Lisa Busklein Brodal

Children´s physical activity level in association with cardiorespiratory fitness and health

The Future Kids In Daily activity (FutureKID) cross-sectional pilot study

Master's thesis in Clinical Health Science - Obesity and Health
Supervisor: Arnt Erik Tjønna, ISB, NTNU
Co-supervisor: Thomas Fremo, ISB, NTNU
June 2019

Master's thesis

NTNU
Norwegian University of Science and Technology
Faculty of Medicine and Health Sciences
Department of Circulation and Medical Imaging

NTNU
Kunnskap for en bedre verden

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Trondheim, June 3th 2019
Lisa Busklein Brodal

Abstract

Background: Childhood overweight and obesity is a global problem and has been assessed by several studies, targeting physical activity (PA), cardiorespiratory fitness (VO_{2peak}) and health. Still, studies are inconsistent. A better approach may be targeting children´s time trends in PA. **Purpose:** To investigate VO_{2peak}, body composition (BC), metabolic health and a questionnaire in association with time trends in PA. **Material and methods***:* A cross-sectional pilot study on 44 Norwegian children (20 boys, 24 girls, 12-13 years). PA categories (PA at school (PAS), PA at home (PAH), PA during the week (WeekdayPA), PA during the weekend (WeekendPA)) were measured using SenseWear. VO_{2peak} was determined using ergospirometry. BC and metabolic health were measured by standardized procedures. PA, food habits, health- and socioeconomic status were obtained using a self-administered questionnaire. Multiple regression analysis was applied for VO_{2peak}, BC and metabolic health in association with PA categories. General linear modeling was applied for the association between the self-administered questionnaire and PA categories. **Results:** VO_{2peak} had a significant positive association with all PA categories ($p<.01$). Body mass index (BMI), waist circumference (WC) and body fat had significant negative association with PAS, PAH and WeekdayPA ($p<.01$). High-density lipoprotein cholesterol (HDL-C) had a significant positive association with WeekdayPA ($p=.006$). **Conclusion**: VO_{2peak} was positively associated with all PA categories, but especially with WeekendPA. BMI, WC and body fat were especially negatively associated with WeekdayPA, but also with PAS and PAH - while HDL-C was positively associated with WeekdayPA. Larger interventions are warranted.

Key words: Physical activity, children, VO_{2peak}, body composition, metabolic health.

Sammendrag

Bakgrunn: Overvekt og fedme blant barn og ungdom er et globalt problem. Flere studier har undersøkt problematikken, og rettet fokuset sitt mot blant annet fysisk aktivitet (FA), kardiorespiratorisk form (VO_{2peak}) og helse – med varierende resultater. En bedre tilnærming kan være å rette fokuset mot barnas trender i FA. **Hensikt:** Å undersøke effekten av VO_{2peak}, kroppssammensetningen, metabolsk helse og et spørreskjema i sammenheng med trender i FA. **Materiale og metode**: En pilot-tverrsnittstudie på 44 norske barn (20 gutter, 24 jenter, 12-13 år). FA-kategorier (FA i skolen (PAS), FA hjemme (PAH), FA i løpet av uken (WeekdayPA), FA i løpet av helgen (WeekendPA)) ble målt ved bruk av SenseWear. VO_{2peak} ble målt ved bruk av ergospirometri. Kroppssammensetning og metabolsk helse ble målt ved bruk av standardiserte metoder. FA- og matvaner, samt helse- og sosioøkonomisk status ble innhentet ved bruk av spørreskjema. Multippel lineær regresjon ble brukt for sammenhengen mellom VO_{2peak}, kroppssammensetning og metabolsk helse i forhold til FA-kategorier. Generell lineær modell ble brukt for sammenhengen mellom spørreskjema og FA-kategorier. **Resultater:** VO_{2peak} hadde en signifikant sammenheng med FA-kategorier ($p<.01$). Kroppsmasseindeks, midjeomkrets og kroppsfett hadde en signifikant negativ sammenheng med PAS, PAH og WeekdayPA ($p<.01$). HDL-C hadde en signifikant positiv sammenheng med WeekdayPA ($p=.006$). **Konklusjon**: VO_{2peak} hadde en positiv sammenheng med alle FA-kategorier, men spesielt med WeekendPA. Kroppsmasseindeks, midjeomkrets og kroppsfett hadde spesielt en negativ sammenheng med WeekdayPA, men også med PAS og PAH - samt HDL-C hadde en positiv sammenheng med WeekdayPA. Større intervensjoner behøves.

Nøkkelord: Fysisk aktivitet, barn, VO_{2peak}, kroppssammensetning, metabolsk helse.

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Relevance

Childhood overweight and obesity is considered a global problem. According to Imperial College London and World Health Organization there will be more obese children and adolescents than moderate and severe underweighted by 2022 if this continues. A high prevalence of overweight and obese children is associated with several health complications, early onset of illness and an increased risk of non-communicable diseases. Overall results targeting childhood overweight and obesity are inconsistent. Targeting children´s physical activity at specific points of time during the day and week may be a better approach. This may ease future prevention regarding the increased prevalence of overweight and obese children - and reduce the amount of time and effort spent on treatments of this epidemic, both in child- and adulthood.

Abbreviations

BIA	Bioelectrical impedance analysis
BP	Blood pressure
BMI	Body mass index
CPET	Cardiopulmonary exercise test
CRF	Cardiorespiratory fitness
CS	Cross-sectional
FG	Fasting glucose
HDL-C	High density lipoprotein cholesterol
METs	Metabolic equivalents
MVPA	Moderate- to vigorous- physical activity
PA	Physical activity
PAH	Physical activity at home
PAS	Physical activity at school
PE	Physical education
RER	Respiratory exchange ratio
RPE	Rated perceived exertion
ST	Sedentary time
TC	Total cholesterol
TG	Triglyceride
VO_2	Oxygen uptake
VO_{2max}	Maximal oxygen consumption
VO_{2peak}	Peak oxygen consumption
WC	Waist circumference
WeekdayPA	Weekday physical activity
WeekendPA	Weekend physical activity

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1. Background

1.1 Introduction

Increased prevalence of overweight and obesity is observed from an early age, and childhood overweight and obesity is considered a global problem. Through the last 4 decades, the prevalence has increased substantially. Although the prevalence in some developed countries have plateaued, the numbers are still too high. According to Imperial College London and World Health Organization there will be more obese children and youth than moderate and severe underweighted by 2022 if this continues [(1)].

The earlier obesity develops, the more significant obese-related risk factors become - and early childhood obesity has been associated with decreased quality of life and increased morbidity and mortality in adulthood [(2)]. A high prevalence of overweight and obesity among children and youth are associated with several health complications, early onset of illness and an increased risk of non-communicable diseases - in addition to psychosocial consequences [(3)]. This is caused by an environment that has drastically changed over the last decades, which affects the prevalence in a complex interplay in a variety of health-related lifestyle factors - mainly because of a decrease in physical activity (PA), increased sedentary lifestyle and intake of food high in sugar and fat [(4,5)]. Thus, the increased prevalence is not a consequence of changes in genetic or biological factors – rather it is driven by changes in our lifestyle and behavior [(6)]. A change in lifestyle and reduced weight gain early in life, may contribute to a prevention of overweight and obesity among children and adolescents [(7)]. Good habits and a healthy lifestyle can be adopted during childhood and later preserved in the complex interplay and dynamic transition from child to adolescent [(8)].

In Norway, childhood overweight and obesity increases from 2 to 8 years of age. From 8 years there is a stabilization period until the age of 13. From this age, there is a sudden increase in the prevalence – partly due to decreased PA levels and increased time spent sedentary [(9)]. On an average, the prevalence does not stop increasing until 40 years of age [(10)]. Thus, the transit from childhood to adolescent is a crucial time to prevent the risk of overweight and obesity [(11)]. Increased PA levels and decreased time spent sedentary results in higher levels of cardiorespiratory fitness (CRF), also referred to as peak oxygen consumption (VO_{2peak}), and a positive metabolic profile among children and adolescents, compared to lower levels of PA [(12,13)]. Children´s VO_{2peak} has been associated with a general health and cardiometabolic risk profile during childhood [14,15] and with risk of cardiovascular disease later in life [16]. Increased VO_{2peak} has a positive effect regarding the prevalence of childhood overweight and obesity [17].

A decrease in PA levels and increased ST in Norway are observed from the age of 6 to the age of 15. Thus, the percentage of children and adolescents who fulfil PA recommendations from The Norwegian Directorate of Health decrease with age [18]. Recommendations includes at least 1 hour of moderate- to vigorous- activity (MVPA) per day, 3 times a week the activity should be of high intensity and ST should be reduced [19]. The recommendations will have beneficial effects on cardiovascular and metabolic health, but also social and physiological aspects of wellbeing and quality of life will be enhanced [20–25]. Secular trends in Norway have likewise shown an increase in adiposity with age [26].

Numerous studies have assessed childhood overweight and obesity – approaching it with different strategies to prevent and/or decrease the overweight and obesity prevalence. Several studies have assessed the effect of PA, targeting different areas, e.g. at school [27] or outside of school [28]. Studies have been carried through with different methodology. Some have focused on children´s PA assessed with objective measurements [29,30], some on training induced programs, aiming at increasing VO_{2peak} [31], while others have focused on children´s body composition (BC) and metabolic profile [12]. Studies have shown mixed results, but some have given positive insight – especially favoring the obese children which resulted in decreased body mass index (BMI) and increased PA during the intervention period [32,33]. Regardless, overall results are inconsistent [34]. A better approach may be to target specific time periods of a child's day [35].

1.1.1 The aim of the study

The main aim is to investigate VO_{2peak} in association with children´s PA at different points of time during the day and week. The second aim is to investigate children´s BC, metabolic health and subjective reporting in association with their PA at different points of time during the day and week. The hypothesis is that there is an association between children's VO_{2peak} and PA, but how VO_{2peak} affects PA through the day and week is uncertain. Furthermore, we expect to detect an effect of BC, metabolic health and subjective reporting on PA at different points of time during the day and week – but how great of an impact the aforementioned have on PA is uncertain.

1.2 Theoretical Background

1.2.1 Physical activity

PA is a musculoskeletal movement which leads to increased energy expenditure and achievement of caloric balance [36]. PA is a complex behavior and may occur as free play, physical education (PE), organized sports and training among children and adolescents. PA has several health benefits like improved VO_{2peak}, normal growth and development, enhances learning and prevents social problems among others as illustrated in **Figure 1** [20–25].

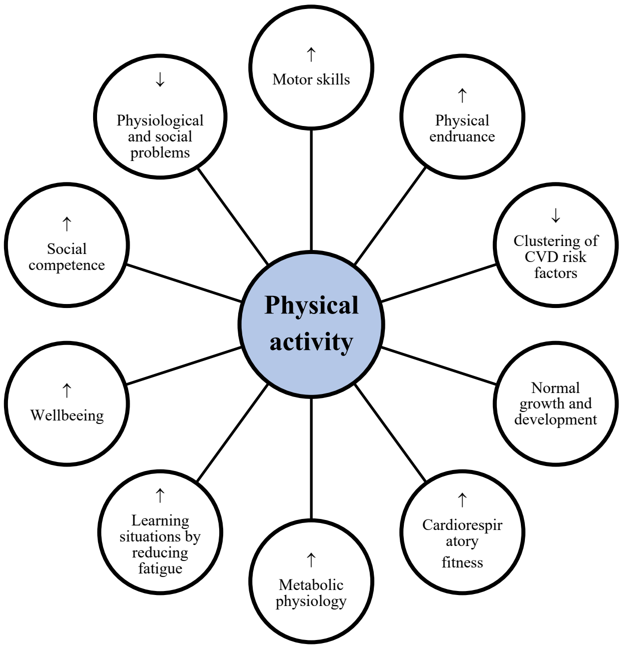

Figure 1. Health beneficial effects of PA among children and adolescents [20–25]. CVD; Cardiovascular disease.↑; Increase ↓; Decrease.

PA has a contributing role in the prevention of becoming overweight and obese. There is a higher risk for overweight and obese children to become obese adults, compared to their normal weight equals, and a contributing factor is lower levels of PA [37]. Obese children and adolescents have a higher risk of early morbidity and mortality later in life. Long term effects of increased PA levels among children, is likely to be at least as essential as weight loss for reducing premature mortality [38]. Low levels of PA is a global problem, with major implications for general health and prevalence of non-communicable diseases like the metabolic syndrome – physical inactivity is stated as the 4th leading risk factor for global mortality [39]. Physical inactivity, also referred to as sedentary time (ST), is clearly connected with overweight and obesity among children and youth, and is associated with an adverse cardiometabolic risk profile and adiposity [13].

Physical activity pattern

ST increases among Norwegian children; 6-year-old children spend 6.5 hours per day, while 15-year-olds spend 9.5 hours per day ST averagely [(18)]. Overall and individual ST increases during the transition from primary/middle to secondary/high school [(40)]. This is partly due to a society which discourages PA by reducing the possibilities to everyday movement and to expend energy, like a decline in active transport to and from school [(24)]. Thus, not nearly enough of Norwegian children fulfill PA recommendations from The Norwegian Directorate of Health (**Figure 2)**; at least 1 hour of daily MVPA [(19,41)] - and the numbers decrease substantially with age [(42)].

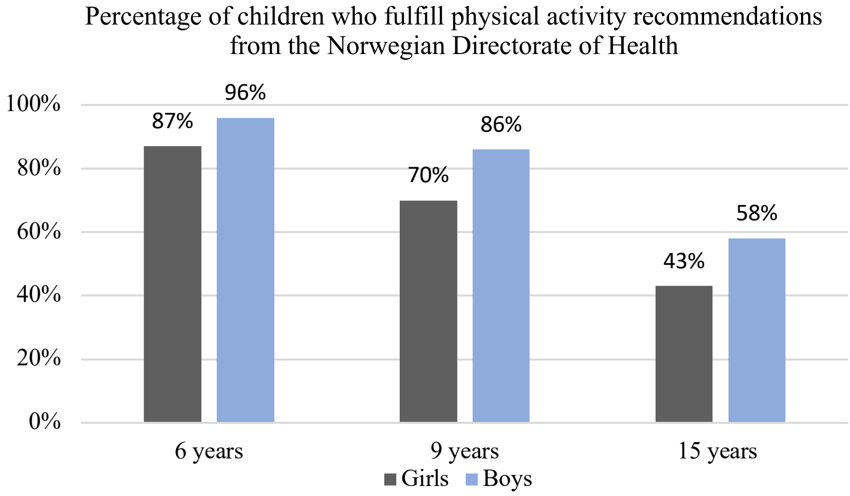

Figure 2. The percentage of Norwegian children and adolescents who fulfill the daily recommendations for physical activity from the Norwegian Directorate of Health [(18)].

