunmat | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Hádegismat | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Nestispakka í skólanum | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) Kvöldmat | ☐ | ☐ | ☐ | ☐ | ☐ |
| e) Bita á milli máltíða | ☐ | ☐ | ☐ | ☐ | ☐ |

**19. Hvar borðar þú að jafnaði eftirtaldar máltíðir á virkum dögum (ef þú borðar þær)?**

| | Í skólanum | Heima | Annars staðar |
|---|---|---|---|
| a) Morgunmat | ☐ | ☐ | ☐ |
| b) Hádegismat | ☐ | ☐ | ☐ |
| d) Kvöldmat | ☐ | ☐ | ☐ |

**20. Hversu oft í viku, að jafnaði, borðar fjölskylda þín máltíð saman?**

**(Merktu í EINN reit í HVERJUM lið)**

| | Nánast aldrei | 1-2 sinnum í viku | 3-4 sinnum í viku | 5-6 sinnum í viku | Nánast á hverjum degi |
|---|---|---|---|---|---|
| a) Morgunmat | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Hádegismat | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Kvöldmat | ☐ | ☐ | ☐ | ☐ | ☐ |

**21. Hversu oft borðar þú eitthvað af eftirtöldu?**
**(Merktu aðeins í EINN reit í HVERJUM lið)**

| | Nær aldrei | Sjaldnar en 1 sinni í viku | 1 sinni í viku | Nokkrum sinnum í viku | Einu sinni á dag | Oftar en einu sinni á dag |
|---|---|---|---|---|---|---|
| a) Ávexti eða grænmeti | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Sælgæti | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Kjötmáltíð | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) Fiskmáltíð | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| e) Pastamáltíð | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| f) Kex, kökur eða kartöfluflögur | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| g) Skyndibitamat (pizzu, pylsu hamborgara, franskar kartöflur) | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |
| h) Brauðsneið, samloku eða langloku | ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**22. Hvað drekkur þú mörg glös/ bolla af eftirtöldum drykkjum á dag?**
**(Merktu í EINN reit í HVERJUM lið)**

| | Drekkur nær aldrei | Sjaldnar en daglega | 1-2 á dag | 3-4 á dag | 5 eða fleiri á dag |
|---|---|---|---|---|---|
| a) Sykurlausum gosdrykkjum | ☐ | ☐ | ☐ | ☐ | ☐ |
| b) Sætum drykkjum (gosdrykkir eða orkudrykkir, aðrir en sykurlausir) | ☐ | ☐ | ☐ | ☐ | ☐ |
| c) Mjólkurdrykkjum | ☐ | ☐ | ☐ | ☐ | ☐ |
| d) Söfum/djúsi (appelsínu-, epla- o.s.frv.) | ☐ | ☐ | ☐ | ☐ | ☐ |
| e) Vatni | ☐ | ☐ | ☐ | ☐ | ☐ |

**23. Ef þú drekkur mjólk hvaða tegund er það helst?**
**(Merktu í EINN eða FLEIRI reiti)**

| nýmjólk | léttmjólk | fjörmjólk | kókómjólk | undanrenna | drekk ekki mjólk |
|---|---|---|---|---|---|
| ☐ | ☐ | ☐ | ☐ | ☐ | ☐ |

**24. Hvað gerir þú vanalega (oftast) í frímínútum í skólanum?**
**(Merktu aðeins í EINN reit)**

- ☐ Sit (spjalla/les/spila)
- ☐ Hreyfi mig (hleyp um eða tek þátt í leikjum)
- ☐ Geri annað

**25. Hvað notar þú mikinn tíma í heimavinnu, heima hjá þér á dag?**
**(Merktu aðeins í EINN reit)**

- ☐ Þrjá klukkutíma eða meira
- ☐ U.þ.b. tvo klukkutíma
- ☐ U.þ.b. klukkutíma
- ☐ Minna en hálftíma
- ☐ Vinn aldrei heimavinnu heima hjá mér

