Association between fitness and sleep among 15 year old Icelandic adolescents

Health behavior of Icelandic adolescents

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Júní 2016
Lokaverkefni til M.Ed.-prófs
Íþrótta-, tómtunda- og þroskaþjálfadeild
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Lokaverkefni til M.Ed.-prófs í Íþróttar- og heilsufræði
Leiðbeinandi: Sigríður Lára Guðmundsdóttir

Íþróttar-, tómstunda- og þroskaþjálfadeild
Menntavisindasvið Háskóla Íslands
Júni 2016
Association between fitness and sleep among 15 year old Icelandic adolescents – Health behavior of Icelandic adolescents

Ritgerð þessi er 30 eininga lokaverkefni til M.Ed.-prófs í Íþrótt- og heilsufræði við Íþrótt-, tómstunda- og þroskaþjálfadeild,
Menntavísindasviði Háskóla Íslands

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Lokaverkefni má ekki afrita né dreifa rafrænt nema með leyfi höfundar.
Preface

This thesis is based on a study called *Health behavior of Icelandic adolescents*. The data collection lasted for two months in the spring of 2015 and I was a part of the research team collecting the data. It was an excellent experience to participate in the data collection process with the research team and I would like to thank Erlingur Jóhannsson, the research manager and everyone on the team for this instructive time. The study was sponsored by The Icelandic Center for Research (Rannís) and National Institutes of Health (NIH).

I decided to write my thesis in English because I wanted it to be accessible to a larger audience and also because this thesis is a part of a larger study.

My guidance teacher was Sigríður Lára Guðmundsdóttir, lector at the School of Education at the University of Iceland. I would like to thank her for the guidance, good cooperation and all her help, I really appreciate it. I would like to thank Guðmundur Sæmundsson, specialist, and Björg Þorleifsdóttir, external examiner, for their work. I would also like to thank Vaka Rögnvaldsdóttir for supplying me with the processed data and the assistance. My fellow master students, Bjarki Gíslason, Steinar Logi Rúnarsson and Ásta Heiðrún Jónsdóttir get a special thank for the assistance and support. My family was very supportive of me and I would like to thank them, my parents Herðís and Jóhann as well as my brother, Birkir Orri and a special thanks to my twin sister, Eyrún Inga, for proofreading this thesis.

Last but not least, I would also like to thank all the participants in the study, because without them this study would not be possible and they made the data collecting process really enjoyable.
Abstract

Adolescence is a period in a person’s life when physiological and psychiatric changes, socio-cultural and psychological factors are changing and that affects the health and behavior of adolescence, including their sleep. It is important to take responsibility for a healthy lifestyle throughout childhood and adolescence to decrease risk of diseases which can appear later in life.

The aim of this study is to examine the association between fitness and sleep among Icelandic adolescents who were born in the year of 1999.

Health behavior of Icelandic adolescents is a continuing study from Lifestyle 7 and 9 year old Icelandic children. A total of 301 students from previous study, as well as new students participated in this cross-sectional study and out of them, 258 participants were included in this thesis. Measurements used in the thesis were cycle ergometer fitness test on a testing bike (W/kg), vertical jump test (cm), grip strength (lb.) and weight (kg). In addition, a questionnaire was used to assess screen time and depression. Sleep was measured with accelerometers (ActiGraph GTX3+) that students wore around their wrist for 7 days.

The association between fitness and sleep was assessed with linear regression analyzes, considering the effects of possible confounding factors.

Results shows that mean sleep duration on school nights is 6.2 h (SD=0.81) in boys and 6.2 h (SD=0.68) in girls. A total of 40% of boys and 46% of girls sleep less than 6 hours on a school night. The association between sleep duration on school days and fitness (W/kg) was significant (p<0.05) in the whole group and borderline significant for girls (p=0.051) but not within the group of boys. A significant association was found between non-school days (weekends and holidays) sleep duration and vertical jump in girls (p<0.05) and also after adjusting for screen time and depression in girls (p=0.05). There was no association with sleep and grip strength.

Sleep efficiency was not significantly associated with fitness variables in any of the analyses.

The study shows that there is a significant association between fitness and sleep among the whole group and girls but not boys.
Á unglingsárum eiga sér stað ýmsar breytingar í lífi einstaklinga svo sem lifeölisfræðilegar, félagslegar og sálfræðilegar. Þessar breytingar hafa áhrif á heilsuhægðun ungranna og einnig svefn þeirra. Það er mikilvægt að taka ábyrgð á eigin heilsu og heilbrigði um lifstil snemma í æsku og þegar komið er á unglingsár til að auka lifsgæði og minnka áhættu á sjúkdónum sem gætu annars komið fram seinna á lifsleiðinni.

Markmið þessarar rannsóknar er að skoða samband þreks og svefn meðal ungranna í 10. bekk í grunnskóla.

Heilsuhægðun ungra Íslandinda er framhaldsrannsókn af Lifstill 7 og 9 ára íslenskra barna – íhlutunarrannsókn til bættarar heilsu. Um þversniðsrannsókn er að ræða og voru þátttakendur 301 nemendur úr fyrri rannsókn, ásamt nýjum nemendum en 258 nemendur voru í eftirfarandi rannsókn. Þrekpróf á hjóli (W/kg), hámarksstökkkraftspróf (cm), gripstyrkur (pund), þyngd (kg) og hæð (cm) voru mæld auk þess sem spurningalisti var notaður til að meta skjáttima og þunglyndi. Svefn var mældur með svefnmælum (ActiGraph GTX3+) sem nemendur bæru á úlnlið í eina viku.

Samband þreks og svefn var metið með línulegri aðhvarfsgreiningu, að teknu tilliti til áhrifa frá huganlegum gruggandi þáttum.

Helstu niðurstöður rannsóknarinnar sýna að meðalsvefnlengd á skóladögum eru 6,2 klst (SF=0,81) hjá drengjum og 6,2 klst (SF=0,68) hjá stúlkum. Þegar hópurinn er skoðaður í heild er samband svefnlengdar á skóladögum og þrektölu marktækt (p<0,05). Samband reynist á mörkum marktektar hjá stúlkum (p=0,051) en ekki marktækt hjá drengjum. Samband svefnlengdar á frídögum og hámarksstökkkrafts is marktækt hjá stúlkum (p<0,05) og einnig eftir að leiðréttað fyrir skjáttima og þunglyndi en ekki hjá drengjum. Hvorki var samband á milli svefn og gripstyrks hjá stúlkum né drengjum.

Svefn skilvirkni var ekki marktækt hjá neinni þrekþrekgju. Rannsóknin sýnir að marktækt samband er á milli svefn og þreks hjá hópnum í heild og stúlkum en ekki drengjum.
# Table of contents

Preface .......................................................................................................................... 3  
Abstract ......................................................................................................................... 4  
Ágrip ............................................................................................................................... 5  
List of figures .................................................................................................................. 7  
List of tables ................................................................................................................... 7  
1 Introduction ................................................................................................................ 8  
2 Literature review ........................................................................................................ 9  
   2.1 Adolescence .......................................................................................................... 9  
   2.2 Fitness .................................................................................................................. 9  
   2.3 Sleep ..................................................................................................................... 10  
   2.4 Factors that affect sleep ..................................................................................... 13  
   2.5 Gender differences ............................................................................................. 14  
   2.6 Aim of the study .................................................................................................. 15  
3 Methods and subjects ............................................................................................... 16  
   3.1 Participants ......................................................................................................... 16  
   3.2 Research design .................................................................................................. 17  
   3.3 Measurements ..................................................................................................... 18  
      3.3.1 Sleep ........................................................................................................... 18  
      3.3.2 Fitness ......................................................................................................... 19  
      3.3.3 Other measures ......................................................................................... 21  
   3.4 Statistical analysis ............................................................................................... 22  
4 Results ....................................................................................................................... 24  
   4.1 Participants ......................................................................................................... 24  
   4.2 Sleep duration ..................................................................................................... 26  
   4.3 Sleep across categories of fitness, screen time and depression ......................... 27  
   4.4 Linear association between fitness and sleep ..................................................... 29  
5 Discussion .................................................................................................................. 34  
6 Conclusion ............................................................................................................... 39  
References ..................................................................................................................... 40  
Appendix 1 – Informed consent ................................................................................... 45  
Appendix 2 – Sleep log ............................................................................................... 51  
Appendix 3 – Questionnaire ....................................................................................... 52
List of figures

Figure 1. Participation. ...................................................................................................................... 17
Figure 2. Vertical jump display for participants.............................................................................. 20
Figure 3. Association between nocturnal sleep duration (minutes) on school
days and cycle ergometer fitness test (W/kg) for the whole group................................. 32
Figure 4. Association between vertical jump and nocturnal sleep duration
(minutes) on non-school days. ....................................................................................................... 33

List of tables

Table 1. Baseline characteristics of participants and mean values of sleep
parameters during one-week of measurements........................................................................ 25
Table 2. Values representing tertiles for each variable by gender.................................................. 27
Table 3. Sleep duration associated with fitness, depression and screen time
variables. ........................................................................................................................................ 28
Table 4. Linear regression of the association between fitness variables and
nocturnal sleep duration. ............................................................................................................... 30
1 Introduction

This thesis is based on the study Health behavior of Icelandic adolescents, a continuation study of Lifestyle 7 and 9 year old Icelandic children – research for improved health that was completed in 2006 and 2008. In the Health behavior study, the participants from the previous Lifestyle study were invited to participate along with new participants. The data for the Health behavior study was collected in the spring of 2015. In this thesis the association between fitness and sleep duration and efficiency will be studied, along with screen time and depression. This thesis is a cross-sectional study.

Fitness is the ability that an individual needs to perform certain motor skills (Bouchard, Blair, & Haskell, 2012). It is important to take responsibility for a healthy lifestyle for current and future health in childhood and adolescence to increase the quality of life and decrease the risk of diseases (Bouchard et al., 2012).