Recent studies from Norway indicates that 9- and 15-year-old's were significantly more active during weekdays than during weekends [(42,43)]. This is in line with a similar study, which suggests that interventions should target the least active children after school and during weekends [(44)]. It may be a great opportunity to influence PA during some specific time segments of the day or week, i.e. tailor intervention strategies to specific time periods regarding promoting and increasing PA [(35)].

Moderate- to vigorous- physical activity

Something to acknowledge is that higher MVPA among children and adolescents result in reduced cardiometabolic risk factors, regardless of the amount of ST; replacing 30 minutes ST with equal amount MVPA will enhance the benefits [(23,45)]. This also includes a more favorable

BC and adiposity marker [46]. Suggested methods from different interventions to enhance children´s MVPA, is to increase MVPA during PE in school or focus on organized sports among others [47,48]. PA is prospectively – and inversely associated with cardiometabolic risk in healthy children, and to reduce the risk, the main focus should be to increase PA of at least moderate intensity instead of reducing ST [49]. This is supported in a recent study from Marcues et al. (2015), where it is stated that time in MVPA was associated with better CRF independent of ST, and increased time in MVPA contributes to better VO_{2peak} in children and youth [50].

Assessing physical activity

PA is a complex behavior which is difficult to assess under free-living conditions - especially among children and youth who have a more unique, sporadic and intermittent PA pattern, in addition to inherent variability due to growth and maturation [51]. Due to the nature of PA among children and youth, several assessment methods exist. These methods can roughly be divided into 2 groups, which include subjective and objective methods. Both methods have several advantages and disadvantages, which must be considered when choosing a specific assessment tool [52].

Subjective methods may include interviewed recalls, diaries and individual self-administered questionnaires. Self-administered questionnaires are the most commonly used subjective method among children and youth – due to its simple nature. Subjective methods have broadly been used in the field of research, especially in large epidemiological research which has given useful information at a population level. These methods are inexpensive and easy to use, but may have a difficulty in capturing reliable data due to children and youth's sporadic activity, BMI, gender and age [52]. Still, when used methodically right, subjective methods have a value of interest - like the Health habits among school children (HEVAS)-questionnaire, which has been developed through several national meetings, conducted pilot tests and focus group interviews before being implemented in studies [53].

Objective methods include among others double labeled water (DLW), direct observation and accelerometers. Unlike subjective methods, objective methods are expensive and require logistics in a bigger scale. DLW is considered to be the "gold standard" in assessing total energy expenditure under free living conditions, but gives no information about PA duration, intensity or frequency. For PA assessment, direct observation is considered to be the "gold standard”. When using direct observation, children and youth are being observed for extended periods of time – which require a labor- and time-intensive data collection [(52)]. Accelerometers is a simpler objective method than the aforementioned and is increasingly used in the assessment of PA among children and adolescents in large epidemiological studies [(54)]. The tool has a lower subject burden and can detect intermittent and sporadic PA, including description of the intensity, duration and frequency of PA. Still it has some disadvantages, like inaccurate assessment of a large range of activities such as upper-body movement and high intensity running [(55)]. Because of the complex nature of PA, a combination of methods might give better accuracy than a single method alone. One example of a sensor which combines different methods is SenseWear Armband - which combines triaxial accelerometry with a series of physiological measures like skin temperature, heat flux and galvanic response. By combining different methods, this tool measures ST, sleep, time spent in light-, moderate- and vigorous intensity and estimates energy expenditure under free-living conditions [(56)]. Further on, this method has shown to provide acceptable reliability when assessing children´s PA in a 7-day monitoring phase [(30)].

1.2.2 Cardiorespiratory fitness

CRF is a direct measurement on functional aerobic capacity and is related to PA [(57)]; PA is stated as the most important modifiable determinant of $VO2_{peak}$ [(58)]. Increased PA is associated with higher levels of CRF and serves as a marker for cardiovascular health – which affect the morbidity and mortality among children, and later on into adulthood [(13)]. A reduced CRF is independently associated with cardiovascular risk and adiposity, and by reducing sedentary activities such as screen time, CRF in youth may be improved [(59)]. Also, a reduced CRF is associated with metabolic syndrome among adolescents. Children with low fitness or low fitness and high fatness have a greater cardiovascular risk than those with high fitness [(60)]. It is important to enhance children´s CRF level in the early stages of life [(61,62)], which will also lead to a more positive attitude towards PE and decrease ST [(63)]. CRF is determined by non-modifiable factors, like heredity, growth, age, sexual maturation and gender [(64,65)], but MVPA and ST also affect CRF levels [(66)]. Thus, a method to enhance children´s CRF is to increase PA levels among all children – not only the obese, even though an increased BMI decreases CRF in general [(67)].

Maximal oxygen consumption

The "golden standard" for estimation of CRF is maximal oxygen consumption (VO_{2max}) and is defined as "the highest rate at which oxygen can be taken up and utilized by the body during strenuous, dynamic exercise with a large muscle mass". In other words, the ability of the cardiorespiratory system to deliver oxygen to the exercising muscles [(68)]. In children and youth, the best single measure of CRF is often referred to as VO_{2peak} [(69)]. VO_{2peak} is usually measured with ergospirometry and gives a quantitative measure of an individual´s capacity for aerobic ATP resynthesis. A high VO_{2peak} requires high levels and integrated response of physiologic support systems, like high hemoglobin concentrations, blood volume and cardiac output among others as illustrated in **Figure 3** [(70)].

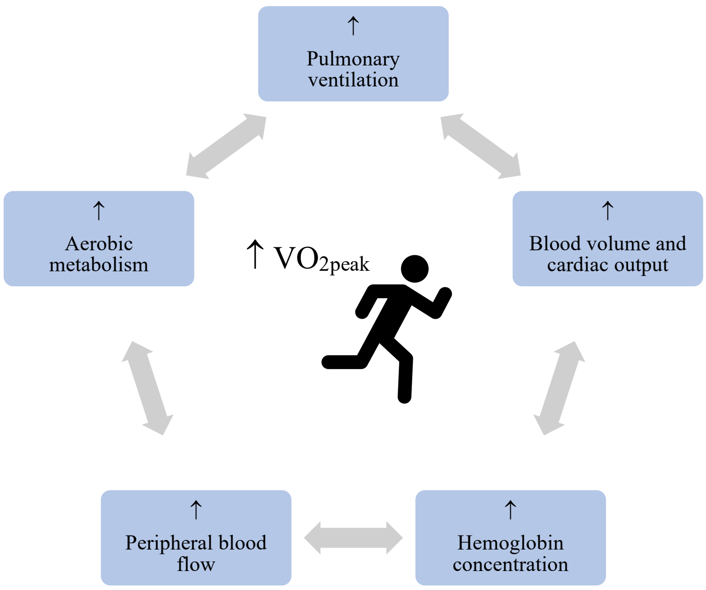

Figure 3. Physiologic support systems which a high VO_{2peak} requires [(70)]. ↑; Increase.

There are a lot of factors that affects children's VO_{2peak}. Exercise performed on a treadmill usually produce the highest values. With the use of a treadmill in the laboratory, one can easily regulate and quantify effort intensity. Healthy subjects who perform a VO_{2peak}-test on a treadmill, meet 1 or more of the criteria for VO_{2peak} more easily, compared to when it is performed on a bike [(71)]. Age and gender also affect VO_{2peak} in both absolute and relative values. When it comes to children, absolute values remain similar until the age of 12. At the age of 14, boys have a 25% higher VO_{2peak} than girls, and by the age of 16 the differences are above 50% in an average - due to a greater muscle mass and greater daily PA levels among boys. Relative values have an average aerobic capacity of about 52 $mL \cdot min^{-1} \cdot kg^{-1}$ from ages 6 to 16 for boys, and for girls an average aerobic capacity accounts for about 40 mL · min $^{-1}$ · kg $^{-1}$ - a 32% smaller value than their gender counterparts, which indicate a sex difference among young boys and girls. Trained individuals of either sex show a greater VO_{2peak} than untrained [72]. The calculation of VO_{2peak} is affected by body size and composition; body size strongly correlates with VO_{2peak}. Compared to adults, children's oxygen uptake (VO_2) per kilogram of body mass is higher in general, i.e. the VO_2 per kilogram does not increase proportionally to their body mass. Among children appropriate scaling will underpin the interpretation of VO_{2peak} [73]. Independent of body size and composition, pubertal maturation is associated with increased VO_{2peak} [74].

1.2.3 Body composition and metabolic health

Insulin resistance, glucose intolerance, elevated blood pressure (BP) and clustering of cardiometabolic risk (total cholesterol (TC), fasting glucose (FG), triglyceride (TG), waist circumference (WC), BMI increases, high-density lipoprotein cholesterol (HDL-C) decreases) rises when children are less physical active and excessively sedentary [75–77]. Clustering of risk factors may be a biological marker for poor cardiometabolic health in otherwise healthy children [78]. An unfortunate cardiometabolic health in childhood is linked to an increased risk of metabolic syndrome, cardiovascular diseases and type 2 diabetes in adulthood – and can lead to premature mortality and morbidity [79–81]. By increasing total PA energy expenditure, MVPA, vigorous PA and decreasing ST, overall cardiometabolic risk and individual cardiometabolic risk factors can be reduced among school-aged children [82]. This is supported by recent findings in the HELENA-study with Barker et al. (2018). They also suggest that public health recommendations should promote an increase in activity to minimize the development of cardiovascular disease (CVD) risk factors in youth [12]. **Figure 4** illustrates the benefits of PA among children and youth regarding overall cardiometabolic health.

Figure 4. The effects of increased PA levels among children and youth regarding cardiometabolic health. *Reduced cholesterol, TG, FG, WC, BMI and increased HDL-C [75–77]. ↑; Increase ↓; Decrease.

2. Materials and methods

2.1 Subjects

The present study included 76 subjects who were recruited through local primary schools in southern parts of Trøndelag. Principals and responsible teachers were approached with an information sheet and an invitation for their schools to participate in the study by research members – both by e-mail and as personal attendance. After meeting the principals and teachers, the research members presented the study in front of primary school children in 7th grade. The children received a separate information sheet (**Appendix 1**) and an information sheet and consent form to deliver to their parents (**Appendix 2**), with a 1-week deadline to respond.

Essentially, the exclusion criteria included pulmonary diseases involving severe/poorly controlled asthma, diabetes, smoking, neurological/orthopaedic limitations according to exercise, history of seizures or epilepsy, steroid medications, diagnosed attention deficit hypersensitivity disorder, kidney failure (self-reported), major organ transplants, family history of hypertrophic obstructive cardiomyopathy, congenital cardiac abnormalities, elevated BP (>95th percentile for systolic/diastolic values), abnormality during resting or stress echocardiography (unsafe to participate) and coronary heart disease.

2.2 Study design

The data collection in the cross-sectional (CS) pilot study was conducted by master's students in Clinical Health Science – Obesity and Health and Bioengineers at St. Olav Hospital and at the respective participating schools. Subjects were assessed and tested 1 time during an 11-week data collection period, with PA levels, cardiopulmonary exercise test (CPET), BC, anthropometric measurements, blood samples and pressure and a questionnaire (**Figure 5**).

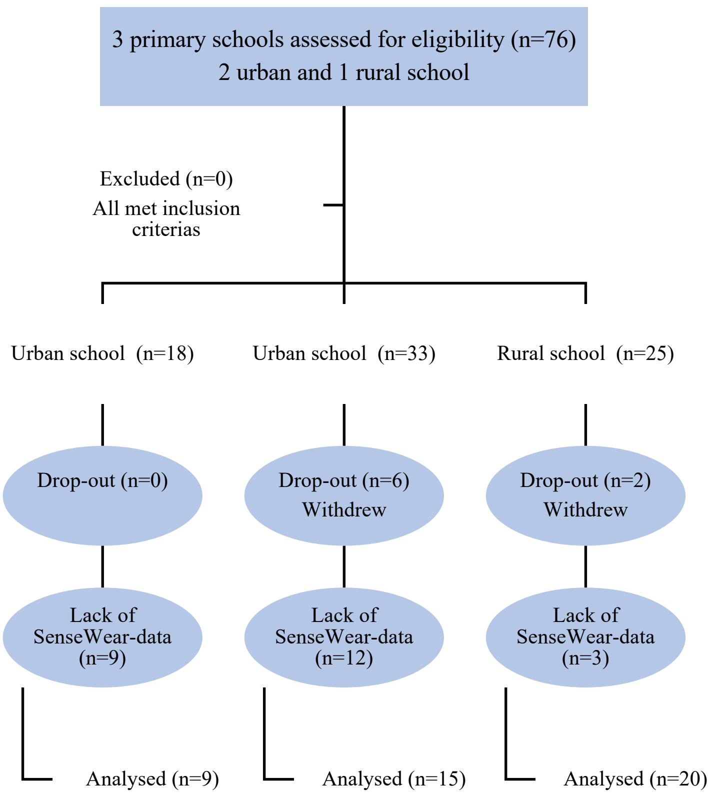

Figure 5. Flow chart of the study design.

The study progressed as follow: After the recruitment period (week 48 to 51, 2018), all the tests and data collection were executed (week 2 to 13, 2019). The data collection period was dichotomous. Part 1 involved personal attendance by the participants at the research facilities. Firstly, the participants and their parents received a link to an online booking sheet, where they booked in time for a screening involving BC, anthropometric measures and BP - which were taken to assess the subject's metabolic health, and a questionnaire which was given in order to assess the subject´s PA in an outside of school, health-, socio-economic status and food habits. Also, a CPET was performed to evaluate the subject´s VO_{2peak}. Part 2 involved WC-measurements and blood samples which were collected simultaneously at the participants respective schools, 1 time during the 11-week data-collection period – by researchers and bioengineers. This was executed to assess the subject´s metabolic health. The activity monitor SenseWear Armband was handed out to participants when suitable during the data collection period to objectively assess the subject´s PA.

