UiT The Arctic University of Norway

Faculty of Health Sciences

Department of Community Medicine

Physical Activity and Body Composition in Norwegian Adolescents

Results from The Tromsø Study: Fit Futures

Nils Abel Aars

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Nils Abel Aars

Faculty of Health Sciences,

Department of Community Medicine,

UiT – The Arctic University of Norway.

Nordland Hospital, Bodø

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The position as a PhD candidate has presented me with the opportunity of gaining knowledge within a research field I have always found interesting, and which was highly relevant for me as a physiotherapist. I had not held this position for long when I came to realize that taking a PhD is an education in itself. The learning curve has been steep, and periods of anxiety and stress have been plentiful– something which I suspect is common feelings for most Ph.D. students. Thankfully, I've had some fantastic help. I owe a lot to my supervisor Sameline Grimsgaard and co-supervisor Bjarne K. Jacobsen. Thank you for your guidance and contributions, for your input and discussions, and for calming my nerves at times when I thought I had made some grave mistake (which turned out to be nothing).

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Contents

List of Tables

List of figures

Summary

Background:

Physical activity is recognized as important in the prevention of numerous health problems across all age-groups, but its relationship with adiposity during adolescence has been debated. Conflicting evidence has been reported, which might be a reflection of the array of available measures of both physical activity and adiposity. It is clear that volume of physical activity declines with age during childhood and adolescence, and thus a less stable habit than in adults. The decline in physical activity coincides with age-related increases in body mass index (BMI). Determining a cause- and effect relationship in adolescent populations has nevertheless proven difficult, perhaps especially so because an increase in most measures of body composition are natural during growth spurts.

Objectives:

Our objective was to ascertain whether an association between physical activity and body composition exists in a cohort of Norwegian adolescents, and to determine how level of physical activity in the first year of upper secondary high school, or change in physical activity between baseline and follow-up, was associated with changes in body composition over two years of follow-up.

Methods:

To meet our objectives we used data from The Fit Futures Cohort Study. The study contains data from two surveys, performed in 2010-11 (FF1) and again in 2012-13 (FF2). All students in their first (FF1) and last (FF2) year of upper secondary high school in the neighboring counties of Tromsø and Balsfjord were invited to attend a clinical examination and answer a questionnaire. Of the invited, there were 1,038 (FF1) and 870 (FF2) students participating

from the eight different upper secondary high schools. Trained research nurses performed all clinical measurements at the Clinical Research Unit at the University Hospital of North Norway. Participants underwent a low radiation Dual Energy X-Ray Absorptiometry (DXA) scan, which produced the estimates of fat mass, lean mass and appendicular lean mass (sum of lean mass in the four extremities) used to calculate Fat Mass Index (FMI), Lean Mass Index (LMI) and appendicular Lean Mass Index (aLMI). These measures, in addition to BMI and waist circumference, represent the outcomes in the present thesis. Data on physical activity was gathered from questionnaires and accelerometers. The raw data from the accelerometers were processed into physical activity variables using software developed at the UiT.

Results:

We found evidence to suggest a cross-sectional association between self-reported physical activity and tissue-specific measures of body composition, but not with BMI. The associations between fat mass index and lean mass index with physical activity were inverse to another, meaning that a high BMI could be the result of either high fat- or high lean mass. With the exception of waist circumference in boys, self-reported activity was not associated with changes in either measure of body composition between FF1 and FF2. Similarly, objectively measured physical activity did not predict changes in body composition for either sex, except an association between time spent in sedentary- and light physical activity and changes in indices of lean mass in girls. We observed an association between changes in level of self-reported activity and changes in some measures of body composition for both sexes. This confirms how physical activity is subject to change during adolescence, and that there are potential positive health gains of increasing activity or remaining physically active during this period of life.

Conclusion

We found cross-sectional associations between self-reported physical activity and measures of body composition, but only minor longitudinal effects of baseline physical activity on two-year changes in body composition. Changes in level of self-reported physical activity between baseline and two-year follow-up was associated with changes in some indices of body composition. Studying a population that is subject to natural growth, parallel to undergoing substantial changes in lifestyle, is challenging. These changes create uncertainty and variation around the exposure and the outcome, despite the robust nature of the measurements included, which in turn might explain the absence of clear associations of greater magnitude.