Previous studies have shown that sleep duration seems to have a major impact on the health status of adolescents (Bawazeer et al., 2009; Lowry et al., 2012). According to guidelines from The National Sleep Foundation, recommended sleep duration for adolescents is 8 – 10 hours (Hirshkowith, 2015).

There is not a great deal of research that has been conducted to explore the association between fitness and sleep. In this thesis objective measurements along with subjective measurements will be used to assess the association between fitness and sleep among 15 year old Icelandic adolescents, a total of 258 participants. This thesis consists of a literature review, study methods including statistical analyses, results, discussion and conclusion.

Results of the research can provide important information about fitness and sleep of Icelandic adolescents in this age group and what preventive actions welfare, health and education authorities might need to consider in the coming years and decades.

The aim of the thesis is to assess the association between fitness and sleep among 15 year old Icelandic boys and girls.
2 Literature review

2.1 Adolescence

Adolescence is defined by the World Health Organization as:

“The period in human growth and development that occurs after childhood and before adulthood, from ages 10 to 19. It represents one of the critical transitions in the life span and is characterized by a tremendous pace in growth and change that is second only to that of infancy. Biological processes drive many aspects of this growth and development, with the onset of puberty making the passage from childhood to adolescence. The biological determinants of adolescence are fairly universal; however, the duration and defining characteristics of the period may vary across time, cultures, and socioeconomic situations. This period has seen many changes over the past century namely the earlier onset of puberty, later age of marriage, urbanization, global communication, and changing sexual attitudes and behaviors” (World Health Organization, n.d.).

Adolescence has also been described as a vulnerable period in a person’s life. Physiological, psychiatric, socio-cultural and psychological factors are changing and can have effects on the health and behavior of adolescence including sleep (Lang et al., 2013).

2.2 Fitness

Fitness is the ability individuals need to perform certain motor skills. Fitness plays a vital role for health and activities in daily life for adolescents (Bouchard et al., 2012). Physical fitness is defined as “the ability to perform muscular work satisfactorily” by The World Health Organization (Bouchard et al., 2012). Fitness is usually classified as a focus on one of two objectives: performance-related fitness or health-related fitness. Performance-related fitness is defined as a part of fitness that is essential to reach a high sport performance. Health-related fitness is defined as a lifestyle that benefits physical activity and is connected to persons health (Bouchard et al., 2012). The focus in this thesis is on health-related fitness.

Studies have indicated that individuals who have better physical fitness as children and adolescents are more physically active in their adulthood (Malina, 2001). Fitness improves by aerobic exercise and there are many health benefits of exercising and being physically active; it decreases the risk of hypertension, diabetes type 2, obesity
and several cardiovascular diseases. Fitness can also play a vital part when it comes to mental health as well as the health of muscles, bones and joints (Wilmore, Costill, & Kenney, 2008).

When an individual has reached his maximal limit to increase oxygen consumption ($V_O^2$), he has reached his maximal oxygen uptake ($V_O^{2max}$). $V_O^{2max}$ has often been referred to as one of the best indexes of cardiorespiratory endurance capacity. $V_O^{2max}$ is expressed relative to body mass when cardiorespiratory fitness is measured (Wilmore et al., 2008).

There is a gender difference in $V_O^{2max}$ but the average female reaches her peak $V_O^{2max}$ between ages 12 – 15 while the average male reaches his peak between ages 17 – 21. After puberty, the average female $V_O^{2max}$ is only 70% - 75% of the average male. The gender differences are primarily due to body size differences (Wilmore et al., 2008).

Grip strength has been defined as the maximal power of forceful flexion of all fingers and it indicates individual muscular strength (Fallahi & Jadidian, 2011; Koley & Singh, 2010). Factors that affect grip strength are age, body size and gender among other factors (Koley & Singh, 2010).

Vertical jump test is often used to assess power and anaerobic fitness (Siegler, Robergs, & Weingart, 2006; Yanci et al., 2016).

Physical activity and exercise increase and maintain fitness and strength (Wilmore et al., 2008). Physical activity decreases significantly during adolescence. Studies have shown that physical activity has multifactorial benefits for health; it increases quality of life and decreases risk of diseases and mental disorders. Sedentary behavior can have bad effects on health but according to Icelandic Directorate of Health, adults should get at least 30 minutes of physical activity a day and children at least 60 min ( Lýðheilsustöð, n.d.).

### 2.3 Sleep

We spend about one-third of our lifetime sleeping (Chang, Huang, Chen, Wright, & Liao, 2013). Sleeping is important to us because it helps us maintain good health condition, promotes a healthy lifestyle and maintains physical and mental function (Chang et al., 2013). Sleep quality was one of the most important standards of health in the year 2000 by the World Health Organization. The effects that sleep duration and sleep difficulties have on health are becoming more acknowledged and sleep problems in adolescents are often noticed (Arora, Broglio, Thomas, & Taheri, 2014).
It has been suggested that about 15 million American children and adolescents do not get adequate sleep duration throughout the night (Smaldone, Honig, & Byrne, 2007). Research shows that adolescents report an average sleep duration of around 7 - 8 hours and even less, almost 7 out of 10 high school students in the United States report sleeping less than 8 hours during the night on a school night (Calamaro et al., 2010; Knutson, 2005; Lowry et al., 2012). A study conducted on middle school students in the United States found that about 70% of adolescents and students do not achieve the adequate 8 hour sleep duration on school nights. By getting insufficient hours of sleep per night may be connected to a variety of risks in health behavior, for example feelings of sadness or hopelessness, not performing 60 minutes of physical activity a day in 5 of 7 days and watching TV or using a computer more than 3 hours a day (Lowry et al., 2012; McKnight-Eily et al., 2011).

Studies about adolescent sleep have shown varying mean sleep duration on school days, depending on age, such as 7.7 hours (SD=1.08) (Javaheri, Storfer-Isser, Rosen, & Redline, 2011) and 7.91 hours (SD=0.04) (Calamaro et al., 2010). Mean sleep duration on school days has been reported as 7.60 hours (SD=1.10) compared with 9.23 hours on weekends (SD=1.42) (Chen et al., 2014). Difference in the mean sleep duration has also been reported for the genders, or 6.7 hours (95% CI: 6.7-6.8) for girls and 6.9 hours (95% CI: 6.8-6.9) for boys (Lowry et al., 2012). In the early 20th century, average sleep of adolescents was measured 9.1 hours per night but in the second half of the 20th century, it measured 7.4 hours per night (Knutson, 2005).

Many studies classify short sleep or insufficient sleep, depending on age, as less than 8 hours (<8 h/night) on weekdays and on weekends (Chen et al., 2014; Countryman et al., 2013; Felden et al., 2015; McKnight-Eily et al., 2011; Sung et al., 2011) but studies have also classified short sleep as less than 7 hours (<7 h/night) (Bawazeer et al., 2009; Krueger, Reither, Peppard, Burger, & Hale, 2015) and less than 6 hours (<6 h/night) (Calamaro et al., 2010). Insufficient sleep has been associated with obesity, depression, low school performance and various risk behaviors (Chaput & Janssen, 2016). Furthermore, poor sleep quality has been associated with low physical activity the next day (Gupta, Mueller, Chan, & Meininger, 2002). Studies of the association between health and sleep quality show that sleep duration has been related to cardiovascular diseases and studies have also shown a positive relationship between health and good sleep quality (Pilcher, Ginter, & Sadowsky, 1997).

High hormonal functions take place in sleep and therefore a good nights sleep for adolescents is important (Taheri, Lin, Austin, Young, & Mignot, 2004). Obesity and
lower grades in school have been linked to short sleep duration and daytime sleepiness (Arora et al., 2014) and it has been shown that short sleep can play a major role as a cause of obesity and higher BMI and waist circumference in children and adolescents (Krueger et al., 2015; Morrissey et al., 2016).

Public health guidelines for sleep duration are different for children, adolescents and adults. According to guidelines from The National Sleep Foundation, recommended sleep duration for adolescents is 8 – 10 hours (Hirshkowith, 2015).

Studies show that sleeping patterns change a lot when adolescence is reached. Sleep duration is decreased, time of sleep is delayed and daytime sleep is increased (Carskadon, 1990). Naps during the day are rare among young school aged children but a study showed that 40% of adolescents, age 15-20, took a nap during the day on school days (Thorleifsdottir, Bjornsson, Benediktsdottir, Gislason, & Kristbjarnarson, 2002). Parents often decrease their involvement in controlling bedtime when their children reach adolescence, but many adolescents rely on their parents to wake them up in the morning. Many changes happen during this period in life: most adolescents are experiencing new social situations, for example making new friends and converting the relationship with their parents (Carskadon, 1990, Thorleifsdottir, 2002). In this period the circadian clock is changing, adolescents prefer to go late to bed and wake up later, which is different from preadolescents and adults, but early rise on school days causes adolescents to lose sleep (Hansen, Janssen, Schiff, Zee, & Dubocovich, 2005). It has been shown that males sleep longer than females before the age of 18 but after the age of 19 this trend alters and males sleep less than females (Krueger et al., 2015).

We live in a time where technology plays a big part in the life of adolescents. With increased technological advances in recent years, many adolescents spend a lot of time using their personal and mobile devices, which may have negative effects on sleep (Knutson, 2005). Adolescents sleep schedule can be unstable due to differences between school days and weekends where sleep duration is longer on the weekends (Hansen et al., 2005). This implies that adolescents are trying to catch up on sleep on weekends because they do not get sufficient duration of sleep during the week (Hansen et al., 2005) but it has also been estimated that adolescents only sleep 1 hour longer on weekends than on school days (Chaput & Janssen, 2016).