2.3 Data collection, procedures and equipment

2.3.1 SenseWear Armband

Objectively measured PA using SenseWear Armband (BodyMedia Inc., Pittsburgh, PA, USA) was 1 of 2 primary outcome variables. SenseWear is a portable monitor including a 2-axis accelerometer. It contains numerous sensors measuring near-body ambient temperature, speed, skin temperature, galvanic skin response and heat flux. Along with characteristics such as gender, smoking status, right – or left handedness and date of birth; total steps walked, ST, intensity in metabolic equivalents (METs), total energy expenditure in $kcal \cdot day^{-1}$ and activity energy expenditure in $kcal \cdot day^{-1}$ can be estimated. The subjects wore SenseWear around the dominant arm (defined as the arm one writes with), attached over the triceps muscle for a 7-day period (24 hours/day), besides during water-activity (showering, swimming etc.) (**Figure 6**). Use of SenseWear was supported with written instructions. Cut-off values for PA were based on METs, of which sedentary activity was defined as <1.5 METs, light activity was defined as ≥1.5 - <4.3 METs, moderate activity was defined as ≥4.3 – <7 METs, vigorous activity was defined as ≥7 - <9, and very vigorous was defined as ≥9 METs [83]. To identify time trends in PA, total daily average PA-value given in hours from SenseWear was divided in 4 variables based on moderate and vigorous activity (MVPA); PA in school (PAS), PA at home (PAH), weekday PA (WeekdayPA) and weekend PA (WeekendPA). PAS was based on the hours the subjects were at school, PAH was based on hours awake before school and hours awake after school, WeekdayPA was based on hours awake during a normal weekday and WeekendPA was based on the hours awake during a normal day of the weekend. Subjects with at least 3, preferably 5, measured weekdays and 1 measured weekend (Saturday and Sunday) were included.

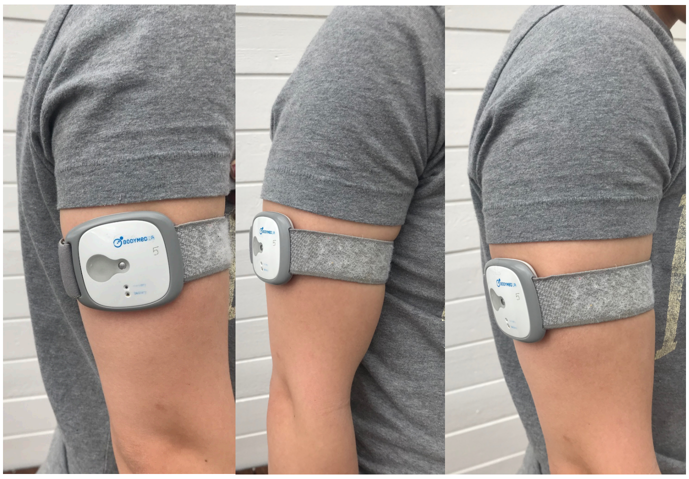

Figure 6. Illustration of the use of SenseWear Armband.

2.3.2 Cardiopulmonary Exercise Test

The second primary outcome variable was subject´s exercise capacity, measured using a CPET. CPET measures CRF directly, known as VO_{2max} ($mL \cdot min^{-1} \cdot kg^{-1}$). The test was performed on a treadmill (Woodway USA Inc., Waukesha, WI, USA), using an ergospirometry system with a mixing chamber (Metalyzer II, CORTEX Biophysik GmbH, Leipzig, Germany) to measure VO_2. Volume calibration was performed for each test (3L Calibration Syringe, Hans Rudolph, Lenexa, USA) and gas calibration was performed before the testing began with ambient air (0.03 CO_2, 20.93 O_2) and calibration gas (5% CO_2 and 15% O_2) (HIQ Center, AGA A/S, Oslo, Norway), and repeated every 6th test when the sample line was changed and calibration repeated. Barometric pressure was read off from the weather station. Heart frequency (HF) was measured with Polar H7 heart rate transmitter (Polar Electro, Kempele, Finland). Five beats was added to the HF achieved at VO_{2max} and set as maximal HF (HF_{max}) [84].

Prior to the test, each participant was informed about the procedure, including Rated Perceived Exertion (RPE), Borg scale [85]. After getting familiar with the treadmill, the testing began. Before the submaximal test started, a 2-minute rest measurement was performed. As a warm-up and to get familiar with the subject, 2 submaximal tests consisting of 4 minutes each were completed according to standardized load (4km • h^{-1}, 0% inclination and 4km • h^{-1}, 4% inclination, respectively). Thereafter, the VO_{2max}-test began, with an individual protocol; incline or speed were increased 2% or 1 km • h^{-1}, or both incline and speed were increased 1% and 0.5 km • h^{-1} after each minute until exhaustion (**Figure 7**). Instantly after the test, 1-minute heart rate recovery (1-HRR), RPE, HF_{max} and respiratory exchange ratio (RER) was written down. 1-HRR indicates the autonomic activity in the cardiovascular system. RPE indicates the subjective intensity of the test, HF_{max} is the maximal speed of the number of contractions (beats) of the heart per minute, and RER indicates the ratio of CO_2 expired and O_2 inspired. The term VO_{2max} often implies a plateau in VO_2 during the test. This plateau represents the maximal achievable level of oxidative metabolism with the use of large muscle groups [86]. This is not always the case among children and youth, where in this age group some can complete a VO_{2max}-test without a leveling-off in VO_2; thus, the best single measure of CRF is often referred to as VO_{2peak} ($mL \cdot min^{-1} \cdot kg^{-1}$) [69]. If a child demonstrates sign of maximal effort supported by objective criteria (e.g. RER $\geq$1.05 and/or breathing frequency (BF) $\geq$40), VO_{2peak} can be accepted as equal to VO_{2max} [87]. To classify a value as VO_{2max}; RER $\geq$1.05, BF $\geq$40 and RPE above 17/20 on the Borg scale were required – this was not achieved with all participants in the present study, hence VO_{2peak} was used to classify CRF [88]. The 3 continuously highest measurements determined VO_{2peak}.

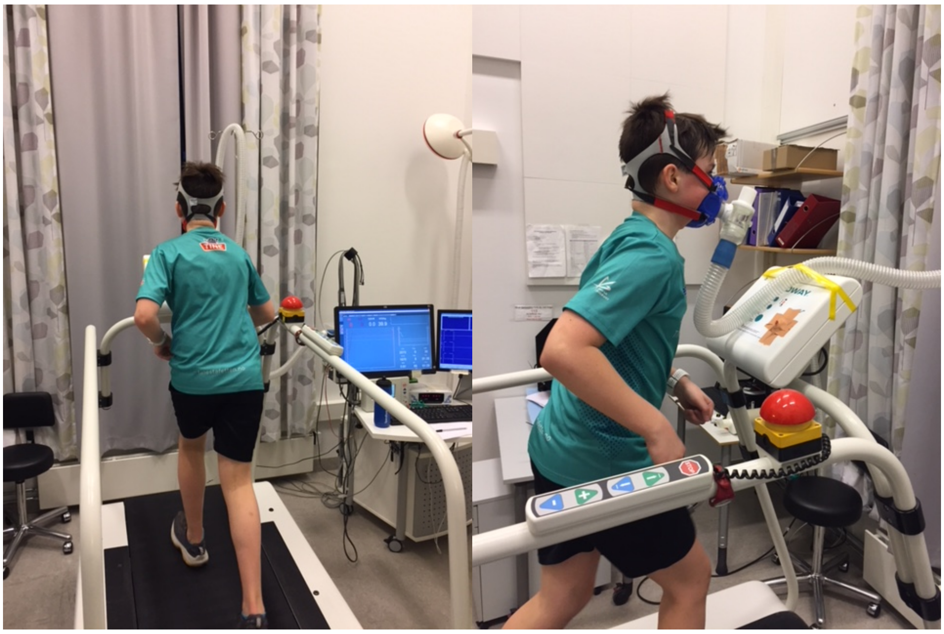

Figure 7. Illustration of the cardiopulmonary exercise test.

2.3.3 Bioelectrical Impedance Analysis

BC (weight (kg), estimation of muscle mass (kg) and body fat (%)) was measured using a multi-frequency Bioelectrical Impedance Analysis (BIA) (Inbody 720, Biospace CO, Ltd, Seoul, Korea). BIA measures BC by dividing the body into the torso and lower – and upper extremities. The device predicts extra – and intracellular water content, which is used to estimate BC. The subjects were encouraged to go to the toilet if needed before measurements were taken and they were asked if they had a pacemaker for safety reasons. Furthermore, they were instructed to remove objects containing metal (watches, jewelry, belts, wallets, mobile phones etc.) before standing barefoot on the BIA. When entering the aperture, the subjects were instructed to maintain an upright position; avoiding any contact between trunk and upper extremities (**Figure 8**). Talking during the measurement was not permitted, due to obtaining a normal breathing pattern.

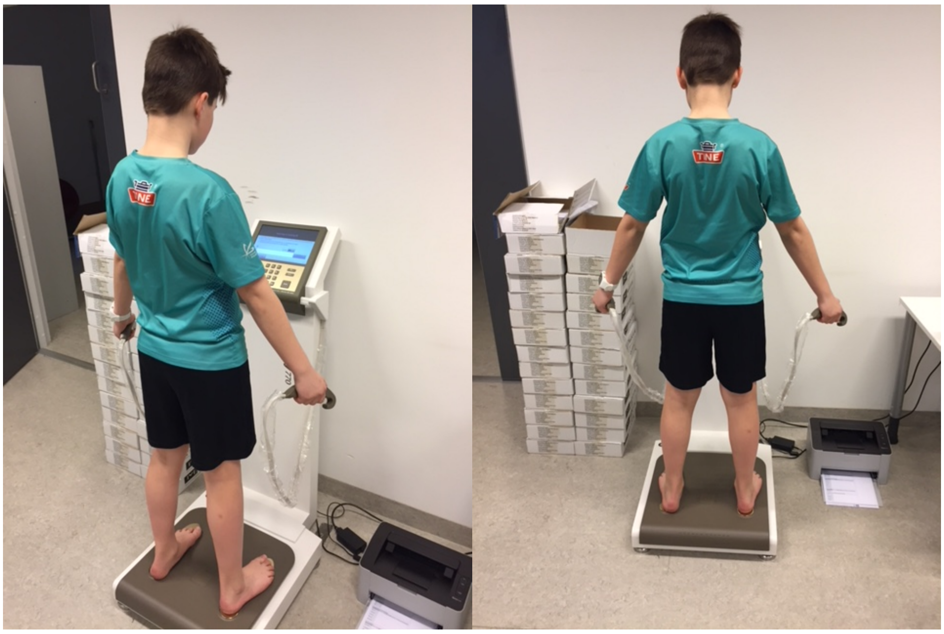

Figure 8. Illustration of the subject's position during the bioelectrical impedance analysis measurement.

2.3.4 Anthropometric measurements

Height was measured without shoes using a stadiometer (nearest 0.1 cm). Body weight was measured using BIA with light clothing (Nearest 0.1 kg). BMI was calculated using the international standard [89]. WC was measured using a measuring tape (nearest 0.5 cm) and was measured between the lowest rib and iliac crest, as illustrated in **Figure 9**.

Figure 9. Illustration of the waist circumference measuring technique.

2.3.5 Blood collection and blood samples

Blood collection involved TC (mmol • L^{-1}), FG (mmol • L^{-1}), TG (mmol • L^{-1}) and HDL-C (mmol • L^{-1}) and were collected from each participant at their respective school or at St. Olavs Hospital in Trondheim, Norway, after 12 hours of fasting. One blood sample from each participant was collected. The vacutainers were kept in room temperature for 20 minutes, before being centrifuged for 10 minutes at 3000 rounds per minute. Prior to the blood test, each subject was offered a local anesthetic plaster named EMLA (AstraZeneca Pty Ltd, Sydney, Australia).

BP was measured with a Diacore Criticare 506N-2 (Criticare Systems Inc., Waukesha, WI, USA) and involved systolic BP (mmol • L^{-1}), diastolic BP (mmol • L^{-1}) and mean arterial pressure (mmol • L^{-1}). Before measurements, each participant sat down for 10 minutes. Measurements were conducted 3 times, with 1 minute between each measurement; all at the dominant arm (defined as the arm one writes with). An extra measurement was completed if the value of the last 2 measurements differed with >15% (systolic or diastolic). The standing values were calculated from the mean BP of the last 2 measurements. During the BP-measurements the participants were instructed to be quiet. Furthermore, the display of the apparatus was pointing away from the participant in order to avoid possible disturbance that could have affected the results (**Figure 10**).

Figure 10. Illustration of the blood pressure technique.

2.3.6 Self-administered questionnaire

A standardized questionnaire concerning subjective PA in and outside of school, health status, socio-economic status and food habits was given to the subjects. The questionnaire was based on an adjusted excerpt from the HEVAS questionnaire (**Appendix 3**). The subjects answered the questionnaire anonymously and in cooperation with their parents.

2.4 Statistical analyses

Primary outcome variables were the subjects PA-level (PAS, PAH, WeekendPA and WeekdayPA) and VO_{2peak}. Other specific data in relation to BC, metabolic health and the self-administered questionnaire were served as secondary outcome variables. By inspection of boxplots for values greater than 3 box-lengths from the edge of the box, extreme outliers were detected and excluded from following analyses; 1 value from the TG blood sample was considered as an extreme outlier and excluded from the dataset. By using Shapiro-Wilk tests and examination of quantile-quantile (QQ) plots, data was considered normally distributed, except WC, BMI and TG. PAS, PAH, WeekdayPA and WeekendPA was transformed to a daily average measured in hours. Independent Samples T-Test and a Mann-Whitney U Test were applied for difference between gender. Paired-Samples T-Test was applied for the difference between PA categories. Multiple linear regression analysis was applied mainly for the association between VO_{2peak} and PA categories – but also for the associations between BC and metabolic health with PA categories. BC variables were separately analyzed due to multicollinearity. General linear model analysis was applied for the association between PA categories and the self-administered questionnaire. All statistical analyses were adjusted for gender. Where appropriate, data was presented as mean ± standard deviation or standardized regression coefficient ± 95% confidence interval, unless stated otherwise – in text, tables and figures. As this was a pilot study, no formal sample size calculation was performed. Significance level was set to $p<.01$ to account for multiple comparisons unless stated otherwise. For statistical analyses, Statistical Package for the Social Sciences 25 (SPSS) (IBM Corp., Armonk, New York, USA) was applied. Graphical illustrations were made in SPSS and Prism 8 (GraphPad Software, San Diego, USA).

2.5 Funding

This study is a part of a Master´s degree in Clinical Health Science – Obesity and Health and was funded by master's degree students at Norwegian University of Science and Technology (NTNU).