Norsk sammenfatning

Bakgrunn

Fysisk aktivitet er anerkjent som en viktig faktor i forebyggingen av en rekke helseproblemer over alle aldersgrupper, men sammenhengen med overvekt i ungdomsårene er gjenstand for diskusjon. Motstridende resultater har blitt rapportert, hvilket kan reflektere det tilgjengelige antallet av metoder for å måle henholdsvis fysisk aktivitet og overvekt. At volumet av fysisk aktivitet reduseres med økende alder gjennom barne- og ungdomsårene er velkjent, og det er derfor en mindre stabil faktor av livsstil enn blant voksne. Reduksjonen av fysisk aktivitet sammenfaller med alders-relaterte økninger i kroppsmasseindeks (KMI). Det har vist seg utfordrende å påvise hva som er årsak og virkning i denne assosiasjonen blant ungdom, hvilket kanskje kan skyldes at en økning i de fleste mål på kroppssammensetning er naturlig i vekstfasen.

Mål

Målet med avhandlingen var å avdekke hvorvidt det er en sammenheng mellom fysisk aktivitet og kroppssammensetning i en gruppe av norske ungdommer, og i hvilken grad nivået av fysisk aktivitet på første året av videregående skole, eller endring i fysisk aktivitet mellom først- og siste året på videregående skole, påvirker endringer i kroppssammensetning over to års oppfølging.

Metode

Vi brukte data fra Tromsøundersøkelsens ungdomskohort, Fit Futures. Fit Futures ble gjennomført i 2010-11 (FF1) og igjen i 2012-13 (FF2), og inviterte alle elever i deres første (FF1) og siste (FF2) år av videregående skole i nabokommunene Tromsø og Balsfjord til å delta i en klinisk undersøkelse og til å fylle ut et spørreskjema. Av de inviterte deltok 1,038

(FF1) og 870 (FF2) elever fra de åtte videregående skolene. Alle kliniske målinger ble utført av forskningssykepleiere ved Klinisk Forskningsavdeling på Universitetssykehuset i Nord-Norge (UNN). Deltakerne gjennomgikk en lavdose røntgen måling (DXA) som produserte estimater på fettmasse, magermasse (kroppsmasse minus fett- og beinmasse) og appendikulær magermasse (summen av magermasse i ekstremitetene), hvilket ble brukt i beregningen av fettmasseindeks (FMI), magermasseindeks (LMI) og appendikulær magermasseindeks (aLMI). Disse målene, i tillegg til KMI og midjeomkrets, representerer endepunktene i avhandlingen. Data på fysisk aktivitet ble innhentet ved bruk av spørreskjema og akselerometer. Rådataene fra akselerometrene ble prosessert til fysisk aktivitetsvariabler ved bruk av programvare utviklet ved UiT.

Resultat

Resultatene tyder på en sammenheng mellom selvrapportert fysisk aktivitet og de vevs-spesifikke målene på kroppssammensetning, men ikke med KMI, i Fit Futures 1. Assosiasjonene mellom fysisk aktivitet og henholdsvis FMI og LMI var inverse, hvilket tilser at en høy KMI kan være forklart av enten høy fettmasse eller høy magermasse. Med unntak av midjeomkrets blant gutter var selvrapportert fysisk aktivitet i FF1 ikke assosiert med endringer i målene på kroppssammensetning mellom FF1 og FF2. Fysisk aktivitet målt med akselerometer predikerte heller ikke endring i noen av utfallsmålene, med unntak av tid tilbrakt i sedat- og lett fysisk aktivitet som var assosiert med indeksene på magermasse blant jenter. Vi observerte en assosiasjon mellom endringer i selvrapportert fysisk aktivitet mellom FF1 og FF2 og endringer i noen av målene på kroppssammensetning for begge kjønn. Dette bekrefter hvordan fysisk aktivitet er i endring gjennom ungdomsårene, og at det er potensielle positive effekter av å øke aktiviteten eller forbli fysisk aktiv gjennom denne perioden av livet.

Konklusjon

Vi fant assosiasjoner mellom fysisk aktivitet og kroppssammensetning på tverrsnittsnivå, men observerte mindre effekt av fysisk aktivitet under første året av videregående skole på endringer i kroppssammensetning over en to-års periode. Det er utfordringer knyttet til å studere en gruppe som gjennomgår naturlige endringer i kroppssammensetning, parallelt med substansielle endringer i livsstil. Disse endringene skaper usikkerhet og variasjon omkring målingene, på tross av at målemetodene for kroppssammensetning i utgangspunktet er robuste, og kan være en potensiell forklaring på fraværet av tydelige og sterke assosiasjoner.