Sleep quality can be a very complicated health issue, because of many specific factors like genetics, physical health, emotional and psychological elements. Sleep quality consists of factors including sleep efficiency, sleep duration and sleep disturbances (Chang et al., 2013).
Sleep can be evaluated by using subjective measures like questionnaires. Most studies use self-reported questionnaire to collect information about adolescents' sleep. The advantages of using questionnaires are that they are relatively cheap, take short time to collect data and it is possible to get a large sample of participants. The disadvantages are that participants might overestimate or underestimate their sleep duration or not correctly remember their sleep patterns. Sleep can also be evaluated by using objective measures like accelerometers. It is not as common to use accelerometers to study sleep but it will probably be more common in the future because of technological advances that have been emerging for the last years. Accelerometers are very accurate, but they are expensive to get for a large group and the study sample is therefore most often much smaller.

The association between fitness and sleep has not been studied extensively. Fitness can be measured by many different tests, objective or subjective and that can make it difficult to compare previous studies. A study of Portuguese girls found that poor sleep quality was associated with a low cardiorespiratory fitness, but the authors point out that the relationship between sleep duration and VO$_{2\text{max}}$ in adolescents has not been researched in other studies (Mota & Vale, 2010). Countryman and colleagues (Countryman et al., 2013) discuss the metabolic syndrome and the association between physical activity, physical fitness and sleep. The association between physical activity and physical fitness is well known but existing literature shows that it is unclear how sleep duration can be linked to physical activity and physical fitness. Their study showed that lifestyle related factors like low physical activity, short sleep duration, poor sleep quality and increased fatigue is associated with the risk of metabolic syndrome and inflammation, possibly due to less physical fitness in adolescents who are at risk at developing cardiovascular disease.

2.4 Factors that affect sleep
Various factors have effects on adolescent sleep. A study conducted on self-reported exercise showed that adolescents who exercised had better sleep patterns, including higher sleep quality and less fatigue, but males who had low exercise levels had an increased risk for insufficient sleep and psychological function (Brand et al., 2010).

Psychological health issues, such as depression among children and adolescents are becoming a great public health concern (Cao et al., 2011). An association has been found between short sleep and depression (Calamaro et al., 2010) but there are also indications that depression may result in sleep problems such as short sleep duration in
adolescents (Peach, Gaultney, & Reeve, 2015). Depression increases significantly in adolescence between ages 13 – 18 years, which is a vulnerable developmental period (Tesler et al., 2016).

Internet use has increased enormously over the last years (Tan, Chen, Lu, & Li, 2016). Various guidelines advise that children and adolescents should limit their screen time to no more than 2 hours a day (Cao et al., 2011) but over 50% go beyond these guidelines (Suchert, Hanewinkel, & Isensee, 2016). Results show that sleep problems are higher among students who are addicted to the internet and too much internet use can influence the health of individuals through sleep deficiency (Tan et al., 2016). It has been shown that many adolescents use devices with screens after they go to bed and more than 60% of them send/or receive text messages during that time. These adolescents reported more fatigue at school (American Academy of Pediatrics, 2013). Screen time has also been associated with health problems such as obesity (Morales-Ruan, Hernandez-Prado, Gomez-Acosta, Shamah-Levy, & Cuevas-Nasu, 2009), mental health problems, depressive anxiety symptoms and lower academic outcome (Cao et al., 2011; Suchert et al., 2016).

The average adolescent spends around 3 hours per day using small screens (Suchert et al., 2016) and males report more hours of screen time than females (Sirard et al., 2013). Studies have shown that screen time does not affect fitness if a person maintains sufficient physical activity (Bai et al., 2016).

### 2.5 Gender differences

Changes during adolescence happen at different rates between the genders. The average age when individuals reach maximum height is 16 for girls and 18 for boys, but it is also common for some boys to reach their maximal height in their early 20s. Girls mature about 2 years earlier than boys because of physiological reasons. If growth in height is examined, girls reach their peak in growth around age 12 while boys reach theirs at the age of 14, but after that they start to grow slower. Increase in body weight has a similar pattern but it occurs slightly later than growth in height. Girls usually reach their peak increase in body weight at age 12.5 years and boys at 14.5 years. The body’s muscle mass is increasing from birth through adolescence, along with weight. The skeletal muscle mass increases faster in boys than girls. Fat is around 10% of the body weight at birth. At physical maturity, fat is about 15% of the total body weight in boys and around 25% in girls. Reasons for this gender differences are mainly hormonal.
differences. The estrogen levels in girls increases when they reach puberty which contributes the precipitation of body fat (Wilmore et al., 2008).

2.6 Aim of the study

The aim of the study is to evaluate the association between fitness and nocturnal sleep in boys and girls while taking into account the possible effects of screen time and depression. As a secondary aim, the association between fitness and sleep efficiency will be assessed. The associations will be evaluated for regular school days and non-school days.

The hypothesis for this thesis is that adolescents with high fitness level sleep longer than adolescents with low fitness level and that their sleep efficiency is better.
3 Methods and subjects

3.1 Participants

This thesis is based on a study called Health behavior of Icelandic adolescents, which is a continuation study of Lifestyle 7 and 9 year old Icelandic children – research for improved health. The Lifestyle study was conducted in 2006 and 2008. In the Health behavior study, the individuals from the Lifestyle study were invited to participate along with new students. Participants in the study were students born in the year 1999 in six elementary schools in Reykjavik, Iceland. The elementary school system in Iceland is a mandatory education for children and adolescents from age 6 – 16 year old. Children start in 1st grade and finish in 10th grade. The participant schools in the Lifestyle study were the same as in the Health behavior study, except for two, because they only have students up to 7th grade and the Health behavior study required students from 10th grade. The two schools that were selected for a replacement were schools that only have students in 8 – 10th grade. These schools had participants from the Lifestyle study along with new students who were offered participation. In the Lifestyle study the schools were randomly selected.

A sample of 418 students was offered participation. Members of the research team went into the schools about two weeks before the study was going to take place and introduced it to students and what was expected from them if they chose to take part. The students received an envelope with an introduction letter and an informed consent to take home for their parents to sign if they decided to participate in the study (see appendix 1). The study was approved by The National Bioethics Committee of Iceland, The Icelandic Data Protection Authority and The Icelandic Radiation Safety Authority.

A total of 301 students participated in the study, 179 from previous study and 127 new students, which accounts as about 72% participation. For this thesis, data was needed for sleep, fitness, screen time and depression (see figure 1). After eliminating students with missing data for sleep, 278 students remained in the sample. To have valid data for sleep duration and quality, the students needed to have valid measures for 3 school days and 1 non-school day. This is comparable to the Danish sleep study using accelerometers (Hjorth et al., 2014). After eliminating students without data for
fitness outcome, there were 258 participants remaining. Out of the 258 students included in this thesis, 105 boys and 153 girls.

In this thesis adolescents are defined as 15 - 16 years olds and in their last year of elementary school. The study took place in 2015, starting in April and ending in early June.

Figure 1. Participation.

3.2 Research design

The Health behavior of Icelandic adolescents is a continuation study of the Lifestyle of 7 and 9 year old Icelandic children – research for improved health, which was conducted in 2006 and 2008. In the Health behavior study, the students from the Lifestyle study were invited to participate along with new students.

This thesis is a cross-sectional study based on data collected in Reykjavik, Iceland in the spring of 2015. Researchers got access to a classroom or a gym dressing room in each of the six schools to set up devices that they used for measurements. Most of the measurements took place at the schools. Participants started the process by answering a questionnaire using iPads (see appendix 3). Next, accelerometers were placed on their non-dominant wrist and participants wore them for one week. Participants also
received a sleep log were they wrote down information about their sleep habits (see appendix 2). After answering the questionnaire and receiving the accelerometers, participants were given scheduled times for their measurements.

Participants showed up in the research lab on scheduled times. The lab was usually set up in a classroom or a gym dressing room and researchers had made a partition with curtains so participants would have privacy while performing the measurements. Participants performed an endurance test on a cycle ergometer bike, vertical jump test and grip strength test. Body composition was measured (height, weight, fat% and circumference) and blood pressure was measured by using a sphygmomanometer.

Two parts of the study measurements, a blood test and bone densitometry (DXA) took place at the Icelandic Heart Association (Hjartavernd), which is located in Kópavogur, Iceland. Due to the distance of the location the researchers drove the students by a van to the Icelandic Heart Association and back to the school afterwards (data not used in the current study).

It took participants approximately one hour to complete the measurements at the schools and it took around 2 to 3 hours at the Icelandic Heart Association, due to driving time.

3.3 Measurements
A wide range of data was collected in the study but in this thesis, parameters on sleep, fitness and related measures were used.

3.3.1 Sleep
3.3.1.1 Accelerometer
Accelerometers, ActiGraph GTX3+ (ActiSleep by Actigraph Inc. Pensacola Florida) were used to evaluate the nocturnal sleep of participants. The accelerometers are blocks, similar in size to a wristwatch, that participants wore around their non-dominant wrist continuously like a watch for 7 days, including overnight and when they showered or swam. When the block is activated it counts the fluctuations within a given period, and places it in the memory each minute. The block can collect information for up to 21 days (ActiGraph, n.d.). Researchers put the accelerometers on participants in the school and removed them 7 days later at the same school. Data was processed from the monitors with Actilife software 6.13.0. and sleep parameters calculated based on Sadeh’s scoring algorithm, previously validated for sleep assessment in adolescents (Sadeh, Sharkey, & Carskadon, 1994)
The accelerometer documents diverse sleep characteristics; actual sleep duration during rest period which is the total time spend sleeping, total rest duration which is the total time spent in bed or sleeping, sleep efficiency which is the ratio of total sleep time to total time in bed (Weinhold et al., 2016), number of awakenings (NOA) which is when participants wake up during sleep duration or total sleep time (TST), wakening after sleep onset (WASO) which is minutes of lost sleep time of the sleeping period, sleep fragmentation index (SFI) which is calculated by summing the movement index. The accelerometer also documents: clock times for bed time (BT) which is time of going to bed, midpoint of sleep (MS) which is the clock time in the middle of the sleep period and rise time (RT) which is the clock time of when participants woke up.

The main sleep parameter used in this thesis is sleep duration (actual sleep time) and sleep efficiency was also looked at. Only data from valid measurement days were used.