2.6 Ethical concern

This protocol was given approval by The Regional Medical Research Ethics Committee in November 2018 (**Appendix 4**) (reference number: 2018/950/REK Midt). Furthermore, the study was conducted according to the ethical standards stated in the Helsinki Declaration [90]. Numerous ethical questions appear when conducting research on children, including considerations concerning discomfort during testing, examinations and blood sampling, as well as safety. There is a certain risk of testing VO_{2peak}, considering the small chance of complications including death increase. Compared to rest, the risk of sudden death during a VO_{2peak}-session or training otherwise, is increased – but this increase is substantially low. Also, it is shown that benefits with exercise outweigh these risks. The VO_{2max}-test was aborted when the subjects could no longer increase or sustain the exercise load, or if there was any sign of ischemia. Good and adequate information prior to participation was highly prioritized, so that the participants (nor school and parents) were in no doubt as to what a consent implied. Participation was voluntary and at any time and without giving grounds, the subjects could withdraw their consent. The present study emphasized safe handling of personal and health information using NTNU solutions for data processing and storage. All pictures used as illustrations are approved by models. In accordance with the subject's protection of privacy, the present study followed the standards of the new EU General Data Protection Regulation (GDPR) and the State Data Protection Inspectorate (SDPI).

2.7 Time frame

Time frame of the present study is illustrated in **Figure 11.**

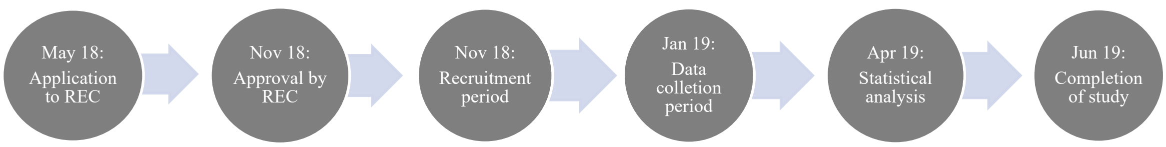

Figure 11. Time-frame of the present study. REC: Regional Committees for Medical and Health Research Ethics.

3. Results

3.1 Subjects characteristics

As shown in **Figure 5**, 8 subjects withdrew from the project due to lack of interest and 24 subjects were not included in the present study due to lack of SenseWear-data, thus the present study included 44 primary school children (mean age: 12.18 (± 0.39) years) grade 7, 3 schools: 2 urban and 1 rural. Subjects characteristics are presented in **Table 1**.

Table 1. Subjects characteristics.

	Boys (n = 20)	**Girls** (n = 24)		**Total** (n = 44)
Residence				
Urban (n)	11	13		23
Rural (n)	9	11		21
Reaching PA as recommended				
Yes (n)	20	23		43
No (n)	0	1		1
Anthropometric measurements			**p-value**	
Weight (kg)	50.8 ± 10.3	49.3 ± 9.6	.622	50.0 ± 9.8
Height (cm)	160.3 ± 7.8	158.4 ± 7.4	.400	159.3 ± 7.5
BMI (kg/m^2)	19.7 ± 3.7	19.5 ± 2.9	.654	19.6 ± 3.3
Muscle mass (kg)	22.2 ± 3.2	20.1 ± 3.1	**.034**	21.1 ± 3.3
WC (cm)	68.3 ± 9.1	65.2 ± 5.9	.389	66.6 ± 7.6
BF (%)	18.3 ± 9.6	22.8 ± 7.7	.091	20.7 ± 8.8
Metabolic measurements				
BPs (mmHg)	115.2 ± 10.1	110.8 ± 9.8	.159	112.7 ± 10.0
BPd (mmHg)	70.6 ± 6.1	70.0 ± 8.6	.799	70.2 ± 7.5
MAP (mmHg)	84.2 ± 7.5	83.5 ± 8.7	.497	84.3 ± 8.1
TC ($mmol \cdot L^{-1}$)	4.1 ± 0.7	4.2 ± 0.7	.615	4.1 ± 0.7
FG ($mmol \cdot L^{-1}$)	5.1 ± 0.4	4.8 ± 0.3	**.002**	5.0 ± 0.4
TG ($mmol \cdot L^{-1}$)	0.8 ± 0.5	0.7 ± 0.2	.989	0.7 ± 0.4
HDL-C ($mmol \cdot L^{-1}$)	1.6 ± 0.3	1.6 ± 0.3	.505	1.6 ± 0.3

Note. Data is presented as n = sample size and continuous variables are presented as mean values ± standard deviation (SD) and appurtenant p-value. PAS; Physical activity at school. PAH; Physical activity at home. WeekdayPA; Weekday physical activity. WeekendPA; Weekend physical activity. PA; Physical activity. BMI; Body mass index. WC; Waist circumference. BF; Body fat. BPs; Blood pressure systolic. BPd; Blood pressure diastolic. MAP: Mean arterial pressure. TC; Total cholesterol. FG; Fasting glucose. TG; Triglycerides. HDL-C; High-density lipoprotein cholesterol. Bold numbers highlight a significant difference between gender (p<.05).

3.1.1 Subjects physical activity level

Subjects had different average PA levels (hours/day) during school (1.7 ± 0.5), outside of school hours (2.1 ± 0.7), during weekdays (3.6 ± 1.0) and during the weekend (2.4 ± 1.6). Subjects were in average 0.4 hours/day more active outside of school hours compared to activity at school (p<.0001) and averagely 1.2 hours/day more active on weekdays compared to the weekend (p<.0001) (**Figure 12).**

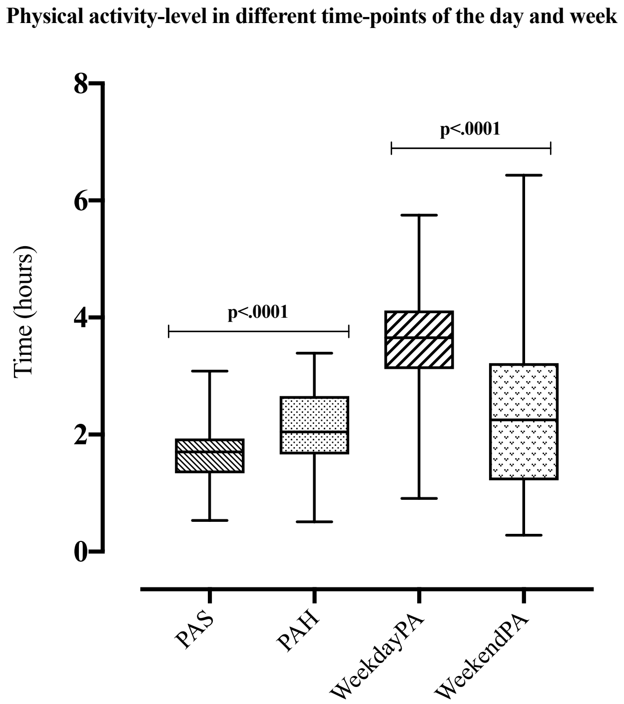

Figure 12. Box plot of physical activity level (hours/day). PAS; Physical activity at school. PAH; Physical activity at home. WeekdayPA; Weekday physical activity. WeekendPA; Weekend physical activity. The box covers the range between the upper and lower quartiles, the whiskers cover the range between the lowest and highest observation and the horizontal bar dividing the box indicates the mean.
Bold numbers highlight a significant difference between groups (p<.05).

In an average, girls (1.4 ± 0.4) were 0.6 hours less active than boys (2.0 ± 0.5) at school (p<.0001) and 0.2 hours/day (2.0 ± 0.8) less active than boys (2.2 ± 0.6) outside of school hours (p=.218). Furthermore, girls (3.3 ± 1.1) were 0.7 hours/day less active than boys (4.0 ± 0.7) during the week (p=.025) and 0.9 hours/day (2.0 ± 1.2) less active than boys (2.9 ± 1.8) during the weekend (p=.043) as illustrated in **Figure 13**.

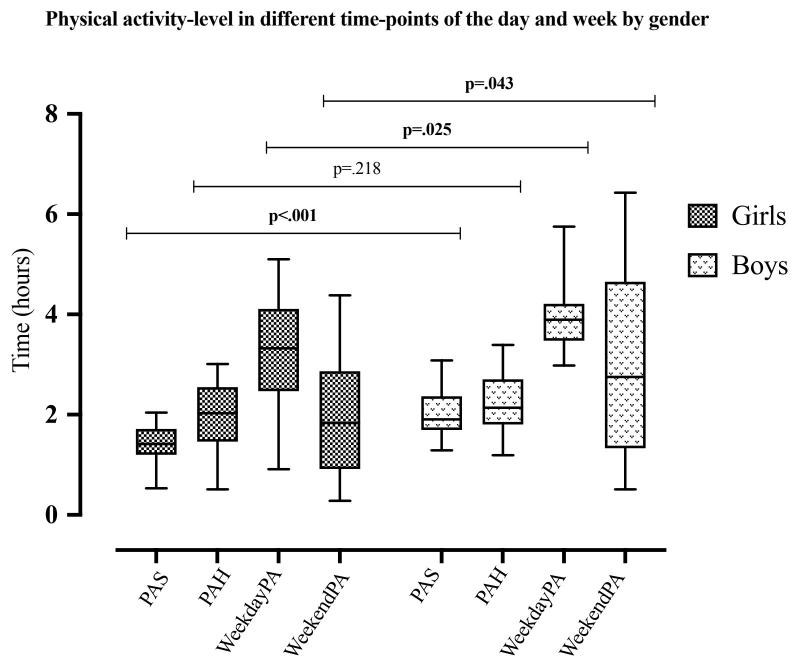

Figure 13. Box plot of physical activity level (hours/day) separated by gender. PAS; Physical activity at school. PAH; Physical activity at home. WeekdayPA; Weekday physical activity. WeekendPA; Weekend physical activity. The box covers the range between the upper and lower quartiles, the whiskers cover the range between the lowest and highest observation and the horizontal bar dividing the box indicates the mean. Bold numbers highlight a significant difference between groups ($p<.05$).

3.1.2 Subjects cardiorespiratory fitness

Average VO_{2peak} among subjects were 51.3 ± 9.4. Boys (54.8 ± 8.4) had in average 3.4 higher VO_{2peak} compared to girls (48.4 ± 9.3) as illustrated in **Figure 14** ($p=.025$).

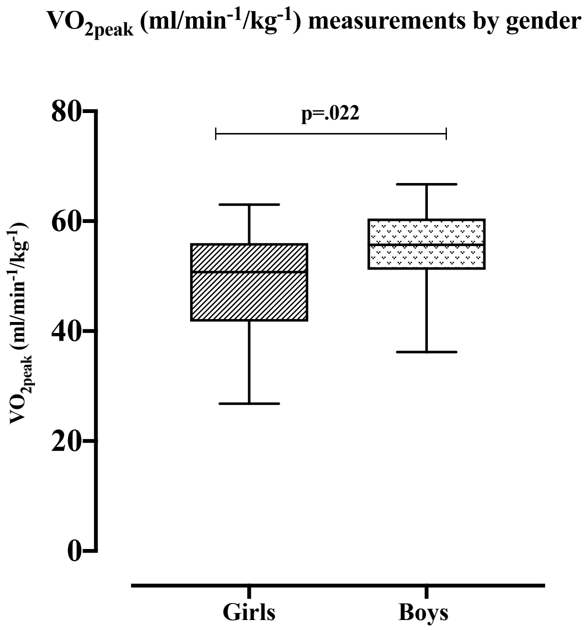

Figure 14. Box plot of measured VO_{2peak} ($mL \cdot min^{-1} \cdot kg^{-1}$) separated by gender. The box covers the range between the upper and lower quartiles, the whiskers cover the range between the lowest and highest observation and the horizontal bar dividing the box indicates the mean. Bold number highlight a significant difference between groups ($p<.05$).

3.2 Time trends in physical activity in association with cardiorespiratory fitness

VO_{2peak} was significant and positively associated with both PAS (p<.0001), PAH (p=.001), WeekdayPA (p=.001) and WeekendPA (p=.002). The greatest association was found to be between VO_{2peak} and WeekendPA (**Table 2**).

Table 2. Effect of VO_{2peak} on physical activity levels at different points of time during the day and week derived from separate models.

	PAS (hours/day)	**PAH** (hours/day)	**WeekdayPA** (hours/day)	**WeekendPA** (hours/day)
Exposure variable	B (95% CI)	B (95% CI)	B (95% CI)	B (95% CI)
VO_{2peak} (mL · min $^{-1}$ · kg $^{-1}$)	**.026 (.013-.040)**	**.037 (.016-0.59)**	**.054 (.024-.083)**	**.079 (.032-126)**
	p<.0001	**p=.001**	**p=.001**	**p=.002**

Note. Data are reported as the unstandardized regression coefficient (B) with 95% confidence interval (95% CI) and the appurtenant p-value. PAS; Physical activity at school. PAH; Physical activity at home. WeekdayPA; Weekday physical activity. WeekendPA; Weekend physical activity. Gender was adjuster for in all tests. Bold numbers highlight a significant regression (p<.01).

Scatter plots illustrate the effect of VO_{2peak} in association to PAS, PAH, WeekdayPA and WeekendPA separately, given in **Table 2**. Overall results indicate that an increase in VO_{2peak} is associated with an increase in the different PA categories – with adjustment for gender (**Figure 15**).