List of papers

This thesis is based on three papers, which in the following text are referred to as Paper I, Paper II and Paper III.

Paper I

Aars, N.A., Jacobsen, B.K., Furberg, A.-S. and Grimsgaard, S. (2019). Self-reported physical activity during leisure time was favourably associated with body composition in Norwegian adolescents. Acta Paediatr, 108: 1122-1127. doi:10.1111/apa.14660

Paper II

Aars, N.A., Jacobsen, B.K., Morseth, B., Emaus, N. and Grimsgaard, S. (2019). Longitudinal changes in body composition and waist circumference by self-reported levels of physical activity in leisure among adolescents: the Tromsø study, Fit Futures. BMC Sports Sci Med Rehabil 11, 37. doi:10.1186/s13102-019-0150-8

Paper III

Aars. N.A., Beldo S, Jacobsen, B.K., Horsch, A., Morseth, B., Emaus, N., Furberg, A.S. and Grimsgaard, S. (2020). Association between objectively measured physical activity and longitudinal changes in body composition in adolescents: the Tromsø study fit futures cohort. BMJ Open 2020;10:e036991. doi: 10.1136/bmjopen-2020-036991

Abbreviations

aLMI: appendicular Lean Mass Index

BMI: Body Mass Index

COPD: Chronic Obstructive Pulmonary Disease

CPM: Counts Per Minutes

DALY: Disability-Adjusted Life Year

DXA: Dual energy X-ray Absorptiometry

EAT: Exercise Activity Thermogenesis

FF1: Fit Futures 1 (2010-11)

FF2: Fit Futures 2 (2012-13)

FFMI: Fat-Free Mass Index

FMI: Fat Mass Index

INT$: International Dollars

IOTF: International Obesity Task Force

IPAQ: International Physical Activity Questionnaire

LMI: Lean Mass Index

NEAT: Non-Exercise Activity Thermogenesis

MI: Multiple Imputation

MVPA: Moderate-to-Vigorous Physical Activity

PDS: Pubertal Development Scale

PHV: Peak Height Velocity

QCAT: Quality Control & Analysis Tool

SAT: Subcutaneous Adipose Tissue

SD: Standard Deviation

SES: Socio-Economic Status

SF: Skinfold Thickness

SGPALS: Saltin-Grimby Physical Activity Level Scale

VAT: Visceral Adipose Tissue

VMU: Vector Magnitude Unit

WHO: World Health Organization

1. Introduction

In simple terms, overweight and obesity is the result of a sustained positive energy balance, wherein consumption of energy exceeds its expenditure [1, 2]. Physical activity is a logical remedy in both the treatment and prevention of excess adiposity because of its potential effect on the expenditure part of the energy balance equation, and recommended as part of a multidisciplinary approach to overweight and obesity management [3]. A core belief within the field of public health is that prevention is superior to treatment in terms of cost-efficiency and potential health gains for populations [4]. By that logic, prevention of overweight and obesity has considerable potential [2], despite being a complex and challenging endeavor [5]. Because the prevalence of overweight and obesity often increases with age [6, 7], and because overweight and obesity tracks from adolescence into adulthood [8], understanding the relationship between overweight and obesity and one of its potential remedies, physical activity, in younger age-groups is of particular importance.

1.1 Background

In adults (aged 18 and above), overweight is commonly defined as a Body Mass Index (BMI) greater than- or equal to 25.0 [1], and the prevalence has increased in adolescent populations of western countries [7]. Presently 15-20% of Europeans in their late adolescence are classified as overweight [9-11]. The prevalence of obesity (BMI $\geq$ 30.0) has shown a similar pattern [7], with around 6% of European adolescents being classified as obese, albeit with substantial differences between- and within countries [10, 11]. These numbers may be an underestimate of the magnitude of the problem, because BMI fails to identify a substantial number of children and adolescents with excess body fat [12, 13]. Physical activity during adolescence is associated with self-reported health [14] and adolescents with overweight or obesity have lower health-related quality of life than their normal-weight peers [15]. Also, adolescent BMI is predictive of adult mortality [16, 17]. Because weight status tracks from childhood and adolescence into adulthood, early intervention has potential for substantial benefits as overweight and obesity in adulthood is an established risk factor for numerous diseases and illnesses, including musculoskeletal pain, type 2 diabetes, osteoarthritis, hypertension, cardiovascular disease and several forms of cancer [1, 18-20].