3.3.1.2 Sleep log
Participants received a sleep log along with the accelerometer (see appendix 2). The sleep log contained questions about when participants went to bed in the evening, when they went to sleep, when they woke up in the morning and when they got out of bed among other questions. These questions were used when the results from the accelerometers were examined. One of the reasons why a sleep log was needed was because if a participant goes to bed and lies still in the darkness, the accelerometer counts that the person is asleep while he might be lying completely still in bed and watching TV. By comparing the accelerometer and the sleep log, it is possible to estimate the sleep time.

3.3.2 Fitness
Cardiorespiratory fitness, muscle strength and power were measured in the following fitness tests.

3.3.2.1 Cycle Ergometer fitness test (VO$_{2\text{max}}$)
Cardiorespiratory fitness was measured by a standard endurance test (VO$_{2\text{max}}$ test) on a stationary testing bike (Monark Ergometer 839E). The test was explained in details by the researchers before participants took the test. Implementation of the VO$_{2\text{max}}$ test is that strain is very small to begin with and then it is increased slowly. Rate of rotations per minute (rpm) is kept between 60 to 80 rpm to begin with. The watts in the test are not the same for girls and boys due to biological gender differences (Wilmore et al.,
Boys start the test at 50 watts and the intensity is increased by 50 watts every 3 minutes. This is increased until the person cannot keep up the speed or at least 30 rpm or if the person decides to stop the test and then the test is completed. The test is the same for both genders except the test for the girls starts at 40 watts and the intensity is increased by 40 watts every 3 minutes. Participants wore heart rate monitors during the test and their safety was ensured. During the test participants were encouraged to do their best, but they were also reminded that they could quit the test at any time. Maximal watts from the cycle ergometer test was calculated by using following equation: 

\[ W_{\text{max}} = W_1 + \frac{W_2}{T}/180 \]

where \( W_1 \) is the total power in the last level that was completed and \( W_2 \) is the increase of power in the final level that was not completed. \( T \) is the time for the unfinished final level and 180 is the pulse (Margrét H. Indriðadóttir, Þórarinn Sveinsson, Kristján Þór Magnússon, Sigurbjörn Árni Arngrímsson, & Erlingur Jóhannsson, 2015). Fitness outcome (W/kg) was measured by dividing watts (W) with kilograms (kg) (Riddoch et al., 2005).

### 3.3.2.2 Vertical jump test

Power was measured by a vertical jump test with a device called Optojump. Optojump is a measurement system that uses a transmitting and a receiving bar with leds to measure vertical jumps. The bars are connected to a computer that preserves information about the jump in height (cm) and time (sec) (Optojump, n.d.).

To begin with, researchers explained how to perform the test. A picture of a vertical jump (see figure 2) was hanging on the wall to display the jump for participants. The implementation of the test was that participants stepped in between the bars, without shoes and with a gap between their feet. They put hands on their hips and when they were ready, they bent their knees and took the jump. When landing after the jump, they tried to land in a similar place as the jump started and on both feet. Each participant got 3 attempts at jumping and their best attempt was documented.

![Figure 2. Vertical jump display for participants.](image)
3.3.2.3 Grip strength test
Muscle strength was measured with a grip strength test (lb) using a SAEHAN hydraulic hand dynamometer by Jamar (Wieczorek, Wilinski, Struzik, & Rokita, 2015). Researchers began by explaining how to perform the test. Participants sat in a chair and flexed their dominant elbow in 90°. The hand dynamometer was fixed to fit in their hand and when participants were ready, they squeezed the hand dynamometer as fast as they could until the researcher told them to let go. Each participant got 3 attempts and their best attempt was documented.

3.3.3 Other measures
3.3.3.1 Questionnaire
Participants were asked to fill out a health related questionnaire on iPads provided by the researchers (see questions used in this thesis in appendix 3). The questionnaire is large and consists of many diverse questionnaires, for example The Symptom Checklist 90 (SCL 90) (Prinz et al., 2013), The Offer Self-Image questionnaire (Treger, Matusiak, Pilecki, & Rogoz, 2015) and Rosenberg Self-Esteem questionnaire (Robins, Hendin, & Trzesniewski, 2001). The questionnaires were assigned to estimate factors that were related to lifestyle choices such as sports and recreation, physical fitness, outlook on life along with physical and mental wellbeing of participants.

Screen time was estimated as the total time spent in front of a screen (see appendix 3). Screen time was evaluated by questions about how many hours participants spend per day watching TV, playing computer games, on the internet and in the computer, both on school days and weekends. Reply options for screen time were the following:

- None
- About ½ hours
- 1-2 hours
- 2-3 hours
- 3-4 hours
- 4-5 hours
- More than 5 hours

The Symptom Checklist 90 (SCL 90) is a widely used questionnaire for various mental disorders (Prinz et al., 2013). In this study, depression was evaluated with 10 questions from the checklist, about how often the individual experienced distress or
discomfort over the past week, for example feeling sad, lonely and having trouble sleeping. Reply options for depression were the following:

- Almost never
- Rarely
- Sometimes
- Often
- Almost always

Depression score ranged from 10 – 50, where the lowest score of depression was 10 and the highest score of depression was 50 (Gestsdottir et al., 2015).

### 3.3.3.2 Body Mass Index

Body mass index (BMI) is a clinical standard assessment to evaluate obesity. BMI was calculated by measuring height and weight of participants. BMI is calculated by dividing the individuals body weight in kilograms by the square of body height in meters. When BMI is calculated for children and adolescents, BMI-for-age percentile growth chart is used. A standard table for children and adolescents from age 2 to 20 years has four categories: underweight, normal or healthy weight, overweight and obese. Children and adolescents have a different BMI table than adults because their weight, height and body fat is changing with age and they need to be compared to other children and adolescents within the same sex and age group (Centers for Disease Control and Prevention, n.d.).

### 3.4 Statistical analysis

The software package SPSS (Statistical Package for the Social Sciences, version 22.0) was used for statistical analysis. All analyses were conducted for each gender separately. Descriptive statistics were used to present the characteristics of the study participants. A T-test was used for comparisons between genders. Linear regression analysis was used for estimation of the linear association between sleep and fitness variables. Separate models were run for sleep on school days and sleep on non-school days and for each of the fitness variables, cycle test, grip strength and jump height. In addition to treating the study variables as continuous variables in the linear regression analysis, those variables were categorized in tertiles and treated as categorical parameters in analysis of variance (ANOVA) with post hoc test (least significant difference) for differences between genders. The groups were named low, medium and high. The low group contained the participants with the lowest scores for each
measure, the medium group had participants that fell between the low and high tertiles and lastly the high group contained participants with the highest score. The variables used were: cycle ergometer fitness test, grip strength test and vertical jump test, depression and screen time. Significance was based on 95% significance level ($p<0.05$).
4 Results

4.1 Participants
A total sample size of the Health behavior of Icelandic adolescents study is 301 participants while 258 participants, 153 girls (59%) and 105 boys (41%) had all data needed in this thesis. Baseline characteristics are described in table 1. Means and standard deviations were calculated for all variables for both genders and the group as a whole.
Table 1. Baseline characteristics of participants and mean values of sleep parameters during one-week of measurements.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Total (n=258)</th>
<th>Boys (n=105)</th>
<th>Girls (n=153)</th>
<th>Comparison between boys and girls</th>
<th>P-value for T test</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td>Mean (SD)</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Height (cm)</td>
<td>171.4 (5.8)</td>
<td>178 (5.9)</td>
<td>166.8 (5.8)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Weight (kg)</td>
<td>64.6 (11.1)</td>
<td>68.6 (11)</td>
<td>61.9 (10.3)</td>
<td>0.546</td>
<td></td>
</tr>
<tr>
<td>BMI (kg/m²)</td>
<td>22 (3.2)</td>
<td>21.6 (3)</td>
<td>22.2 (3.3)</td>
<td>0.152</td>
<td></td>
</tr>
<tr>
<td>All Valid Sleep Days (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep duration</td>
<td>395.9 (39)</td>
<td>392.6 (42.5)</td>
<td>398.1 (36.5)</td>
<td>0.264</td>
<td></td>
</tr>
<tr>
<td>Rest duration</td>
<td>451.8 (42.1)</td>
<td>449.18 (44.3)</td>
<td>453.6 (40.7)</td>
<td>0.407</td>
<td></td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>87.7 (4)</td>
<td>87.5 (3.9)</td>
<td>87.7 (4.2)</td>
<td>0.539</td>
<td></td>
</tr>
<tr>
<td>School Sleep Days (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep duration</td>
<td>371.6 (43.9)</td>
<td>371.3 (48.6)</td>
<td>371.8 (40.4)</td>
<td>0.934</td>
<td></td>
</tr>
<tr>
<td>Rest duration</td>
<td>423.2 (48.5)</td>
<td>422.6 (52)</td>
<td>423.7 (46.8)</td>
<td>0.870</td>
<td></td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>87.9 (4.3)</td>
<td>88 (4.5)</td>
<td>87.9 (4.2)</td>
<td>0.895</td>
<td></td>
</tr>
<tr>
<td>Non-School Sleep Days (min)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sleep duration</td>
<td>439.1 (66.3)</td>
<td>432.4 (78.1)</td>
<td>443.8 (56.8)</td>
<td>0.177</td>
<td></td>
</tr>
<tr>
<td>Rest duration</td>
<td>502.9 (73.7)</td>
<td>498.8 (87.8)</td>
<td>505.7 (62.4)</td>
<td>0.463</td>
<td></td>
</tr>
<tr>
<td>Sleep efficiency</td>
<td>87.4 (4.7)</td>
<td>86.8 (4.3)</td>
<td>87.8 (5)</td>
<td>0.081</td>
<td></td>
</tr>
<tr>
<td>Fitness</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Cycle ergometer fitness test (W/kg)</td>
<td>2.79 (0.68)</td>
<td>3.33 (0.59)</td>
<td>2.42 (0.47)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Grip strength test (lb)</td>
<td>73.5 (18.3)</td>
<td>86.9 (17.6)</td>
<td>64.4 (12.2)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Vertical jump test (cm)</td>
<td>25 (6.8)</td>
<td>29.5 (5.5)</td>
<td>21.9 (5.5)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Screen time (hours)</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>School days</td>
<td>5.5 (2.7)</td>
<td>5.8 (2.8)</td>
<td>5.2 (2.6)</td>
<td>0.074</td>
<td></td>
</tr>
<tr>
<td>Non-school days</td>
<td>6.6 (3.1)</td>
<td>7.2 (3.1)</td>
<td>6.2 (3.1)</td>
<td>&lt;0.05</td>
<td></td>
</tr>
<tr>
<td>Depression</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SCL 90 (10 - 50 scale)</td>
<td>17.5 (8.9)</td>
<td>14.6 (6.5)</td>
<td>19.5 (9.7)</td>
<td>&lt;0.001</td>
<td></td>
</tr>
<tr>
<td>Insufficient sleep on school days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;6 hours</td>
<td>38</td>
<td>40</td>
<td>36</td>
<td>0.473</td>
<td></td>
</tr>
<tr>
<td>&lt;7 hours</td>
<td>88</td>
<td>86</td>
<td>89</td>
<td>0.572</td>
<td></td>
</tr>
<tr>
<td>&lt;8 hours</td>
<td>99</td>
<td>98</td>
<td>100</td>
<td>0.087</td>
<td></td>
</tr>
<tr>
<td>Insufficient sleep on non-school days</td>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;6 hours</td>
<td>12</td>
<td>12</td>
<td>11</td>
<td>0.756</td>
<td></td>
</tr>
<tr>
<td>&lt;7 hours</td>
<td>35</td>
<td>41</td>
<td>31</td>
<td>0.098</td>
<td></td>
</tr>
<tr>
<td>&lt;8 hours</td>
<td>77</td>
<td>77</td>
<td>77</td>
<td>0.865</td>
<td></td>
</tr>
</tbody>
</table>
In table 1 nocturnal sleep duration, rest duration and sleep efficiency is examined in different periods: all valid sleep days, school days and non-school days. The first period is all valid sleep days, including all days that students were measured sleeping. Next period is school days, which are the days students went to school. The last period is non-school sleep days, which refers to sleep on weekends and school holidays. Insufficient sleep is displayed into three categories, less than 6, 7 or 8 hours sleep a night, on school days and non-school days. Mean sleep duration for boys and girls is around 6 hours on school days and 7 hours and 20 minutes on non-school days. Mean rest duration is almost 1 hour longer than sleep duration for both genders. Boys have significantly higher scores than girls for all fitness variables (p<0.001). The correlations between the fitness variables were examined. In boys and girls the correlation between cycle ergometer fitness test (W/kg) and vertical jump is significant (p<0.01) and also between grip strength and vertical jump is significant (p<0.01). On school days girls spend on average 5.2 hours in front of a screen and boys 5.8 hours (ns). On non-school days, boys spend on average 7.2 hours in front of a screen and girls spend 6.2 hours (the difference between gender was significant). Mean depression score is much higher for girls (19.5) than boys (14.6) (the difference between gender was significant).