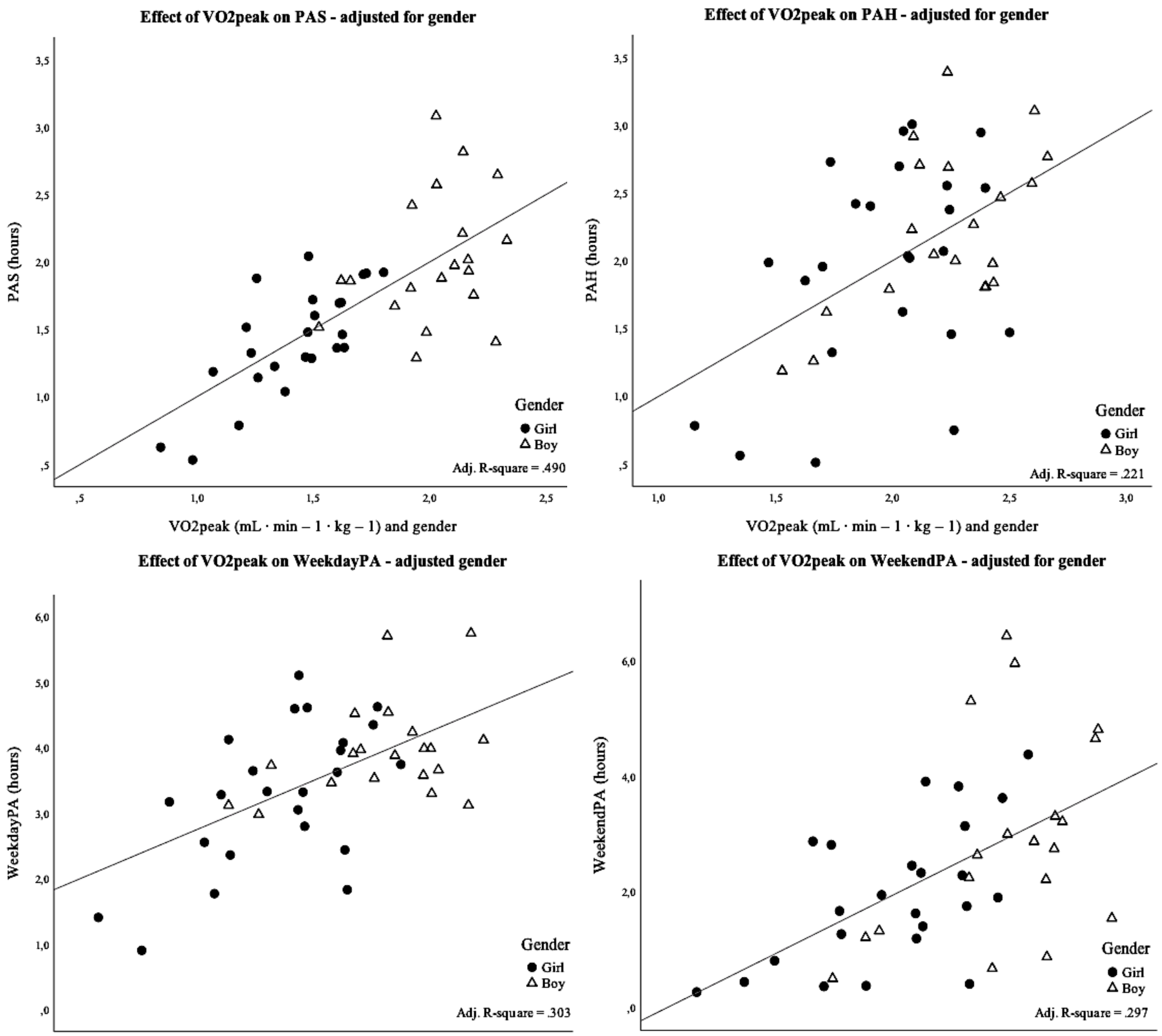

Figure 15. Scatter-plot illustrating the association between dependent variables PAS, PAH, WeekdayPA and WeekendPA and exposure variables VO_{2peak} and gender. Adj. R-square; Adjusted R-square.

3.3 Time trends in physical activity in association with body composition

BMI was significant and negatively associated with both PAS (p=.007), PAH (p<.0001) and WeekdayPA (p<.0001). WC was significant and negatively associated with PAS (p=.007), PAH (p=.001) and WeekdayPA (p=.001). A significant negative relationship was observed between body fat and PAS (p=.002), PAH (p=.003) and WeekdayPA (p=.001) separately. The greatest association was found to be between BMI and WeekdayPA (**Table 3**).

Table 3. Effect of body composition on physical activity levels at different points of time during the day and week derived from separate models.

	PAS (hours/day)	**PAH** (hours/day)	**WeekdayPA** (hours/day)	**WeekendPA** (hours/day)
Exposure variable	B (95% CI)	B (95% CI)	B (95% CI)	B (95% CI)
BMI (kg/m^2)	**-.054 (-.093 – -.016) p=.007**	**-.116 (-.171 – -.061) p<.0001**	**-.160 (-.236 – -.084) p<.0001**	-.159 (-.295 – -.023) p=.023
Muscle mass (kg)	-.018 (-.062 – .026) p=.411	-.078 (-.143 – -.013) p=.020	-.110 (-.200 – -.020) p=.018	-.096 (-.244 – .052) p=.198
WC (cm)	**-.024 (-.041 – -.007) p=.007**	**-.044 (-.070 – -.019) p=.001**	**-.063 (-.098 – -.029) p=.001**	-.056 (-.117 – .006) p=.075
Body fat (%)	**-.024 (-.038 – -.010) p=.002**	**-.035 (-.058 – -.012) p=.003**	**-.053 (-.084 – -.022) p=001**	-.062 (-.114 – -.009) p=.022

Note. Data are reported as the unstandardized regression coefficient (B) with 95% confidence interval (95% CI) and the appurtenant p-value. PAS; Physical activity at school. PAH; Physical activity at home. WeekdayPA; Weekday physical activity. WeekendPA; Weekend physical activity. Gender was adjusted for in all tests. Bold numbers highlight a significant regression (p<.01).

3.4 Time trends in physical activity in association with metabolic health

HDL-C was significant positively associated with WeekdayPA (p=.006), and the greatest association was found to be between the aforementioned (**Table 4**).

Table 4. Effect of metabolic health on physical activity levels at different points of time during the day and week derived from separate models.

	PAS (hours/day)	**PAH** (hours/day)	**WeekdayPA** (hours/day)	**WeekendPA** (hours/day)
Exposure variable	B (95% CI)	B (95% CI)	B (95% CI)	B (95% CI)
TC (mmol • L^{-1})	-.270 (-.514 – -.026) p=.031	-.425 (-.779 – -.071) p=.020	-.628 (-1.107 – -.149) p=.012	-.730 (-1.598 – .139) p=.097
FG (mmol • L^{-1})	-.123 (-.571 – .325) p=.581	-.531 (-.1.181 – .119) p=.106	-.409 (-1.288 – .470) p=.351	-1.377 (-2.932 – -177) p=.081
TG (mmol • L^{-1})	.304 (-.089 – .697) p=.125	-.019 (-.589 – .550) p=.946	.192 (-.578 – .963) p=.615	.012 (-1.346 – 1.370) p=.986
HDL-C (mmol • L^{-1})	.316 (-.211 – .843) p=.231	.867 (.103 – 1.631) p=.027	**1.505 (.471 – 2.539)** **p=.006**	1.144 (-.706 – 2.993) p=.217

Note. Data are reported as the unstandardized regression coefficient (B) with 95% confidence interval (95% CI) and the appurtenant p-value. PAS; Physical activity at school. PAH; Physical activity at home. WeekdayPA; Weekday physical activity. WeekendPA; Weekend physical activity. Gender was adjusted for in all tests. Bold numbers highlight a significant regression (p<.01).

3.5 Time trends in physical activity in association with subjective reporting

No subjective reported answers from the questionnaire (**Appendix 3**) resulted in significant associations (p>.01) with different PA categories, as illustrated in **Table 5**. Still, participation in organized activities, PA at school, health status, socio-economic status and food habits all influenced the subjects PAS, PAH, WeekdayPA and WeekendPA in different ways.

Table 5. Subjects PAS, PAH, WeekdayPA and WeekendPA in association with the self-administered questionnaire.

	Subjective reported themes				
PA variable	***Participation in organized activity***	***Physical activity at school***	***Health status***	***Socio-economic status***	***Food habits***
PAS	*Participation in organized team sports* Participants who reported "*I don´t do this type of activity" (n=8)* had 3 minutes less PAH than those who reported *"2 times a week or more frequently" (n=33).* *p=.864*	*Participation in PE and additional PA subjects (e.g. sports, Outdoor life-subjects)* Participants who reported "1 *time per week*" (n=15) had 43 minutes less PAS than those who reported "More than 4 times per week" (n=2). *p=.038*	*Self-reported body image* Participants who reported *"About the right size"* (n=21) had 7 minutes more PAS than those who reported "*I´m not thinking about it" (n=14)* *p=.497*	*Number of cars in the family* Participants who reported "*We have 1 car" (n=13)* had 9 minutes more PAS than those who reported *"We have 2 or more cars" (n=30).* *p=.343*	*Intake of fruit per week* Participants who reported *"Once a week" (n=3)* had 46 minutes less PAS than those who reported *"Several times per day" (n=4).* *p=.06* Participants who reported *"5-6 days a week" (n=11)* had 36 minutes less PAS than those who reported *"Several times per day" (n=4).* *p=.03*
PAH	*Participation in organized team sports* Participants who reported "*I don´t do this type of activity" (n=8)* had 45 minutes less PAH than those who reported *"2 times a week or more frequently" (n=33).* *p=.025*	*Participation in PE and additional PA subjects (e.g. sports, Outdoor life-subjects)* Participants who reported "3 *times per week*" (n=5) had 41 minutes more PAH than those who reported "More than 4 times per week" (n=2). *p=.325*	*Self-reported body image* Participants who reported *"About the right size"* (n=21) had 30 minutes more PAH than those who reported "*I´m not thinking about it" (n=14)* *p=.055*	*Number of cars in the family* Participants who reported "*We have 1 car" (n=13)* had 31 minutes more PAH than those who reported *"We have 2 or more cars" (n=30).* *p=.034*	*Intake of fruit per week* Participants who reported *"Once a week" (n=3)* had 16 minutes less PAS than those who reported *"Several times per day" (n=4).* *p=.675* Participants who reported *"5-6 days a week" (n=12)* had 30 minutes more PAS than those who reported *"Several times per day" (n=4).* *p=.246*

	Subjective reported themes				
PA variable	***Participation in organized activity***	***Physical activity at school***	***Health status***	***Socio-economic status***	***Food habits***
WeekdayPA	*Participation in organized team sports* Participants who reported *"I don´t do this type of activity" (n=8)* had 55 minutes less WeekdayPA than those who reported *"2 times a week or more frequently" (n=33).* *p= .057*	*Participation in PE and additional PA subjects (e.g. sports, Outdoor life-subjects)* Participants who reported *"1 time per week*" (n=15) had 35 minutes less PAS than those who reported "More than 4 times per week" (n=2). *p=.472*	*Self-reported body image* Participants who reported "About the right size" (n=21) had 24 minutes more PAH than those who reported "*I'm not thinking about it" (n=14).* *p=.290*	*Number of cars in the family* Participants who reported "*We have 1 car" (n=13)* had 41 minutes more PAH than those who reported *"We have 2 or more cars" (n=30).* *p=.054*	*Intake of fruit per week* Participants who reported *"Once a week" (n=3)* had 38 minutes less PAS than those who reported *"Several times per day" (n=4).* *p=.508* Participants who reported *"5-6 days a week" (n=12)* had 6 minutes less PAS than those who reported *"Several times per day" (n=4).* *p=.880*
WeekendPA	*Participation in organized team sports* Participants who reported *"I don´t do this type of activity" (n=8)* had 1 hour and 5 minutes less WeekdayPA than those who reported *"2 times a week or more frequently" (n=33).* *p= .146*	*Participation in PE and additional PA subjects (e.g. sports, Outdoor life-subjects)* Participants who reported "*4 times per week" (n=2)* had 3 hours more WeekendPA than those who reported "*More than 4 times per week" (n=2).* *p=.062*	*Self-reported body image* Participants who reported "About the right size" (n=21) had 1 hour and 8 minutes more PAH than those who reported "*I'm not thinking about it" (n=14).* *p=.056*	*Number of cars in the family* Participants who reported "*We have 1 car" (n=13)* had 5 minutes more PAH than those who reported *"We have 2 or more cars" (n=30).* *p=.878*	*Intake of fruit per week* Participants who reported *"Once a week" (n=3)* had 1 hour and 10 minutes less PAS than those who reported *"Several times per day" (n=4).* *p=.461* Participants who reported *"5-6 days a week" (n=11)* had 2 minutes more PAS than those who reported *"Several times per day" (n=4).* *p=.977*

Note. PA variable; Physical activity variable. PAS; Physical activity at school. PAH; Physical activity at home. WeekdayPA; Weekday physical activity. WeekendPA; Weekend physical activity. Bold numbers highlight a significant association between subjective reported themes and PA categories (p<.01).

4. Discussion

To our current knowledge, no studies have assessed VO_{2peak} and health in association with children´s PA level at different points of time during the day and week. Our main findings in this CS pilot-study of Norwegian 7th grade children, is that VO_{2peak} is significant positively associated with all PA categories, and especially with WeekendPA. Additionally, BMI, body fat and WC are significant negatively associated with PAS, PAH and WeekdayPA, while HDL-C is significant positively associated with WeekdayPA. Finally, no answers given in the self-administered questionnaire results in significant associations with PA categories.

4.1 Time trends in physical activity in association with cardiorespiratory fitness

Several studies have acknowledged the importance of VO_{peak} and how it affects PA among children and youth [65]. The present study demonstrates a significant positively association between VO_{2peak} and PA within all explored time points. This is in line with similar research on the topic, where MVPA and vigorous PA per day were related to VO_{2peak} [66]. The greatest increase in PA was given when comparing the subjects VO_{2peak} with WeekdayPA and WeekendPA. By increasing VO_{2peak} with 1 unit, WeekdayPA and WeekendPA increased with 3 and 5 minutes per day, respectively. Since the study sample were more active on weekdays and during the weekend, compared to at school and after school hours, it may influence the results and why the association with VO_{2peak} was greater in WeekdayPA and WeekendPA. Still, the association between VO_{2peak} and WeekendPA was greater compared to VO_{2peak} and WeekdayPA – even though average PA level in WeekendPA was smaller compared to WeekdayPA. This may be an indicator to target children´s PA during weekdays in a greater scale. Furthermore, PAH was affected by an increase in VO_{2peak} in a greater scale compared to PAS. This may also be a result from a greater activity level outside of school hours, compared to the activity level at school.

Nevertheless, it is important to acknowledge the present results. Research out of school settings is often given a lower priority, and is seen as a minority compared to research in school settings [91]. A big part of children's PA takes place outside of school hours and countless possibilities may exist there. According to Cox et al. (2006) it is crucial to target outside of school environment, and they see this as a key contributor to a child's overall level of PA. There is a need of interventions targeting families and communities, as well as the school environment [92]. It may be important to tailor interventions to out of school settings.

Especially targeting WeekendPA may give interesting results. This is in line with a similar study which sees weekends, after school and non-school periods as important areas to enhance PA among children [44]. Furthermore, a recent report from UngKan3 and Steene-Johannessen et. al (2018) demonstrates that girls and boys in all age-groups have a significant higher MVPA during weekdays than on weekends [42] – which is similar to the PA level among subjects in the present study. Different possibilities may exist in this point of time regarding increasing VO_{2peak} to affect children´s WeekendPA. It is important to acknowledge that VO_{2peak} had a significant positively association with PAS, PAH and WeekdayPA separately as well. Increased VO_{2peak} will have beneficial effects regardless of which settings we aim to increase activity.