Physical activity is a behavior that tends to decline in volume with age [21], with a rapid decline observed in adolescents [22, 23]. In Norway, it is estimated that 40% of girls and 51% of boys aged 15 years meet the governmental recommendation of ≥ 60 minutes per day in Moderate-to-Vigorous Physical Activity (MVPA) [24]. Objective measurements of physical activity in European adolescents show substantial variation between countries, with between 0 – 60% of adolescents meeting the governmental recommendations [25]. The variation is likely due to different methods of assessment or cut-offs used to define MVPA, but also cultural differences or potential variation in the amount of mandatory physical activity in schools. Both total physical activity and MVPA declines during adolescence [26, 27].

Adolescents constitute an age group that differs in character from children and adults. Substantial changes in body composition takes place naturally as a result of pubertal development during this phase, with considerable differences between sexes [28, 29]. Thus, in longitudinal studies, it is a challenge to separate unhealthy gains from naturally occurring changes [30]. Physical activity during adolescence is influenced by peers, parents, schools and communities [31-33], which in turn can affect the behavior of the individual either positively or negatively. The influence of the societies in which people reside must also be taken into account, with Western countries in particular often indirectly promoting an inactive lifestyle [34, 35]. This obesogenic environment affects both the present and future health of adolescents, since adult lifestyle habits are partly developed in adolescence [36, 37].

Many cross-sectional studies to date indicate an association between low physical activity and excess adiposity [38], but due to the nature of such study designs, no conclusions can be made as to a causal relationship. This means longitudinal studies are warranted [38], and less is known about the longitudinal relationship between physical activity and changes in body composition [39, 40]. Furthermore, studies on these associations have typically been limited by inadequate measures of both exposure and outcome, resulting in imprecise estimates of an association [41]. There has been a lack of studies of the relationship between physical activity and measures of body composition in Norwegian adolescents [42].

1.2 Body composition

In this thesis, body composition is referred to as any clinical- or scientific measure seeking to quantify the stature, mass and different types of tissue of the human body. First, a detailed description of some of the most common methods to assess body composition is provided, with particular focus on those used in the included papers and thesis. Second, a section on the specific aspects of body composition in adolescents is given.

1.2.1 Measurement of body composition

The measurement of body composition, anthropometry and stature has been widely adopted as a means of quantifying the bodily components of individuals and populations, and to various ends. In the 20th century, clinicians, researchers and insurance companies noted an association between higher scores of various measures of anthropometry and body composition and morbidity and mortality [43]. While excess adiposity is one of the primary drivers of these associations, it is not so straightforward to measure directly. However, adipose tissue is reflected in other measures of body composition. Body weight is one such measure, which is likely to be higher in overweight- and obese individuals, but body weight is generally not a sufficient measure of adiposity without considering body height. Because body weight increases with body height, taller individuals will have higher body weight than individuals of smaller stature, all else being equal. The simplest measure of weight in relation to height is calculated as weight in kilograms divided by height in meters squared, and is known as BMI. This measure adjusts bodyweight for height, and is therefore commonly used to assess weight status, especially because of its ease of application. Both height and weight can be measured with high precision in a variety of settings, and may also be calculated using self-reported data, but with less precision [44]. Using established cut-offs, BMI can then be used to classify individuals as underweight, normal weight, overweight or obese, with further sub-classifications within each category [45]. Because BMI naturally increases with age during childhood and adolescence, age- and sex specific cut-offs have been developed in order to correctly classify the weight status of individuals in this age group [46, 47]. These cut-offs have been developed by the International Obesity Task Force (IOTF), based on large amounts of data from several different countries, and enables researchers and health officials to monitor the prevalence of overweight and obesity from childhood through adolescence and into adulthood. Table 1 illustrates the age- and sex specific cut-offs used in the present thesis that correspond to the adult classifications as underweight (< 18.5 kg/m^2), normal weight (18.5 – 24.9 kg/m^2), overweight (25.0 – 29.9 kg/m^2) and obese (≥ 30.0 kg/m^2).

Table 1. Age- and sex specific cut-offs for classification of body mass index (normal weight, overweight and obesity).