4.2 Sleep duration

In this study, participants who sleep less than 6 hours a school night are 40% of the total boy participants and 36% of total girls participants. On non-school nights there are still 12% of boys and 11% of girls who sleep less than 6 hours. When less than 7 hours sleep per night is examined on school days, only 13% of the boys and 13% of the girls get sufficient sleep, which means that 86% boys and 89% girls get insufficient sleep. When examining less than 7 hours sleep a night on non-school days, there are still 41% boys and 31% girls that sleep less than 7 hours. None of the girl participants get more than 8 hours of sleep on school days and only 2% of the boys. On weekends, 77% of both genders do not sleep more than 8 hours a night.

Daytime naps were not included in the sleep duration and the naps among participants were rare. There were only a total of 22 naps taken by all the participants during the week of measurements, with most participants taking 1 nap and one participant took 5 naps during the week. A nap is defined if there were more than 1 distinct sleep period for a given day. The actual sleep time during those naps ranged from 10 minutes up to 286 minutes.
4.3 Sleep across categories of fitness, screen time and depression

Values representing tertiles for each variable by gender are shown in table 2 and mean sleep duration in tertiles of fitness, screen time and depression on school days and non-school days by gender in table 3.

Table 2. Values representing tertiles for each variable by gender.

<table>
<thead>
<tr>
<th>Variable</th>
<th>Boys (n=105)</th>
<th>Girls (n=153)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Cycle ergometer fitness test (W/kg)</strong></td>
<td>Low 0 - 3.07</td>
<td>Low 0 - 2.23</td>
</tr>
<tr>
<td></td>
<td>Medium 3.08 - 3.61</td>
<td>Medium 2.24 - 2.60</td>
</tr>
<tr>
<td></td>
<td>High 3.62 +</td>
<td>High 2.61 +</td>
</tr>
<tr>
<td><strong>Grip strength test (lb.)</strong></td>
<td>Low 0 - 77.3</td>
<td>Low 0 - 60</td>
</tr>
<tr>
<td></td>
<td>Medium 77.4 - 93.6</td>
<td>Medium 60.1 - 67.6</td>
</tr>
<tr>
<td></td>
<td>High 93.7 +</td>
<td>High 67.7 +</td>
</tr>
<tr>
<td><strong>Vertical jump test (cm)</strong></td>
<td>Low 0 - 27</td>
<td>Low 0 - 19</td>
</tr>
<tr>
<td></td>
<td>Medium 28 - 32</td>
<td>Medium 20 - 24</td>
</tr>
<tr>
<td></td>
<td>High 33 +</td>
<td>High 25 +</td>
</tr>
<tr>
<td><strong>Depression (Symptom Checklist 90)</strong></td>
<td>Low 0 - 11</td>
<td>Low 0 - 14</td>
</tr>
<tr>
<td></td>
<td>Medium 12 - 14</td>
<td>Medium 15 - 20</td>
</tr>
<tr>
<td></td>
<td>High 15 +</td>
<td>High 21 +</td>
</tr>
<tr>
<td><strong>Screen time on school days (hours a day)</strong></td>
<td>Low 0 - 4.5</td>
<td>Low 0 - 4</td>
</tr>
<tr>
<td></td>
<td>Medium 4.6 - 6.5</td>
<td>Medium 4.1 - 5.5</td>
</tr>
<tr>
<td></td>
<td>High 6.6 +</td>
<td>High 5.6 +</td>
</tr>
<tr>
<td><strong>Screen time on non-school days (hours a day)</strong></td>
<td>Low 0 - 5.5</td>
<td>Low 0 - 5</td>
</tr>
<tr>
<td></td>
<td>Medium 5.6 - 8</td>
<td>Medium 5.1 - 7</td>
</tr>
<tr>
<td></td>
<td>High 8.1 +</td>
<td>High 7.1 +</td>
</tr>
</tbody>
</table>
Table 3. Sleep duration associated with fitness, depression and screen time variables.

<table>
<thead>
<tr>
<th>Variable</th>
<th>School days sleep duration</th>
<th></th>
<th>Non school days sleep duration</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>Boys (n=105)</td>
<td>Girls (n=153)</td>
<td>Boys (n=105)</td>
<td>Girls (n=153)</td>
</tr>
<tr>
<td></td>
<td>mean min (h)</td>
<td>mean min (h)</td>
<td>mean min (h)</td>
<td>mean min (h)</td>
</tr>
<tr>
<td>Cycle ergometer fitness test (W/kg)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>365 (6)</td>
<td>365 (6.1)</td>
<td>428 (7.1)</td>
<td>448 (7.5)</td>
</tr>
<tr>
<td>Medium</td>
<td>368 (6.1)</td>
<td>373 (6.2)</td>
<td>432 (7.2)</td>
<td>457 (7.6)</td>
</tr>
<tr>
<td>High</td>
<td>380 (6.1)</td>
<td>379 (6.3)</td>
<td>438 (7.3)</td>
<td>427 (7.1)</td>
</tr>
<tr>
<td>Grip strength test (lb)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>376 (6.3)</td>
<td>360 (6)</td>
<td>430 (7.2)</td>
<td>441 (7.4)</td>
</tr>
<tr>
<td>Medium</td>
<td>369 (6.2)</td>
<td>377 (6.3)</td>
<td>429 (7.2)</td>
<td>445 (7.4)</td>
</tr>
<tr>
<td>High</td>
<td>369 (6.2)</td>
<td>370 (6.2)</td>
<td>438 (7.3)</td>
<td>445 (7.4)</td>
</tr>
<tr>
<td>Vertical jump test (cm)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>370 (6.2)</td>
<td>370 (6.2)</td>
<td>423 (7)</td>
<td>460 (7.7)</td>
</tr>
<tr>
<td>Medium</td>
<td>384 (6.4)</td>
<td>373 (6.2)</td>
<td>448 (7.5)</td>
<td>445 (7.4)</td>
</tr>
<tr>
<td>High</td>
<td>358 (6)</td>
<td>375 (6.3)</td>
<td>434 (7.2)</td>
<td>424 (7.1)</td>
</tr>
<tr>
<td>Depression (Symptom Checklist 90)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>368 (6.1)</td>
<td>373 (6.2)</td>
<td>427 (7.1)</td>
<td>438 (7.3)</td>
</tr>
<tr>
<td>Medium</td>
<td>365 (6.1)</td>
<td>381 (6.4)</td>
<td>464 (7.7)</td>
<td>440 (7.3)</td>
</tr>
<tr>
<td>High</td>
<td>366 (6.1)</td>
<td>362 (6.0)</td>
<td>423 (7.0)</td>
<td>460 (7.7)</td>
</tr>
<tr>
<td>Screen time (hours a day)</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Low</td>
<td>377 (6.3)</td>
<td>370 (6.2)</td>
<td>431 (7.2)</td>
<td>448 (7.5)</td>
</tr>
<tr>
<td>Medium</td>
<td>371 (6.2)</td>
<td>375 (6.3)</td>
<td>431 (7.2)</td>
<td>449 (7.5)</td>
</tr>
<tr>
<td>High</td>
<td>363 (6.1)</td>
<td>369 (6.2)</td>
<td>436 (7.3)</td>
<td>435 (7.3)</td>
</tr>
</tbody>
</table>

Results of analysis of variance (ANOVA) with post hoc test for differences between the groups:

1. Girls in the high fitness group slept significantly less than girls in the medium fitness group (p < 0.05)
2. Girls in the high vertical jump group slept significantly less than girls in the low vertical jump group (p < 0.01)
3. Girls in the high depression group slept significantly less than girls in the low depression group (p < 0.05)
4. Boys in the high depression group slept significantly less than boys in the medium depression group (p < 0.05)
5. Girls in the high depression group slept significantly more than girls in the low depression group (p < 0.05)
When looking at the cycle ergometer fitness test, the sleep duration on school days becomes longer as the fitness outcome is higher. The participants in the group with the best fitness (high) sleep longer on school days, both girls and boys although the association was not significant. When looking at the non-school days, the same pattern is seen for boys, that is, those in the highest tertile for fitness had longer sleep than those in lower tertiles. However, girls who were in the best fitness group had the shortest sleep on non-school days, girls in the high fitness group, slept significantly less than girls in the medium fitness group (p<0.05).