The sample in the study presents results where daily average MVPA at school, outside of school hours, during a weekday and during the weekend fall within recommended 1 hour of daily MVPA. Evaluating the sample more closely, 1 out of 44 subjects did not reach the recommendation. The report from UngKan3 and Steene-Johannessen et. al (2018) states that 40% of 15-year-old girls and 51% of 15-year-old boys reach recommended level of daily PA [42]. Furthermore, average VO_{2peak} among girls and boys in the present study were 48.4 ± 9.3 for girls and 54.8 ± 8.4 for boys, respectively. This is in line with what has been shown previously in a study from Nes. et al. (2012), which assessed VO_{2peak} uptake among 13- to 18-Year-Olds via The Young-HUNT Study. In general, absolute VO_{2peak} increases gradually through adolescence for girls and boys [58,72]. Since the sample is in a place between a child and an adolescent, the reported VO_{2peak} values seem rather high, compared to Nes et al. (2012) which assessed children and adolescents aged 13 to 18 [88]. This increases the suspicion that the present study is represented with participation bias - where the most active children have given consent to participate. This may be one of the reasons why the increase in each PA category were not larger than given results. In addition, the study was conducted as a pilot study and the investigated sample was small, which may have affected presented results. Targeting the least active children and/or increase the sample size is recommended. Furthermore, it may be important to target those who do not reach 1 hour of daily MVPA in association with PA at different points of time during the day and week in a greater scale. By doing so, an enhanced understanding and knowledge for future actions in promoting and increasing PA among children may occur. To obtain a greater understanding of how VO_{2peak} affects not only the most active children, but also the ones who do not reach the recommended daily MVPA at different points of time during the day and week, is highly interesting and must be targeted. Also, the present study did not implement scaling for BC and did not assess pubertal stage. This is a limitation, considering that BC and pubertal stage affects VO_{2peak}, and further, PA levels among children and youth [73,74].

4.2 Time trends in physical activity in association with body composition

BMI, WC and body fat were significant negatively associated with time in PAS, PAH and WeekdayPA. Although lack of significance, a similar effect of BC components and their association with WeekendPA were observed, as per the presented association with PAS, PAH and WeekdayPA. Regardless, the presented results are in line with several previous studies that compared BC and PA – like Barker et al. (2018) which suggested that public health recommendations should promote activity to minimize the development of CVD risk factors in children and youth [12]. Furthermore, higher levels of MVPA among children leads to a more favorable BC and adiposity marker [46].

Increased BMI was significant and negatively associated with PAH and WeedayPA, more than the association with PAS. This may be due to the origin of PAS. When children are at school, they follow specific routines set by the school regime, e.g. when it comes to recess and PE. At school children "have to" be in activity compared to out of school hours, e.g. when they come home. Increased BMI also led to a similar decrease in WeekendPA (9.5 minutes per day) as in WeekdayPA (9.6 minutes per day), but without statistical significance. Thus, the association between BMI and WeekendPA needs further investigation. In the present study, the subjects measured mean BMI indicates normal weight according to Cole et al. (2000) and seems to be within normal range [89]. There may exist a greater difference between children with a higher BMI compared to a lower BMI regarding their activity pattern. A study from Dalene et al. (2017) states that substituting 10 min ST per day with vigorous PA was associated with lower WC in 9- and 15-year-olds [93]. This may explain why the unstandardized regression coefficients for WC was smaller, compared to the unstandardized regression coefficients for BMI. In the present study, PA categories are based on cut-off values from MVPA and not only vigorous PA. Thus, associations between WC and PA categories could have been affected by too low cut-off values. This is in line with Ortega et al. (2007), which states that children with low levels of vigorous PA, were more likely to be overweight and have high-risk WC, than children with higher levels of vigorous PA [94]. Some of the subjects WC values are within 85th cut-off values for central overweight, based on reference values for WC of Norwegian children [95]. This indicates a somewhat diverse sample and strengthens presented results regarding WC´s effect on PA categories. The same tendency is observed for the association between body fat and PA categories, which also affected significant negatively on PAS, PAH and particularly WeekdayPA. The greatest association was between body fat and WeekendPA, but without statistical significance. A study from Dencker et al. (2012) stated that minutes of MVPA and vigorous PA were related to the amount of body fat [96]. This is inconsistent compared to the study from Ortega et al. (2007), which stated that vigorous PA was associated with high total fatness [94]. The association between body fat and PA categories may have been affected by cut-off values for PA categories – and needs further investigation. Although our research show a negative association between muscle mass and PA categories, we would expect to see a positive association between the aforementioned based on current understanding in the literature [97,98]. Even though the association was non-significant, it still needs further investigation. Finally, BC was assessed with BIA. The validity of BIA to estimate BC among children is uncertain. Among normal weight children, BIA tends to underestimate body fat and overestimate fat-free-mass in comparison with dual-energy x-ray absorptiometry [99]. The associations between BC and PA categories should be interpreted with caution.

4.3 Time trends in physical activity in association with metabolic health

Clustering of cardiometabolic risk (e.g. TC, FG, TG, increases, HDL-C decreases) rises when children are less physical active and excessively sedentary [75–77]. This has been proven in the present study, where it has been demonstrated that HDL-C was significant and strongly positively associated with WeekdayPA, and strongly associated with WeekendPA - but without statistical significance. By increasing HDL-C with 1 unit, time in WeekdayPA increased with 1 hour and 30 minutes per day and time in WeekendPA increased with 1 hour and 8 minutes per day. HDL-C was also positively associated with PAS and PAH. A related study confirms that time spent in MVPA was positively associated with HDL-C levels [100].

TC was negatively associated with PAS, PAH, WeekendPA and WeekdayPA. This is in line with a study from Duarte et. al (2004) where results indicated that PA had potential benefits in decreasing TC values [101]. Similar results were observed for FG, which also affected negatively time in PAS, PAH, WeekendPA and especially WeekdayPA. This is in line with a study from Huus et al. (2015), where results indicated that low PA increased the load on insulin producing β-cells and might increase the risk of both type 1- and type 2 diabetes [102]. TG was negatively associated with PAH and positively associated with PAS, WeekdayPA and WeekendPA. The association for PAS, WeekdayPA and WeekendPA is inconsistent compared to a study from Ekelund et al. (2012) which reported that TG was negatively associated with MVPA min/day among children [23] – and the present results from the association between TG and PAS, Weekday and WeekendPA needs further investigation.

Several comparisons between metabolic health variables and PA categories gave no significant results, especially TC, FG and TG, but also HDL-C and its association with PAS, PAH and WeekendPA. This may be due to the origin of the different PA-variables. As stated from Barker et. al (2018), higher vigorous PA and not moderate PA was associated with lower TG values and other clustered CVD risk factors [12]. This is in line with another study which states that the strongest association with metabolic health were evident for vigorous PA, and weaker for moderate PA [103]. PAS, PAH, WeekdayPA and WeekdayPA are based on cut-off values from MVPA, and this may have influenced both the significant and non-significant results. Another possible explanation is that the mean in the present sample of metabolic health variables were at a favorable level according to threshold values used to define "at risk" levels in children and youth [104]. The present study could have achieved greater associations and/or significant levels if vigorous PA was used as a reference value for PA categories and/or included more people at risk for CVD.

4.4 Time trends in physical activity in association with subjective reporting

None of the questions from the questionnaire in association with PA categories provided significant results. Still, a tendency towards significance was observed in several cases.

4.4.1 Physical activity at school

Two themes resulted in interesting findings when comparing the questionnaire with PAS. Less participation in PE and additional PE subjects decreased time in PAS - which is not surprising, but still important to acknowledge. PA is considered to be a place where children can learn how to be active. Also, children who are less active outside of school may benefit from being more active at school [31]. Decreased time in PAS was observed among subjects reporting eating less fruit per week. Associations may have been affected by different school policies. The present study included 1 rural and 2 urban schools; e.g. one school may have a higher intake of fruit per week. There could be an association with intake of fruit and activity. Still, an active lifestyle does not automatically result in healthy eating habits. Replies for each aforementioned theme was low and weakens the validity - and warrants further investigation.

4.4.2 Physical activity outside of school hours

Three themes resulted in interesting findings when comparing the questionnaire with PAH. Less participation in organized team sports gave a decrease in PAH. Results may not be surprising when considering the essence of organized team sports; it takes place after school hours and is often organized with several practices per week. Children who participate in organized team sports reach a higher level of MVPA compared to those who do not attend [(105)]. Surprisingly, increased time in PAH was observed among subjects who reported "About the right size" compared to subjects who reported "I´m not thinking about it". Today's society is surrounded by impressions of what the "right" body image is and media is known to have a negative influence on children [(106,107)]. Body image has been identified as a strong determinant of PA; dissatisfaction can either act as a motivator or a barrier [(108,109)]. An increase in PAH was observed among subjects who reported fewer cars in the family. Similar studies have reported that children who walked or cycled to school had significantly more MVPA per day than those who were driven to school [(42)] – and that cycling to school improved VO_{2peak} [(110)].

4.4.3 Physical activity during the week

Two themes resulted in interesting findings when comparing the questionnaire with WeekdayPA. A decrease in WeekdayPA was observed among subjects who participated less in organized team sports, while an increase in WeekdayPA was observed among subjects who reported fewer cars in the family. A closer trend towards significance was observed regarding the comparison between PAH and participation in organized team sports, and PAH and number of cars in the family. PAH includes only hours outside of school, while WeekdayPA includes hours subjects are awake during a weekday. Increased attendance in organized sports and reduced number of cars in the family may have beneficial effects on PA, regardless of which time of the week is targeted. Still, this may be an indicator to encourage future research at targeting specific points of time during the day and week.

4.4.4 Physical activity during the weekend

Two themes resulted in interesting findings when comparing the questionnaire with WeekendPA. Increased WeekendPA was observed for subjects who reported less participation in PE and additional PE subjects. Subjects who reported less participation may have an activity level which is equal throughout the whole week. While subjects who reported higher participation usually are in greater activity during weekdays and are in need of less activity during weekends. Since the number of replies was low, the validity of the comparison is weak and needs further investigation. Furthermore, increased time in WeekendPA was observed among subjects who evaluated their body image as “About the right size” compared to subjects who reported “I´m not thinking about it”. As mentioned in the section regarding PAH and *Self-reported body image*; it has been identified as a strong determinant of PA; dissatisfaction can either act as a motivator or a barrier [108,109].

4.5 Study limitations

The study is presented with some limitations. First, the present study was conducted as a pilot study; hence the sample size may not be of an adequate size. Furthermore, the study was carried through as a CS study. CS studies have an inherent weakness regarding causality. The present study has collected sets of information at the same time, which makes it difficult to draw a clear interference of causality – a causal direction of the association between PA at different times of the day and week to VO_{2peak} and health, cannot be established. In addition, the sample of the present study may not be representative of the general population. Since the present study is voluntary and involved themes like PA and VO_{2peak}, the most active children were likely to be the ones who agreed to participate. By evaluating the sample, 43 of 44 subjects fulfilled recommended 1-hour daily MVPA from The Norwegian Directorate of Health. PA measurements based on SenseWear were conducted on 44 subjects, even though the study recruited a total of 68 – this is due to lack of time, access to necessary equipment and technical issues with the measuring equipment. The device is not water resistant and water-based activities like swimming were not included. The variable WeekendPA is based on 1 whole weekend (Saturday and Sunday). Children´s PA pattern may vary between weekends and the measured WeekendPA may not reflect a normal weekend pattern. One school had PE twice a week, while the others had PE once a week. This may influence the PAS variable, e.g. give higher daily mean numbers or wrong associations. Subjects who used SenseWear may have been more active during the registration period. They were instructed not to change their normal activity level, and if possible, the first day of wearing the device was excluded. SenseWear cut-off choices for classification of intensity does not need to correlate with similar studies – and it is important to be aware of this when comparing similar research and methods. The present study does not consider seasonal variances which may affect PA values [111]. CPET may be confounded if measurements are not, or only partly, adjusted for puberty maturation and body weight. The age of the sample is between 12 and 13 years, somewhere between a child and an adolescent, i.e. the sample is most likely at different stages of puberty. Pubertal status and scaling for body weight were not taken into account in the present study [73,74]. Assessing children´s BC with BIA may have provided wrong associations [99]. Results from the self-administered questionnaire might be affected by subjects desire to provide "socially correct" answers, result in recall bias and/or give wrong conclusion based on their misconception of PA [52]. Number of subjects answering questions from the self-reported questionnaire was low and there was lack of significance. Comparisons to each question answered with PA-categories may not reflect how a larger sample would have responded.

4.6 Conclusion

Targeting specific points of time during the day and week may be important when designing future interventions and informing public health policy - with the purpose of promoting and increasing children´s PA. VO_{2peak} had positive associations with all PA categories, but especially with WeekendPA. BMI, WC and body fat were especially negatively associated with WeekdayPA, but also with PAS and PAH - while HDL-C had a positive association with WeekdayPA. PA at different points of time may be associated with other factors as well, but results are too inconsistent to state an absolute conclusion. Overall, a need for larger interventions to confirm the presented results are warranted.

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Appendix 1: Information sheet for children

Hvordan påvirker fysisk aktivitet utøvd i – og utenfor skolen på barnas fysiske form og helse?, 17.09.2018.

NTNU
Kunnskap for en bedre verden

HVORDAN PÅVIRKER FYSISK AKTIVITET UTØVD I – OG UTENFOR SKOLEN PÅ BARNAS FYSISKE FORM OG HELSE?

BAKGRUNN OG HENSIKT

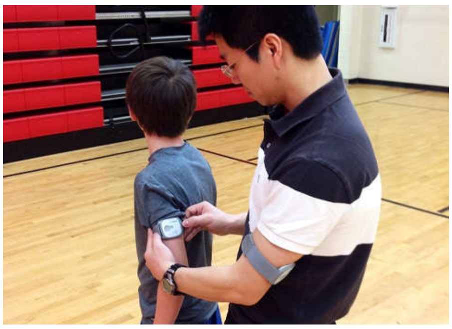
Vi ønsker å finne ut om det er en sammenheng mellom aktiviteten du gjør i – og utenfor skolen, på din fysiske form (det vil si evnen du har til å utføre aktiviteten du gjør) og din helse. Når på dagen er du mest aktiv? Er aktiviteten du gjør i kroppsøvingstimene betydningsfullt? Dette er vi interessert i å undersøke – både til deg som går på skole i byen og på landet. Fysisk aktivitet er viktig for alle **og** spesielt viktig for deg som er i stadig vekst. Ved å delta i denne helseundersøkelsen kan vi få et bedre innblikk i akkurat hvordan din aktivitet gjennom dagen påvirker din fysiske form og helse.