**26. Hvernig líkar þér í skólanum?**
**(Merktu aðeins í EINN reit)**

- ☐ Mjög vel
- ☐ Frekar vel
- ☐ Hvorki vel né illa
- ☐ Frekar illa
- ☐ Mjög illa

**Athugaðu nú hvort þú hefur gleymt nokkrum**
**spurningum ef svo er ekki**

## þökkum við þér kærlega fyrir þátttökuna

# Appendix 3

Tanner scale for boys

HÁSKÓLI ÍSLANDS

# Hreyfing og heilsa íslenskra grunnskólabarna með þroskafrávik

**Kæru foreldrar/forráðamenn**

Þegar börn og unglingar ganga í gegnum kynþroskann verða margvíslegar breytingar á líkama þeirra. Eitt af því sem breytist verulega er hormónaseyti og hormónin hafa áhrif á margvíslegar mælingar (s.s. blóðfitu, insúlín o.fl.) sem notaðar eru til að meta heilsfarsáhættu barnanna. Því þarf í rannsóknum á áhættuþáttum heilsu að meta kynþroska barnanna svo hægt sé að meta hversu kynþroska börnin séu og leiðrétta fyrir áhrif kynþroskans á áhættuþætti heilsunnar. Sú leið sem við höfum kosið að fara til meta kynþroskann í þessari rannsókn er að nota svokölluð Tanner stig. Hún felst í því að börn og foreldrar meta í sameiningu kynþroskann með stuðningi mynda. Þessi leið er farin því hún er ódýr, einföld og krefst ekki mikilla inngripa.

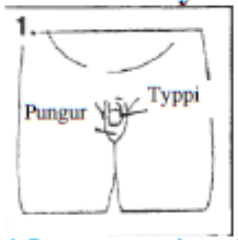
Á meðfylgjandi blaði eru 5 teiknaðar myndir af kynfærum drengja á mismunandi þroskastigi og 5 teiknaðar myndir af hárvexti á kynfærunum á mismunandi þroskastigi. Við viljum biðja ykkur í samvinnu við barn ykkar að meta annars vegar þroska kynfæranna og hins vegar hárvaxtarstigið (þroska hárvaxtarins). Vinsamlegast dragið hring utan um þá tölu sem best samsvarar þroskastigi barns ykkar. Athugið að það þarf að gefa eina tölu fyrir þroska kynfæra og aðra tölu fyrir hárvöxtinn. Athugið einnig að tölunum fyrir þroska kynfæra og hárvöxt þarf ekki að bera saman (þ.e. mismunandi tölur geta átt við hvorn lið um sig).

Þegar matinu er lokið vilum við biðja ykkur um að stinga þessu blaði ásamt spurningalistanum í frímerkta umslagið fylgir og koma umslaginu í póst. Ef þið hafið einhverjar spurningar, hikið ekki að hafa samband við Sigurbjörn Árna Arngrímsson ábyrgðarmann rannsóknarinnar (samgrim@hi.is, 525-5308) eða Inga Þór Einarsson doktorsnema (issi@hi.is, 525-5998).

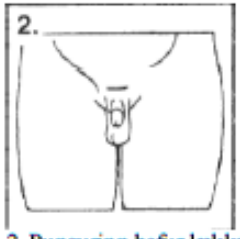
*Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444*