Sleep duration did not differ significantly across groups of grip strength, neither in boys or girls, on school days or non-school days.

On school days, girls in the high vertical jump group slept slightly longer than other girls, although not significantly so. However, they slept significantly less than girls in the medium group (p<0.01) on non-school days. On school days, the girls in all vertical jump groups get similar sleep duration. There is no significant association between jump height and sleep within the group of boys but the medium group has the longest sleep duration, on both school days and non-school days.

Girls in the high depression group slept significantly less than girls in the medium depression group (p<0.05) on school days. Boys in the high depression group also slept significantly less than boys in the medium depression group (p<0.05) on non-school days. On non-school days, the association is reverse for girls, as the girls in the high depression group sleep significantly more than the girls in the medium group (p<0.05).

There is no significant association between sleep and screen time on school days and non-school days for both genders. Boys with high screen time sleep slightly less than boys with low screen time on school days. Boys with high screen time also sleep slightly more than boys with low screen time on non-school days but it is reverse for girls, where the ones with high screen time sleep less than girls with low screen time on non-school days.

4.4 Linear association between fitness and sleep
The association between fitness and sleep was assessed with linear regression analyzes, both in an unadjusted model and in the adjusted model, considering the possible confounding effects of depression and screen time (table 4).
Table 4. Linear regression of the association between fitness variables and nocturnal sleep duration.

<table>
<thead>
<tr>
<th></th>
<th>Linear regression</th>
<th>School days sleep duration</th>
<th>Non-school days sleep duration</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Boys</td>
<td>Girls</td>
</tr>
<tr>
<td>Cycle ergometer fitness test (W/kg)</td>
<td>Unadjusted model¹</td>
<td>14.4</td>
<td>13.7</td>
</tr>
<tr>
<td></td>
<td>(95% CI)</td>
<td>-1.5-30.2</td>
<td>-0.08-27.4</td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>0.03</td>
<td>0.03</td>
</tr>
<tr>
<td></td>
<td>Adjusted model²</td>
<td>5.4</td>
<td>15.0</td>
</tr>
<tr>
<td></td>
<td>(95% CI)</td>
<td>-12.0-22.8</td>
<td>-0.7-30.7</td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>0.08</td>
<td>0.04</td>
</tr>
<tr>
<td>Grip strength (lb)</td>
<td>Unadjusted model¹</td>
<td>-0.13</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(95% CI)</td>
<td>-0.67-0.415</td>
<td>-0.54-0.53</td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>0.002</td>
<td>0.000</td>
</tr>
<tr>
<td></td>
<td>Adjusted model²</td>
<td>-0.07</td>
<td>-0.02</td>
</tr>
<tr>
<td></td>
<td>(95% CI)</td>
<td>-0.61-0.48</td>
<td>-0.59-0.54</td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>0.07</td>
<td>0.01</td>
</tr>
<tr>
<td>Vertical jump test (cm)</td>
<td>Unadjusted model¹</td>
<td>-0.26</td>
<td>0.68</td>
</tr>
<tr>
<td></td>
<td>(95% CI)</td>
<td>-1.87-1.34</td>
<td>-0.50-1.87</td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>0.001</td>
<td>0.008</td>
</tr>
<tr>
<td></td>
<td>Adjusted model²</td>
<td>-0.77</td>
<td>0.63</td>
</tr>
<tr>
<td></td>
<td>(95% CI)</td>
<td>-2.38-0.85</td>
<td>-0.59-1.85</td>
</tr>
<tr>
<td></td>
<td>R²</td>
<td>0.08</td>
<td>0.02</td>
</tr>
</tbody>
</table>

¹Model including only physical measure as independent variable
²Model including in addition to physical measure, score on depression scale and reported screen time.

In the analysis of the relationship between cycle ergometer test and sleep on school days in boys, adjusting for either depression or screen time did not affect the B meaningfully but together these two parameters have a large effect on the B. There is not a significant interaction between the two nor a significant correlation so more likely the added effect of the two is having this large effect on the B.
In the unadjusted model, the association between sleep duration on school days and cycle ergometer fitness test (W/kg) was significant (p<0.05) in the whole group as displayed in figure 3 and borderline significant within the group of girls (p=0.051) but not in the group of boys (p=0.075). Sleep on non-school days and cycle ergometer fitness test (W/kg) was not significantly associated for the whole group (p=0.246), for girls (p=0.144) or for boys (p=0.568).

School days sleep duration and vertical jump was not significantly associated for girls or boys. Increased vertical jump height was significantly associated with shorter sleep on non-school days for girls (p<0.05) but not for boys (p=0.934) as displayed in table 4.

There was no association between sleep duration and grip strength on school days or non-school days sleep duration in boys or girls.

Screen time and depression were possible confounding factors. The association between sleep duration on school days and cycle ergometer fitness test (W/kg) was not significant for boys (p=0.540) or girls (p=0.062) after adjusting for screen time and depression. Sleep duration on non-school days was not significantly associated with cycle ergometer fitness test (W/kg) for boys (p=0.479) or girls (p=0.164) after adjusting for screen time and depression.

The association between sleep duration on school days and vertical jump test was not significant for boys (p=0.349) or girls (p=0.308) after adjusting for screen time and depression.

Sleep duration on non-school days was significantly associated with vertical jump test for girls (p<0.05) after adjusting for screen time and also after adjusting for both screen time and depression (p=0.05) but not for the group of boys (p=0.788).

Sleep efficiency on school days and cycle ergometer fitness test was not significant (p=0.914) for the whole group and not significant for boys (p=0.457) and girls (p=0.380). On non-school days, cycle ergometer fitness test was not significant for the whole group (p=0.376), boys (p=0.507) or girls (p=0.873).

Sleep efficiency on school days and cycle ergometer fitness test was not significant when adjusting for screen time for boys (p=0.45) or girls (p=0.380) and also on non-school days for boys (p=0.5) or girls (p=0.87). When adjusting for screen time and depression on school days, there was no signification for boys (p=0.396) or girls (p=0.570) and also on non-school days for boys (p=0.368) and girls (p=0.803).
Sleep efficiency was not significantly associated with vertical jump on school days for the whole group (p=0.239), boys (p= 0.124) or girls (p=0.552) and also for non-school days there was no association for the whole group (p=0.216), boys (p=0.724) or girls (p=0.886). Sleep efficiency was also not significantly associated with grip strength on school days for the whole group (p=0.145), boys (p=0.137) or girls (p=0.388), and also not for non-school days for the whole group (p=0.847), boys (p=0.302) or girls (p=0.596).

Sleep efficiency was not significantly associated with vertical jump in any of the analyses. Sleep efficiency was also not significantly associated with grip strength in any of the analyses.

Figure 3. Association between nocturnal sleep duration (minutes) on school days and cycle ergometer fitness test (W/kg) for the whole group.
Figure 4. Association between vertical jump and nocturnal sleep duration (minutes) on non-school days.
5 Discussion

The aim of the study was to evaluate the association between fitness and sleep for adolescent boys and girls. The hypothesis was that adolescents with high fitness level sleep longer than adolescents with low fitness level. The key findings in this study are that the association between sleep duration on school days and cycle ergometer fitness test (W/kg) was significant (p<0.05) for the whole group. In particular, girls with higher fitness (W/kg) slept borderline significantly longer than girls with lower fitness (W/kg) on school days. These results match the hypothesis but there are exceptions for other fitness variables. It was also found that the association between vertical jump test and sleep among girls is reverse on school days compared to non-school day while no association is observed in boys. No association was observed between any of the measured fitness variables and sleep efficiency. The results from this current study add support to previous studies indicating that there is a positive association between physical activity or fitness and sleep parameters (Brand, 2010; Mota & Vale, 2010) although further confirmation is needed, for example with intervention studies and long term follow up. Important findings are that many adolescents get insufficient sleep on school days and on weekends, more details regarding these findings are being published elsewhere.

Boys and girls in the highest group in the cycle ergometer fitness test (W/kg) sleep longer than those in the lowest group who get the shortest sleep duration on school days. The same pattern is seen for the vertical jump test for girls on school days. Interestingly the pattern is reversed on non-school days in particular for the vertical jump test where girls with higher jumping height have significantly shorter sleep than girls with lower jump height even when adjusting for confounding factors. The same pattern is seen for the cycle ergometer fitness test. The reason why girls with higher fitness levels have less variability in sleeping duration on school days compared with non-school days is not clear. However, it could be suggested that this is because they are exercising a lot during the week and are tired in the evening and therefore they go early to bed. As they are getting more sleep during the week perhaps they have less need to “catch up” on sleep in the weekends. However, despite that these girls in the high group get more sleep during the week than the other girls, they are still getting
insufficient sleep. The reason could also be that after a busy week girls want to hang out with friends and stay up later on weekends. These interesting findings needs further study.