HVA INNEBÆRER STUDIEN?

Hvis du har lyst til å være med i denne studien og blir valgt ut til å delta, vil vi først og fremst teste kondisjonen din på tredemølle ved bruk av en maske som måler hvor mye du puster ut og inn. Testen kan både gjennomføres gående og løpende på tredemøllen med denne masken på. I tillegg vil du få tildelt et pulsbelte som måler hvor mange ganger hjertet ditt slår i løpet av ett minutt. Beltet blir festet under brystet ditt. Dette er en test av oksygenopptaket ditt, også kalt VO_2-maks test, som sier noe om din fysiske form. På forhånd vil vi gå gjennom nøye med deg hvordan en tredemølle fungerer og hvordan testen gjøres - og det vil bli muligheter for at du kan stille spørsmål. Testen på tredemøllen krever også at vi må få måle vekten - og høyden din, i tillegg til omkretsen rundt midjen.

Vi kommer også til å måle hvor fysisk aktiv du er i løpet av en uke. Dette gjøres ved at du får utdelt et armbånd, enten et som heter MioSlice eller et som heter SenseWear, eller begge to. Disse armbåndene skal brukes sammenhengende i 7 dager – det vil si, døgnet rundt, dag og natt, i en uke. MioSlice er et armbånd som tåler vann og kan dermed brukes når man for eksempel dusjer eller svømmer. SenseWear er ikke vanntett og må tas av under dusjing eller andre vann-aktiviteter. Begge armbåndene skal brukes når du sover. Både MioSlice og SenseWear festes på hånden eller armen din, på en slik måte at det ikke skal være ubehagelig for deg å bruke de – verken på dagen eller natten.

Illustrasjonsbilde: Testing av oksygenopptak på tredemølle.



Illustrasjonsbilde: Bruk av SenseWear.

Side 1 / 3

I tillegg ønsker vi å ta blodprøve av deg og måle blodtrykket ditt. Før blodprøven vil du få utdelt et bedøvelsesplaster som gjør at du mister følelsen i området blodprøven skal tas.

Du vil også bli gitt et spørreskjema som besvares med hjelp fra en foresatt. Et spørreskjema er et skjema med spørsmål vi ønsker at du skal svare på. Spørreskjemaet omhandler spørsmål om blant annet fysisk aktivitet, skjermbruk og hvordan du har det i hverdagen.

Bortsett fra bruk av MioSlice og/eller Sensewear som skal brukes hver dag i 7 dager, vil du totalt komme til å bruke omtrent 2 timer på dette - i tillegg til tiden som brukes til eventuell reising til og fra sykehuset.

Mulige fordeler og ulemper

Fordelen med dette prosjektet er at du får muligheten til å delta i et forskningsprosjekt som kan bidra til å gi viktig og nyttig informasjon. I tillegg vil forskningsprosjektet gi et innblikk i ditt eget aktivitetsnivå og fysiske form.

Ulemper er at man blir sliten rett etter den fysiske testen på tredemøllen. I tillegg kan du oppleve ubehag ved blodprøvetaking - men som nevnt, vil det bli gitt ut bedøvelsesplaster på forhånd. Alle testene kan ta litt tid, så du må regne med at noen timer fra skolen eller fritiden blir brukt i denne sammenhengen.

Hva skjer med prøvene og informasjonen om deg?

Informasjonen og prøvene vi får fra deg vil bli godt tatt vare på og vil kun bli brukt i sammenheng med denne studien. All informasjon og prøver vil vi samle inn uten verken ditt navn eller fødselsnummer, bortsett fra ved blodprøvetaking da dette skal sendes til klinisk kjemi, men det vil ikke bli lagret noen plass hos oss. Det vil da si, at resultatene vi får ut av denne studien, blir umulig å spore tilbake til deg og kan ikke bli knyttet til ditt navn. En kode knytter dine opplysninger og prøver gjennom en navneliste. Det er kun spesiell personell som er med i forskningsprosjektet som vil ha adgang til denne listen og kan finne tilbake til deg. Av kontrollhensyn blir dataene samlet inn oppbevart forsvarlig nedlåst i 5 år. Etter dette vil dataene bli slettet. Det er Dr. Arnt Erik Tjønna som er ansvarlig for datamaterialet i denne perioden.


Illustrasjonsbilde: Spørreskjema.


Illustrasjonsbilde: Bruk av MiloSlice.


Illustrasjonsbilde: Bruk av bedøvelsesplaster.


Illustrasjonsbilde: Måling av blodtrykk.

DELTAKELSE

Det er frivillig å delta i studien. Du kan når som helst, og uten å oppgi noen grunn, trekke deg fra prosjektet. Du kan også velge å si nei til å delta i forskningsprosjektet, selv om dine foresatte sier ja til at du skal delta. Dersom du senere ønsker å trekke deg eller har spørsmål til studien, kan du enten kontakte masterstudenter Lisa Busklein Brodal på følgende telefonnummer: + 47 452 76 546, e-mail: lisabb@ntnu.no og Guro Rosvold på følgende telefonnummer: + 47 452 18 642, email: guroros@ntnu.no, eller lederen av prosjektet Dr. Arnt Erik Tjønna på følgende telefonnummer: + 47 419 27 885, e-mail: arnt.e.tjonna@ntnu.no.

Appendix 2: Information sheet and consent form for parents

NTNU
Kunnskap for en bedre verden

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKTET

HVORDAN PÅVIRKER FYSISK AKTIVITET UTØVD I – OG UTENFOR SKOLEN PÅ BARNAS FYSISKE FORM OG HELSE?

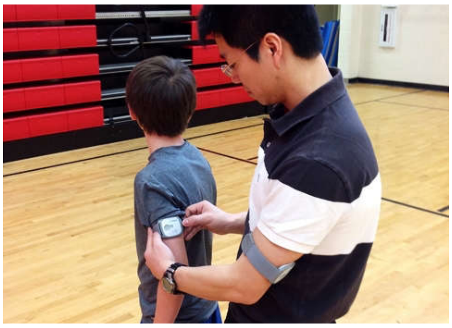
Dette er en forespørsel om tillatelse for at ditt barn kan delta i et forskningsprosjekt for å undersøke om det er en sammenheng mellom aktiviteten barnet ditt utfører i - og utenfor skolen og dens fysiske form, samt helse. Vi ønsker å undersøke hvilket tidspunkt av døgnet han/hun er mest aktivt? Om det er noen sammenheng mellom ditt barns daglige aktivitetsnivå og deltagelse i kroppsøving? Dette ønsker vi å sammenligne på tvers av skolelokasjon – by og land. Testing og undersøkelser vil hovedsakelig bli gjennomført ved det medisinske fakultet ved NTNU i Trondheim, samt ved ditt barns skole.

HVA INNEBÆRER PROSJEKTET?

Hvis ditt barn ønsker å delta, samt du som foresatt godkjenner til deltakelse - og deres skole blir valgt ut til å delta, vil ditt barn første og fremst gjennomføre en test av utholdenhet (VO2-maks test) på tredemølle. Barnet blir utstyrt med en maske som illustrert på bildet, samt pulsbelte som vil gi oss de verdiene vi trenger for å beregne barnets fysiske form. Barnet vil gjennomføre enten testen løpende eller gående på tredemøllen – alt ettersom hva barnet er kapabel til. På forhånd av testen, vil testpersonell gjennomgå hvordan tredemøllen fungerer og hvordan testen utføres - og det vil bli muligheter for at du som forelder og ditt barn kan stille spørsmål. Testen på tredemøllen krever også at vi måler barnets vekt, høyde, i tillegg til midjeomkrets. Vi kommer også til å måle hvor fysisk aktiv barnet er i løpet av en uke.

Illustrasjonsbilde: Testing av oksygenopptak på tredemølle.

Dette måles ved at barnet ditt får utdelt et armbånd, enten MioSlice eller SenseWear, som skal brukes sammenhengende i syv dager – det vil si døgnet rundt, også på natten. MioSlice er vannavstøtende og skal dermed brukes under dusjing og andre vann-aktiviteter. SenseWear er ikke vannavstøtende og skal dermed tas av under dusjing og andre vann-aktiviteter. Begge armbånd er designet for å skape minst mulig ubehag og irritasjon for de som bruker dem. I tillegg ønsker vi å ta blodprøver og blodtrykk av ditt barn. Barnet vil bli på forhånd av blodprøvetakingen bli utstyrt med et bedøvelsesplaster, som vil gi midlertidig følelsesløshet i området blodprøven skal tas.



Illustrasjonsbilde: Bruk av SenseWear.

Barnet ditt vil også få utdelt et spørreskjema som kan besvares i samhandling med deg som foreldre. Spørreskjemaet omhandler spørsmål om blant annet fysisk aktivitet, skjermbruk og livskvalitet. Utenom bruk av MioSlice eller SenseWear, vil omtrent tidsbruk for innsamling av data vil være på 2 timer - ekskludert eventuell reising.

Illustrasjonsbilde: Spørreskjema.

I prosjektet vil vi innhente og registrere opplysninger om ditt barn. Oppsummert vil dette innebære oksygenopptak, blodprøver, blodtrykk, høyde, impedansvekt, midjeomkrets, fysisk aktivitetsnivå og spørreskjemaopplysninger.

Mulige fordeler og ulemper

Fordelen med dette prosjektet er at barnet ditt får muligheten til å delta i et forskningsprosjekt som kan bidra til å gi viktig og nyttig informasjon. I tillegg vil forskningsprosjektet gi et innblikk i ditt barns aktivitetsnivå og fysiske form.

Illustrasjonsbilde: Bruk av MiloSlice.

Ulemper er at man blir sliten rett etter den fysiske testen på tredemøllen. I tillegg kan barnet oppleve ubehag ved blodprøvetaking - men som nevnt, vil det bli gitt ut bedøvelsesplaster på forhånd. Alle testene kan ta litt tid, så man må regne med at noen timer fra skolen eller fritiden blir brukt i denne sammenhengen.

Frivillig deltakelse og mulighet for å trekke sitt samtykke

Det er frivillig å delta i prosjektet. Dersom barnet ditt ønsker å delta, undertegner du samtykkeerklæringen på siste side. Barnet ditt kan velge å si nei til å delta i forskningsprosjektet, selv om du som foresatt samtykker i at barnet ditt skal delta. Du kan når som helst og uten å oppgi noen grunn trekke ditt samtykke. Dersom barnet trekker seg fra prosjektet, kan dere kreve å få slettet innsamlede prøver og opplysninger, med mindre opplysningene allerede er inngått i analyser eller brukt i vitenskapelige publikasjoner. Dersom barnet ditt senere ønsker å trekke seg eller har spørsmål til prosjektet, kan du kontakte masterstudenter Lisa Busklein Brodal på følgende telefonnummer: + 47 452 76 546, e-mail: lisabb@ntnu.no og Guro Rosvold på følgende telefonnummer: + 47 452 18 642, email: guroros@ntnu.no, eller kontakte lederen av prosjektet Dr. Arnt Erik Tjønna på følgende telefonnummer: + 47 419 27 885, e-mail: arnt.e.tjonna@ntnu.no.

Illustrasjonsbilde: Bruk av bedøvelsesplaster.

Hva skjer med informasjonen om ditt barn?

Informasjonen som registreres om ditt barn skal kun brukes slik som beskrevet i hensikten med studien. Du og ditt barn har rett til innsyn i hvilke opplysninger som er registrert om ditt barn og rett til å få korrigert eventuelle feil i de opplysningene som er registrert. Dere har også rett til å få innsyn i sikkerhetstiltakene ved behandling av opplysningene.

Illustrasjonsbilde: Måling av blodtrykk.

Alle opplysningene vil bli behandlet uten navn og fødselsnummer eller andre direkte gjenkjennende opplysninger, bortsett fra ved blodprøvetaking da dette skal sendes til klinisk kjemi, men det vil ikke bli lagret noe hos oss. En kode knytter ditt barn til dine opplysninger gjennom en navneliste. Det er kun Dr. Arnt Erik Tjønna, Lisa Busklein Brodal og Guro Rosvold som har tilgang til denne listen.

Prosjektleder har ansvar for den daglige driften av forskningsprosjektet og at opplysninger om ditt barn blir behandlet på en sikker måte. Informasjon om ditt barn vil bli anonymisert eller slettet senest 5 år etter prosjektslutt.

Hva skjer med prøver som blir tatt av ditt barn?

Blodprøvene som tas av ditt barn skal analyseres direkte og blir deretter destruert, så det skal ikke oppbevares i noe biobank.

Forsikring

Deltakere i studien vil være forsikret gjennom pasientskadeerstatningsordningen (pasientskadeloven).

Økonomi

Ingen etiske eller praktiske utfordringer er knyttet til økonomi. Studien er finansiert gjennom egne forskningsmidler.

Godkjenning

Prosjektet er godkjent av Regional komite for medisinsk og helsefaglig forskningsetikk, [2018/950].

Etter ny personopplysningslov har behandlingsansvarlig [Norges Teknisk Naturvitenskaplige Universitet] og prosjektleder Dr. Arnt Erik Tjønna har et selvstendig ansvar for å sikre at behandlingen av dine opplysninger har et lovlig grunnlag. Dette prosjektet har rettslig grunnlag i EUs personvernforordning artikkel 7a.

Du har rett til å klage på behandlingen av dine opplysninger til Datatilsynet.

KONTAKTOPPLYSNINGER

Dersom du har spørsmål til prosjektet kan du ta kontakt med masterstudenter Lisa Busklein Brodal på følgende telefonnummer: + 47 452 76 546, e-mail: lisabb@ntnu.no og Guro Rosvold på følgende telefonnummer: + 47 452 18 642, email: guroros@ntnu.no, eller kontakte lederen av prosjektet Dr. Arnt Erik Tjønna på følgende telefonnummer: + 47 419 27 885, e-mail: arnt.e.tjonna@ntnu.no.

Du kan ta kontakt med institusjonens personvernombud dersom du har spørsmål om behandlingen av dine personopplysninger i prosjektet. [Thomas Helgesen, 93079038, thomas.helgesen@ntnu.no.]