HÁSKÓLI ÍSLANDS

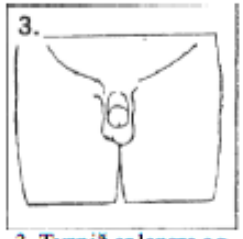
## Kynfæraþroski



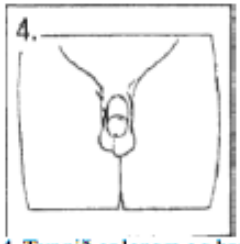

1. Pungur og typpi eru af sömu stærð og þegar þú hófst skólagöngu



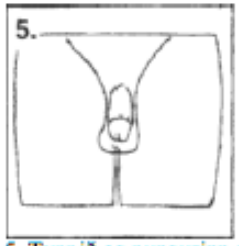

2. Pungurinn hefur lækkað aðeins og typpið er aðeins stærra




3. Typpið er lengra og pungurinn stærri



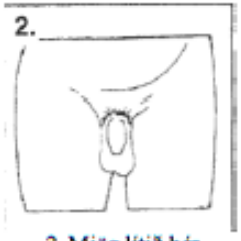

4. Typpið er lengra og breiðara og pungurinn stærri og dekkri en áður




5. Typpið og pungurinn eru að stærð og lögun eins og hjá fullorðnum

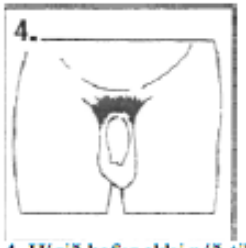
## Hárvöxtur


1. Ekkert hár




2. Mjög lítið hár


3. Nokkuð af hári




4. Hárið hefur ekki náð til náð til læranna


5. Hárið hefur náð til til læranna

*Ef þú hefur spurningar um rétt þinn sem þátttakandi í vísindarannsókn eða vilt hætta þátttöku í rannsókninni getur þú snúið þér til Vísindasiðanefndar, Vegmúla 3, 108 Reykjavík. Sími: 551-7100, fax: 551-1444*

# Appendix 4

Tanner scale for girls

HÁSKÓLI ÍSLANDS

# Hreyfing og heilsa íslenskra grunnskólabarna með þroskafrávik

**Kæru foreldrar/forráðamenn**

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Á meðfylgjandi blaði eru 5 teiknaðar myndir af brjóstum á mismunandi þroskastigi og 5 teiknaðar myndir af hárvexti á kynfærum á mismunandi þroskastigi. Við viljum biðja ykkur í samvinnu við barn ykkar að meta annars vegar þroska brjóstanna og hins vegar hárvaxtarstigið (þroska hárvaxtarins). Vinsamlegast dragið hring utan um þá tölu sem best samsavarar þroskastigi barns ykkar. Athugið að það þarf að gefa eina tölu fyrir þroska brjósta og aðra tölu fyrir hárvöxtinn. Athugið einnig að tölunum fyrir þroska brjósta og hárvöxt þarf ekki að bera saman (þ.e. mismunandi tölur geta átt við hvorn lið um sig).

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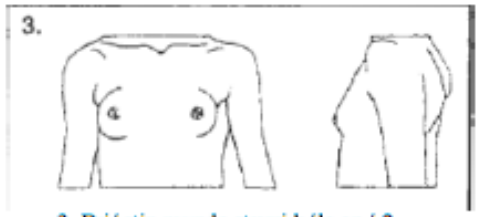
HÁSKÓLI ÍSLANDS

## Brjóstaþroski

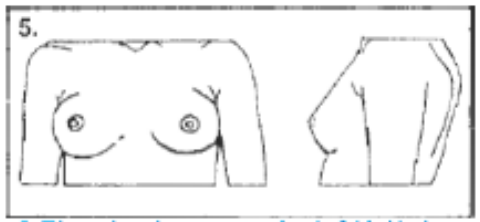

1. Brjóstin eru flöt


2. Brjóstin mynda litla hóla




3. Brjóstin mynda stærri hóla en í 2

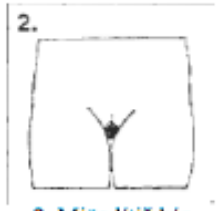

4. Geirvartan og svæðið í kring (Areola) mynda hól sem stendur út frá brjóstinu



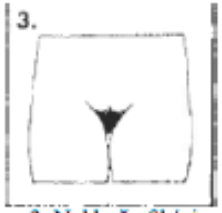

5. Einungis geirvartan stendur út frá brjóstinu

## Hárvöxtur


1. Ekkert hár




2. Mjög lítið hár




3. Nokkuð af hári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