Although the association between fitness and sleep has not been extensively studied, previous studies on associations between sleep and health related factors have found varying results for boys and girls. Sleep has been associated with the likelihood of obesity for girls but not for boys (Lowry et al., 2012), while others have found that sleep duration predicts risk of overweight among boys but not for girls (Knutson, 2005), or even that shortened sleep duration does not predict risk of obesity in adolescents (Calamaro et al., 2010). Possible reasons why studies about adolescents acquire different results might be because adolescence is a vulnerable period and changes are occurring in a person’s life such as physiological, psychiatric, socio-cultural and psychological (Lang et al., 2013). Many changes in body composition are also occurring during adolescence. Many adolescents have still not reached their maximal height, especially boys, and their bones are transforming. Reasons for gender differences may be because girls mature about 2 years before boys (Wilmore et al., 2008). The results of this current study indicate that there is a gender difference in the association between fitness and sleep. Results of this study confirm that when adolescents are studied, gender differences must be taken into the account. Girls and boys are also growing at a very different pace during those years.

When looking at sleep duration for less than 6, 7 or 8 hours a night on school days and non-school days, very few participants of both genders get sufficient sleep. It is common among many adolescents to take naps during the day. A study has shown that high frequency of daytime napping is associated with short sleep duration (Felden, et. al., 2015). The reason for these frequent day time napping can be that adolescents who have shorter sleep duration during the night try to catch up sleep during the day. It has been shown that daytime napping is more common on school days than weekends (Thorleifsdottir, 2002). Data in this current study did not indicate frequent daytime napping but this may reflect different methodologies and definitions across studies. Many participants are not getting enough sleep on weekends as well, which was surprising. The literature has stated that adolescents sleep less on school days than weekends, which matches with the results in this study. It has also claimed that adolescents sleep much longer on weekends to catch up for lost sleep on school days (Hansen et al., 2005) but findings in this study do not support this notion. This study however, matches a research conducted on Canadian children from ages 10 to 17,
were the results indicated that children and adolescents slept 1 hour longer on weekends than on school days, but they went to bed around 1.5 hours later on weekends (Chaput & Janssen, 2016).

Recommendations advise adolescents to sleep from 8 – 10 hours (Hirshkowith, 2015) but according to the results of this study, that goal is far from being reached, at least on school days. According to these results, girls sleep less than boys except on non-school days were they sleep more than 8 hours and when looking at less than 6 hour sleep on school nights and weekends, this applies to slightly more boys than girls.

There is a significant (p<0.001) gender difference between all of the fitness test results. In the cycle ergometer fitness test (W/kg), the difference between the genders compares with established knowledge that average female VO2max is 70%-75% of the average male VO2max. The difference between boys and girls in the vertical jump test and grip strength test may be explained by body size difference between genders (Wilmore et al., 2008). There is a significant correlation between cycle ergometer fitness test (W/kg) and vertical jump and also between grip strength and vertical jump in boys and girls, indicating that those participants who do well in one of the physical measurement also do well in others and therefore have overall better physical fitness. This may be a direct consequence of more physical activity and higher levels of training.

There is a possibility to generalize these results to other preadolescence and adolescents groups. These results could fit for adolescents in other countries who have a similar way of life as Iceland, for example where school starts at similar time along with the similarities in weather and daylight. The results are probably not transferable for children and adults because there are so many changes going on in adolescence that it might not match.

This study shows that there is a need for action. Adolescents are not getting enough sleep. Actions that have been in discussion in the community for a couple of years push for a policy change to delay the time schools in Iceland start in the morning. Many adolescents show up to school and have not slept enough during the night and this can affect their performance at school (Chaput & Janssen, 2016), which can result in lower grades (Arora et al., 2014). It has also been discussed that Iceland is all year round on Greenwich time and does not change the clock like many other countries do. It could affect sleep patterns if Iceland would start changing the clock over wintertime. It could also have bad effects on sleep, because it could be hard for adolescents to change their sleeping patterns, especially the time they go to bed. However, a study on sleep of 20 year old individuals in Iceland, showed that time of year did not have much effect on
sleep duration among them even though half of the individuals reported that they needed more sleep over the winter time (Kristbjarnarson, Magnusson, Sverrisson, Arnarson, & Helgason, 1985).

The strength of the study was that accelerometers were used to measure sleep and they are very accurate. In most studies, self-reported questionnaires are used to measure sleep. This method can be a good way to research a large group in a short time but is not as accurate as using the accelerometers. Studies using self-reported questionnaires have shown mean sleep duration from around 6.7 to 7.91 hours of sleep a night (Calamaro et al., 2010; Chen et al., 2014; Felden et al., 2015; Javaheri et al., 2011; Lowry et al., 2012). Studies using self-reported questionnaires to evaluate sleep duration give longer reports of sleep than this study that uses accelerometer. It can be hard for adolescents to evaluate how much average sleep they get during the school week and on the weekends. The reason can also be that the adolescents underestimate or overestimate their sleep duration. Using the accelerometers probably improves the measurements of sleep parameters. It is strength to the study that sleep is divided into three categories; sleep duration, rest duration and sleep efficiency. Results of the average rest duration shows for both genders that adolescents rest in the bed around 1 hour before sleeping. The reason might be that they are lying still in bed but watching TV or using other devices like a smartphone or an iPad.

The strengths of the fitness tests are that the same two researchers took turns doing measurements at all the schools. The fitness test took place within the school, which was a familiar environment for students. A further strength of this study is that measurements days of sleep were split into school days and non-school days, making it possible to estimate differences between them since adolescents usually get shorter sleep on school days.

Limitations to the study may have affected the measurements and the results. The measurements started in April and ended in June, so the participants in the first schools of the study had different schedules than the participants at the final schools, since the participants in the study were in 10th grade, which is the last year for mandatory education in Iceland. The participants at the school that were measured in the end of May and beginning of June, were almost finished with their studies and during the last weeks of school they had theme days with various projects that are different from normal school days. This might have affected the students sleeping patterns. During the later phases of the data collection the day is very long in Iceland were the sun comes up early and it gets dark late in the evening. If data had been collected during a
different season, for example in summer when it is bright outside 24/7 or over the winter time when it is mostly dark outside, the results may have been different. Many people think it is harder to get up in the morning when it is completely dark outside because their circadian clock thinks it is still night time. The sample of the study is rather small compared to other studies, but it would take a very long time to collect a larger sample because every participant has to use the accelerometer for a week and because the devices are expensive, it would be difficult to finance the study. It could possibly affect the study where the adolescents are aware that they are being studied, especially since they are wearing the accelerometers on their wrist and therefore their sleeping pattern might be different from regular week.
6 Conclusion

The results of this study show that the association between nocturnal sleep duration on school days and cycle ergometer fitness test (W/kg) is significant for the whole group (p<0.05) and borderline significant in girls (p=0.05) but not within the group of boys. This association between fitness and sleep is unclear for boys in this age group and therefore it should be studied further. It is valuable to get information about this age group and also since there is not a great deal of studies about this association. Future studies can be compared to this study and see if adolescents are changing their sleeping patterns in the coming years. Furthermore, it would be interesting to compare athletes and non-athletes to see how fitness and sleep is associated with those different groups.
References


Taheri, S., Lin, L., Austin, D., Young, T., & Mignot, E. (2004). Short sleep duration is associated with reduced leptin, elevated ghrelin, and increased body mass index. *Plos Medicine, 1*(3), 210-217. doi:10.1371/journal.pmed.0010062


Heilsuhegðun ungra Íslingendinga
Langtimarannsókn á heilu og tengslum hennar við náms, nótt og svefn

Kæri þátttakandi


Í rannsókninni Heilsuhegðun ungra Íslingendinga verður leitað til sömu einstaklinga sem í dag eru 15 ára og í 10 bekk. Auk þess verður um 100 einstaklingum sem ekki tóku þátt síðast þeirri þátttaku. Framhaldsrannsókn verður síðan framkvæmd vorið 2017 þegar þátttakendur eru 17 ára og því er nauðsynleg fyrir rannsakendur að varðveita kennitölu þátttakenda þannig að auðveitt verði að ná til þeirra að tveimur árum líðum. Markmiðið er að skoða stöðu og langtímaþreytingar á heilsufari, hreyfingu, þræki, og lífnaðargéttum þessara umgenna þegar þau eru 15 ára og þáðan aftur við 17 ára aldur. Einna að meta samband þessara þáttu við heilsufarsbætti, svefn og námsarárangur. Öflun heilsufarsupplýsinga um þessa einstaklinga geta gefið mjög dýrmáta vitneskjú um t.a.m. hvort og til hvaða fyrirbyggjandi aðgerða heilbrigðis- og menntafyrvöld þurfa að grípa til á komandi árum og áratugum.


Ef þá hefur spurningar um rétt þess sem þátttakandi í viðindarannsókn eða vilt hættu þátttöku í rannsókninni getur þú snúið þér til Viðindasjóðanefndur, Háskóla Reykjavíkur, Torggygjutí 17, 101 Reykjavík. Slimi: 551-7100, fax: 551-1444

Appendix 1 – Informed consent

Reykjavík, 1. apríl 2015.

Með þökk og kærri kveðjur

[signature]

Dr. Erlingur Jóhannsson, prófessor Háskóla Íslands
Ábyrðamaður rannsóknar.
Sími: 897 1115.
Netfang: erlijo@hi.is

Ef þú hefur spurningar um þétt þínn sem þáttakandi í visindarannsókn eða vilt hættu þáttöku í rannsókninni getur þú snúið þér til Visindasiólahnafndar, Hafnarhúsinu, Tryggvagötu 17, 101
Reykjavík. Sími: 551-7100, facx: 551-1444
Heilsuhegðun ungra Íslendinga
Verkþættir rannsóknarinnar

Pátttaka í rannsókninni felst í eftirfarandi sex þáttum.