SAMTYKKE TIL DELTAKELSE I PROSJEKTET

SOM FORESATT ER JEG VILLIG TIL AT BARNET MITT SKAL DELTA I PROSJEKTET

Som foresatte til_ (Fullt navn) samtykker vi til at hun/han kan delta i prosjektet

----

Sted og dato Foresattes signatur

Foresattes navn med trykte bokstaver

Sted og dato Foresattes signatur

Foresattes navn med trykte bokstaver

Som nærmeste pårørende til _ (Fullt navn) samtykker jeg til at hun/han kan delta i prosjektet.

Sted og dato Pårørendes signatur

Pårørendes navn med trykte bokstaver

Jeg bekrefter å ha gitt informasjon om prosjektet

Sted og dato | Signatur

Rolle i prosjektet

Appendix 3: Adjusted excerpt from HEVAS questionnaire used in the study

UNIVERSITETET I BERGEN

HEMIL-senteret

Senter for forskning om helsefremmende arbeid, miljø og livsstil

Helsevaner blant skoleelever.
En WHO-undersøkelse i over 40 land.

Spørreskjema for 2018

7. klassetrinn

Bokmål

Christiesgt. 13 - 5020 Bergen, Telefon: 55 58 48 43, E-post: hevas@uib.no
Etablert i samarbeid med Nasjonalforeningen for folkehelsen 1988
Samarbeidssenter for Verdens Helseorganisasjon (WHO)

Kjære elev!

Ved å svare på disse spørsmålene, vil du hjelpe oss med å finne ut mer om barn og unges livsstil og skolemiljø. De samme spørsmålene vil bli stilt til skoleelever i 40 andre land. Svarene dine skal være hemmelige, derfor skal du ikke besvare spørsmålene mens andre ser på.

Dersom du ikke ønsker å svare, kan du la være. Hvis det er noen spørsmål du ikke ønsker å svare på, kan du gå videre til neste spørsmål.

Les hvert enkelt spørsmål, og svar så ærlig som du kan.

På forhånd takk for hjelpen!

Oddrun Samdal
Professor

Ingebjørg Louise Rockwell Djupedal
Prosjektmedarbeider

Er du gutt eller jente?

(1) ❑ Gutt

(2) ❑ Jente

I hvilken måned ble du født?

(1) ❑ Januar

(2) ❑ Februar

(3) ❑ Mars

(4) ❑ April

(5) ❑ Mai

(6) ❑ Juni

(7) ❑ Juli

(8) ❑ August

(9) ❑ September

(10) ❑ Oktober

(11) ❑ November

(12) ❑ Desember

Hvilket år ble du født?

(13) ❑ 1995 eller tidligere

(1) ❑ 1996

(2) ❑ 1997

(3) ❑ 1998

(4) ❑ 1999

(5) ❑ 2000

(6) ❑ 2001

(7) ❑ 2002

(8) ❑ 2003

(9) ❑ 2004

(10) ❑ 2005

(11) ❑ 2006

(12) ❑ 2007

(14) ❑ 2008 eller senere

I hvilket land er du født?

(1) ❑ I Norge
(2) ❑ I Sverige, Finland, Danmark eller Island
(3) ❑ Annet land i Europa
(4) ❑ Annet land utenfor Europa
(5) ❑ Vet ikke

I hvilket land er din mor født?

(1) ❑ I Norge
(2) ❑ I Sverige, Finland, Danmark eller Island
(3) ❑ Annet land i Europa
(4) ❑ Annet land utenfor Europa
(5) ❑ Vet ikke

I hvilket land er din far født?

(1) ❑ I Norge
(2) ❑ I Sverige, Finland, Danmark eller Island
(3) ❑ Annet land i Europa
(4) ❑ Annet land utenfor Europa
(5) ❑ Vet ikke

Har din familie bil?

(1) ❑ Nei
(2) ❑ Ja, en
(3) ❑ Ja, to eller flere

Hvor mange ganger reiste du og familien din på ferie til utlandet i fjor?

(1) ❑ Ingen
(2) ❑ En gang
(3) ❑ To ganger
(4) ❑ Mer enn to ganger

Hvor mange PC-er har familien din?

(1) ❑ Ingen
(2) ❑ En
(3) ❑ To
(4) ❑ Flere enn to

Har familien din oppvaskmaskin hjemme?

(1) ❑ Ja
(2) ❑ Nei

Hvor bor du?

(1) ❑ I en enebolig
(2) ❑ I et rekkehus (ta også med to- eller firemannsbolig
(3) ❑ I en leilighet

Vil du si at helsen din er….?

(1) ❑ Svært god
(2) ❑ God
(3) ❑ Ganske god
(4) ❑ Dårlig

Med fysisk aktivitet mener vi aktiviteter som gjør at du en del av tiden får økt puls og blir andpusten. Fysisk aktivitet er for eksempel idrettsaktiviteter etter skolen, aktiviteter på skolen, det å leke med venner eller det å gå til skolen. Andre eksempler er å løpe, stå på skateboard, sykle, svømme, spille fotball, stå på ski/snowboard eller danse. For det neste spørsmålet, legg sammen all den tiden du var fysisk aktiv hver dag.

I løpet av de siste 7 dagene. Hvor mange av disse dagene var du fysisk aktiv i minst 60 minutter per dag?

(0) ❑ Ingen dager
(1) ❑ 1 dag
(2) ❑ 2 dager
(3) ❑ 3 dager
(4) ❑ 4 dager
(5) ❑ 5 dager
(6) ❑ 6 dager
(7) ❑ 7 dager

I ukedagene, hvor ofte spiser du vanligvis frokost (mer enn et glass melk eller juice)?

(1) ❑ Jeg spiser aldri frokost på ukedager
(2) ❑ En dag
(3) ❑ To dager
(4) ❑ Tre dager
(5) ❑ Fire dager
(6) ❑ Fem dager

I helgen, hvor ofte spiser du vanligvis frokost (mer enn et glass melk eller juice)?

(1) ☐ Jeg spiser aldri frokost i helgen

(2) ☐ Jeg spiser vanligvis frokost bare en av dagene i helgen (lørdag eller søndag)

(3) ☐ Jeg spiser vanligvis frokost begge dagene i helgen (både lørdag og søndag)

Hvor mange ganger i uken spiser eller drikker du noe av dette?

	Aldri	Sjeldnere enn en gang per uke	En gang i uken	2-4 dager i uken	5-6 dager i uken	En gang hver dag	Flere ganger hver dag
Frukt	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐	(7) ☐
Grønnsaker	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐	(7) ☐
Godteri (f.eks. drops sjokolade)	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐	(7) ☐
Cola, brus eller andre leskedrikker med sukker	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐	(7) ☐
Sukkerfri brus eller leskedrikk	(1) ☐	(2) ☐	(3) ☐	(4) ☐	(5) ☐	(6) ☐	(7) ☐

Hvor ofte spiser du til vanlig disse måltidene?

	Hver dag	4-6 dager i uka	1-3 dager i uka	Sjelden eller aldri
Frokost	(1) ☐	(2) ☐	(3) ☐	(4) ☐
Formiddagsmat/nistepakke	(1) ☐	(2) ☐	(3) ☐	(4) ☐
Middag eller brødmåltid etter skolen	(1) ☐	(2) ☐	(3) ☐	(4) ☐

Hva synes du om kroppen din? Den er:

(1) ☐ Altfor tynn

(2) ☐ Litt for tynn

(3) ☐ Omtrent passe størrelse

(4) ☐ Litt for tykk

(5) ☐ Altfor tykk

(6) ☐ Jeg tenker ikke på det

Hva er den høyeste utdanningen du har tenkt å ta?

(1) ❑ Universitet eller høyskoleutdanning av høyere grad (f.eks. master, lektor, advokat, sivilingeniør, lege)

(2) ❑ Universitet eller høyskoleutdanning av lavere grad (f.eks. bachelor, lærer, politi, sykepleier, ingeniør, journalist)

(3) ❑ Videregående skole: studiespesialisering/idrettsfag/musikk, dans og drama

(4) ❑ Videregående skole: yrkesfag

(5) ❑ Annet _____

(6) ❑ Har ikke bestemt meg

Utenom skoletid: Hvor mange GANGER i uka driver du idrett, eller mosjonerer du så mye at du blir andpusten og/eller svett?

(1) ❑ Hver dag

(2) ❑ 4-6 ganger i uka

(3) ❑ 2-3 ganger i uka

(4) ❑ En gang i uka

(5) ❑ En gang i måneden

(6) ❑ Mindre enn en gang i måneden

(7) ❑ Aldri

Utenom skoletid: Hvor mange TIMER i uka driver du idrett, eller mosjonerer du så mye at du blir andpusten og/eller svett?

(1) ❑ Ingen

(2) ❑ Omtrent 1/2 time

(3) ❑ Omtrent 1 time

(4) ❑ Omtrent 2-3 timer

(5) ❑ Omtrent 4-6 timer

(6) ❑ 7 timer eller mer

Hvor ofte deltar du vanligvis i disse typene organiserte aktiviteter på fritiden? Med organiserte aktiviteter mener vi aktiviteter som er drevet av idrettsklubber, andre klubber eller organisasjoner.

	Holder ikke på med denne aktiviteten	2-3 ganger i måneden eller sjeldnere	Omtrent 1 dag i uken	2 ganger i uken eller oftere
Organisert lagidrett (for eksempel fotball, håndball, basketball, ishockey)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Organiserte individuelle fysiske aktiviteter (for eksempel svømming, sykling, kampsport, friidrett, turn, dans, langrenn)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Organiserte musikk- og dramaaktiviteter i grupper (for eksempel korps, kor, band, teatergruppe)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Organiserte individuelle musikkaktiviteter (for eksempel spille et instrument, ta musikktimer)	(1) ❑	(2) ❑	(3) ❑	(4) ❑
Andre organiserte aktiviteter i grupper (for eksempel kirkelige aktiviteter, speider)	(1) ❑	(2) ❑	(3) ❑	(4) ❑

Hvor lang tid tar det deg vanligvis å dra hjemmefra til skolen?

(1) ❑ Mindre enn 5 minutter
(2) ❑ 5-15 minutter
(3) ❑ 15-30 minutter
(4) ❑ 30 minutter til 1 time
(5) ❑ Mer enn 1 time

På en vanlig dag er MESTEPARTEN av reisen din TIL skolen gjennomført ....?

(1) ❑ Til fots
(2) ❑ Med sykkel
(3) ❑ Med buss, trikk, T-bane, tog eller båt
(4) ❑ Med bil, motorsykkel eller moped
(5) ❑ På andre måter

På en vanlig dag er MESTEPARTEN av reisen din FRÅ skolen gjennomført ....?

(1) ❑ Til fots
(2) ❑ Med sykkel
(3) ❑ Med buss, trikk, T-bane, tog eller båt
(4) ❑ Med bil, motorsykkel eller moped
(5) ❑ På andre måter

I friminuttene: Hvor OFTE beveger du deg så mye at du blir andpusten og/eller svett?

(1) ❑ Hvert friminutt
(2) ❑ Ikke hvert friminutt, men likevel hver dag
(4) ❑ Ikke hver dag, men likevel hver uke
(3) ❑ Ikke så ofte som hver uke
(5) ❑ Aldri

Hvor mange ganger i en vanlig uke deltar du i kroppsøvingstimer? (ta også med tilvalgsfag hvor du er fysisk aktiv, f. eks. idrett, friluftsliv). En dobbeltime = 2 ganger.

(1) ❑ 0 ganger
(2) ❑ 1 gang
(3) ❑ 2 ganger
(4) ❑ 3 ganger
(5) ❑ 4 ganger
(6) ❑ Mer enn fire ganger

Hvor mange minutter i løpet av en enkel kroppsøvingstime (45 minutter) beveger du deg såpass mye at du blir varm og litt andpusten?

(1) ❑ 0 minutter
(2) ❑ 1-10 minutter
(3) ❑ 11-20 minutter
(4) ❑ 21-30 minutter
(5) ❑ Mer enn 30 minutter

Er du medlem av et idrettslag eller en idrettsklubb?

(1) ❑ Nei
(2) ❑ Ja, jeg trener i idrettslaget
(3) ❑ Ja, men jeg er ikke med på treninger

I en vanlig uke, hvor mange dager er du fysisk aktiv i 60 minutter i løpet av skoletiden (i skoletimene, kroppsøving, friminutt, storefri) slik at du får økt puls og blir andpusten en del av tiden?

(0) ❑ 0 dager
(1) ❑ 1
(2) ❑ 2
(3) ❑ 3
(4) ❑ 4
(5) ❑ 5 dager

Nedenfor står noen påstander om hva du tenker om å gå på skolen. Sett ett kryss for hver påstand.

	Helt enig	Enig	Verken enig eller uenig	Uenig	Helt uenig
Jeg gleder meg til å gå på skolen.	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Jeg liker å gå på skolen.	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Jeg har det gøy på skolen.	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Det vi lærer i timene er interessant.	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Jeg liker det vi gjør på skolen.	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

Nedenfor står noen påstander om dine lærere. Sett ett kryss for hver påstand.

	Helt enig	Enig	Verken enig eller uenig	Uenig	Helt uenig
Jeg føler at lærerne mine godtar meg som jeg er.	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Jeg har stor tillit til lærerne mine.	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑
Jeg føler at lærerne mine bryr seg om meg som person.	(1) ❑	(2) ❑	(3) ❑	(4) ❑	(5) ❑

TAKK FOR HJELPEN!

Appendix 4: Approval from Regional Committees for Medical and Health Research Ethics

Emne: Tar reviderte informasjonsskriv til orientering
Fra: post@helseforskning.etikkom.no
Dato: 08.11.2018 11:08
Til: arnt.e.tjonna@ntnu.no
Kopi: oystein.risa@ntnu.no; rek-midt@mh.ntnu.no

Vår ref. nr.: 2018/950
Prosjekttittel: "Har mengde fysisk aktivitet utøvd i skolen og på fritiden en sammenheng med barnas fysiske form?"
Prosjektleder: Arnt Erik Tjønna

Til Arnt Erik Tjønna.

Vi viser til reviderte informasjonsskriv innsendt 05.11.2018. Komiteen tar disse til orientering, uten ytterligere merknader. Studien kan igangsettes.

Med vennlig hilsen
Marit Hovdal Moan
seniorrådgiver
post@helseforskning.etikkom.no
T: 73597504

Regional komité for medisinsk og helsefaglig forskningsetikk REK midt-Norge (REK midt)
http://helseforskning.etikkom.no

REK
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Kunnskap for en bedre verden