1. Spurningalisti: Spurningalistanum er ætlað að varpa ljósi á ýmsa þætti sem tengjast lifnaðarháttum s.s. íþróttu- og heilsurækt, liikamlegt ástand, skólamál, lifsviðhorf, tannhirðu sem og liikamlega og andlega liðan þátttakenda.

2. Prekaprífr: Til að meta þrek verða þátttakendur beðnir um að hjóla á þrekkýló með stigvaxandi ákefð og fylgst verður með hjartslætti hjá þeim. Prófið er hámarksprífr þar sem þátttakendur hjóla þar til þeir geta ekki (eða vilja ekki) hjóla lengur. Prekaprífr tekur venjulega 15-20 minútur.


Allir þessir 4 verkþættir verða framkvæmdir í skólanum.


geislun vegna þátttökku í rannsókninni er sambærileg við 2–3 daga náttúrlægabakgrunnsgeislun á Íslandi. Náttúruleg bakgrunnsgeislun er í öllu okkar umhverfi. Hún kemur frá himingeimnum, jarðskorpunni og geislavirkum efnunum í likama okkar. Pessi 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 ánættu vegna þátttökku í rannsókninni sé hverandi

Þessir tveir verkþættir verða framkvæmdir í Hjartavernd. Rannsakendur munu sækja þátttakendur í skóla, fara með þá í Hjartavernd og aka þeim aftur í skólan að loknum mælingum í Hjartavernd.

Heilsuhegðun ungra Íslendinga
Samkeyrsla heilsufarsþetta og námsárangurs


Ef þú hefur spurningar um rétt þánn sem þátttakandi í víðindarannsókn eða vilt hætta þátttökku í rannsókninni getur þú snúið þer til Víðindasólanefndur, Hafnarhúsinu, Tryggvagötu 17, 101 Reykjavík. Sími: 551-7100, fax: 551-1444
Samþykksýfirlýsing um þátttöku í rannsókninni
Heilsuhægðun ungra Íslendinga
Verkþættir

Nafn unglings:__________________________________________

Kennislta unglings:__________________________________________

Ég, forráðamaður ofgreinds unglings, samþykki þátttöku hans/hennar í öllum 6 þáttum ofangreindar rannsóknar. Ég samþykki einnig að rannsakendur varðveiti kennitölu ofgreinds unglings þar til framhaldsrannsókn hefur verið framkvæmd 2017.

Samþykki forráðamanns:
Dags: _______________ Nafn: ____________________________
(undirskrift)

Samþykki unglings
Dags: _______________ Nafn: ____________________________
(undirskrift)

Undirskrift rannsakanda sem leggur yfirlýsinguna fyrir:
Dags: _______________ Nafn: ____________________________

Ef þú hefur spurningar um rétt þinn sem þátttakandi í visindarannsókn eða vilt hafta þátttöku í rannsókninni getur þú snúið þér til Visindasídabændar, Hafnarhúsið, Tryggvagötu 17, 101 Reykjavík. Simi: 551-7100, fax: 551-3444
Samþykksýfirlýsing um þátttöku í rannsókninni
Heilsuhægðun ungra Íslendinga
Samkeyrsla heilsufarsþatta og námsárangurs

Nafn unglings: ________________________________

Kennitala unglings: __________________________

Ég, forráðamaður ofngreinds unglings, samþykki að námsárangur á samræmund prófum nemenda í 4., 7. og 10. bekk verði tengdur við niðurstöður heilsufarsþatta í ofangreindri rannsókn.

Samþykki forráðamanns:

Dags: ______________ Nafn: ________________________

(undirskrift)

Samþykki unglings

Dags: ______________ Nafn: ________________________

(undirskrift)

Undirskrift rannsakanda sem leggu yfirþýsingu fyrir:

Dags: ______________ Nafn: ________________________

*Eff þá hefur spurningar um rétt þönn sem þáttakandi í viðindarannsókn eða vilt hættu þátttöku í rannsóknini getur það verið þeir til Viðindaslóðinsfedur, Hafnarhússins, Tryggvagötu 17, 101 Reykjavík. Slíti: 551-7100, fax: 551-1444*
Kæra ungmenni.

Við erum þér mjög bakklað fyrir að taka þátt í rannsókninni okkar. Svefn- og hreyfimælirinn sem þú hefur nú fengið um útlöfnin mælir hröðun og ljós og gefur okkur því hugmynd um bæði hreyfingu á daginn og svefnmyndar á nöttuminn. Mælirinn er ágætlega hröðgerður og þóllir að þú farir með hann í sturtu og stuttar sundferðir en við biliðum þig að hafa hann ekki lengur á kafi í vatni en nauðsynleg er.

Ef þú stundar lóbrott bar sem ekki má vera með armbund getur þú annað hvort límt yfir mælinn með sk. lóböttateipu á meðan á æfinu/keppni stendur eða hringt í vöku í s. 696-3344 og við finnum lausn sem hentar þér.

Til þess að geta sem best nýtt þær uppýrslur sem hreyfimælirinn gefur um svefn þinn, þurftum við að víta ýmislegt til viðbótar. Þess vegna biliðum því um að aður en þú ferð að sofa á kvöldin fyllir þú út þessa tóflu, þeir því að gera hring utan um þau svör sem þér fénnast passa best fyrir þig á hverjum degi.

<table>
<thead>
<tr>
<th>Mánudagur</th>
<th>Miðvikudagur</th>
<th>Miðaftur</th>
<th>Fóstudagur</th>
<th>Laugardagur</th>
<th>Sunnudagur</th>
<th>Mánudagur</th>
</tr>
</thead>
<tbody>
<tr>
<td>Strað</td>
<td>Eftir smað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
</tr>
<tr>
<td>Eftir smað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
</tr>
<tr>
<td>Eftir lauga</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
<td>Strað</td>
</tr>
</tbody>
</table>

| Selstrað kl. | : | : | : | : | : | : |
| : | : | : | : | : | : | : |
| Í rött svæði | : | : | : | : | : | : |
| Mjög vel | : | : | : | : | : | : |
| Ágerðlega | : | : | : | : | : | : |
| Sæmileg | : | : | : | : | : | : |
| : | : | : | : | : | : | : |
| Pegar og vaknaðar | : | : | : | : | : | : |
| Útvild(ur) | : | : | : | : | : | : |
| Nokkrud hvíld(ur) | : | : | : | : | : | : |
| Breytt(ur) | : | : | : | : | : | : |
| : | : | : | : | : | : | : |
| Vaknaðar kl. | : | : | : | : | : | : |
| : | : | : | : | : | : | : |
| For á feðtur kl. | : | : | : | : | : | : |
| : | : | : | : | : | : | : |
| Var við það að | : | : | : | : | : | : |
| Sæna við dagleg | : | : | : | : | : | : |
| verk | : | : | : | : | : | : |
| Í hvernig skái | : | : | : | : | : | : |
| Varsu í dag | : | : | : | : | : | : |
| Mjög gðóu | : | : | : | : | : | : |
| Gðóu | : | : | : | : | : | : |
| Sæmu | : | : | : | : | : | : |
| Mjög slæmu | : | : | : | : | : | : |
| Í frumrið í dag | : | : | : | : | : | : |
| : | : | : | : | : | : | : |
### Appendix 3 – Questionnaire

**Q9 Hversu margar klukkustundir á dag gerir þú eftirtalið að jafnaði á virkum dögum?**

<table>
<thead>
<tr>
<th></th>
<th>Ekkert (1)</th>
<th>Um ½ klst. (2)</th>
<th>1-2 klst. (3)</th>
<th>2-3 klst. (4)</th>
<th>3-4 klst. (5)</th>
<th>4-5 klst. (6)</th>
<th>Meira en 5 klst. (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spilar tölvuleiki (t.d. á netinu, heimílistölövu, Playstation) (1)</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Horfir á sjónvarp, DVD eða myndefni af netinu (2)</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ert á netinu (t.d. skoða vefsiður, Facebook eða lesa/skrifa tölvpóst) (3)</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Notar tölvu í annað en að vera á netinu eða spila tölvuleiki (6)</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>

**Q11 Hversu margar klukkustundir á dag gerir þú eftirtalið að jafnaði um helgar?**

<table>
<thead>
<tr>
<th></th>
<th>Ekkert (1)</th>
<th>Um ½ klst. (2)</th>
<th>1-2 klst. (3)</th>
<th>2-3 klst. (4)</th>
<th>3-4 klst. (5)</th>
<th>4-5 klst. (6)</th>
<th>Meira en 5 klst. (7)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spilar tölvuleiki (t.d. á netinu, heimílistölövu, Playstation) (1)</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Horfir á sjónvarp, DVD eða myndefni af netinu (2)</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Ert á netinu (t.d. skoða vefsiður, Facebook eða lesa/skrifa tölvpóst) (3)</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Notar tölvu í annað en að vera á netinu eða spila tölvuleiki (6)</td>
<td></td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>
Q33 Hversu oft varðst þú var/vör við eftirfarandi vanlíðan eða óþægindi síðastiðna viku?

<table>
<thead>
<tr>
<th></th>
<th>Nær alórei (1)</th>
<th>Sjaldan (2)</th>
<th>Stundum (3)</th>
<th>Oft (4)</th>
<th>Nær alltaf (5)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Þú varst leið/leiður eða hafðir lítinn áhuga á því að gera hluti</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Þú hafðir litla matarlyst</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Pérfannst þú einmana</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Þú grést auðveldlega eða langaði til að gráta</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Þú áttir erfitt með að sofa eða sofna</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Þú varst niðurdregin/niðurdreginn eða döpur/dapur</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Þú varst ekki spennt/spenntur fyrir að gera neitt</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Pérfannst þú hægfara eða hafa lítinn mátt</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Pérfannst framtíðin vonlaus</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
<tr>
<td>Þú hugsaðir um að fyrirfara þér</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
<td>○</td>
</tr>
</tbody>
</table>