Age	15.5		16.0		16.5		17.0		17.5		Adult	
Weight class	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**	**Boys**	**Girls**
Normal	17.26	17.69	17.54	17.91	17.80	18.09	18.05	18.25	18.28	18.38	18.5	18.5
Overweight	23.60	24.17	23.90	24.37	24.19	24.54	24.46	24.70	24.73	24.85	25.0	25.0
Obese	28.60	29.29	28.88	29.43	29.14	29.56	29.41	29.69	29.70	29.84	30.0	30.0

Because BMI can be measured with high precision and little equipment, it facilitates comparison between countries and over time without having to consider for instance technical improvements or software development, which can be an issue with more advanced body composition measures. A limitation of BMI is that it does not consider the type of tissue contributing to total BMI. Specifically, within a broad range of BMI, the relative contribution of different types of tissue can differ considerably [48]. The consequence is that lean people with relatively high muscle mass may be incorrectly classified as overweight. Conversely can otherwise lean people with excess abdominal adiposity be classified as normal weight. Thus, BMI is a useful tool at the population level, but with less precision at the individual level [1]. The limitations of BMI has driven the search for other, more tissue-specific measures of body composition. One such measure is waist circumference, which typically is measured with light or no clothing at the height of the umbilicus. This measure is more specific to abdominal adiposity [49], and thus better suited to identifying excess fat – but with sex specific differences in cut-offs for overweight and obesity [50]. For women, excess fat tends to store more at the hips, while for men it stores predominantly around the waist [51]. Waist circumference also has its limitations. For instance are measurement procedures often different between studies, thus limiting comparison [52]. Furthermore, the individual may hold in their abdomen upon measurement, thus biasing the estimate, and interrater reliability has also been shown to vary [52]. Despite such limitations, waist circumference is widely used, and is included as a component in the diagnosis of metabolic syndrome [53].

Two other prevalent tissue-specific measures of body composition are skinfold thickness (SF) and bioelectrical impedance analysis. Skinfold thickness is given in millimeters and enables a calculation of % body fat using different equations. The merits of this measure include low costs and easy application, which explains its extensive use in epidemiological studies [54]. Although adolescent %SF body fat has been found superior to adolescent BMI in predicting adult body fat [55], there are no established cut-offs for defining overweight and obesity by this measure [54]. Bioelectric impedance analysis applies the known properties of resistance to electric current in different types of tissue, and together with height and weight enables a calculation of fat- and fat-free mass using validated equations [56]. Although bioelectric impedance is a recognized measure of body composition and in prevalent use, it is considered less precise than some of the alternatives due to assumptions (for instance concerning hydration status) [56].

The four-compartment model is considered the gold standard for tissue-specific measurement of body composition [48]. In this model, different advanced methods are used to measure body mass, total body water, body volume and bone mineral [56]. For the correct estimation of body composition, a high degree of precision and validity of measurement techniques is required for each of the four components. This makes the four-compartment model labor-intensive and costly, and thus unsuited for wide application in population studies.

A method with acceptable precision and costs is dual-energy x-ray absorptiometry (DXA), which has been put to use by both clinicians and researchers [48]. This method produces estimates of skeletal-, fat- and soft tissue lean mass in grams. However, like body weight, the weight of any tissue is less meaningful without considering also the height of the individual. Therefore, like BMI, the estimation of fat-, bone and soft lean mass may be used to calculate different indexes by dividing amount of specific mass in kilograms by height in meters^2. Fat mass is used to calculate Fat Mass Index (FMI: fat mass in kilograms/height in meters^2), while soft tissue lean mass is used in the calculation of soft tissue lean mass index (LMI: lean mass in kilograms/height in meters^2). By adding bone mass to lean mass, or by subtracting fat mass from total mass, Fat-Free Mass Index (FFMI: fat-free mass in kilograms/height in meters^2) can be calculated. These measures enables a graphic display of the before-mentioned inadequacies of BMI in a Hattori chart (Figure 1). In this graph FMI is plotted against FFMI, using data for boys in Fit Future 1 as an example. Because the sum of FMI and FFMI approximately reflects BMI, the graph illustrates how the same BMI can occur at different combinations of FMI and FFMI [48]. This means that a BMI of 26.0, which would be considered overweight, can occur as the result of either high fat mass index and low fat-free mass index, or as the result of low fat mass index and high fat-free mass index.

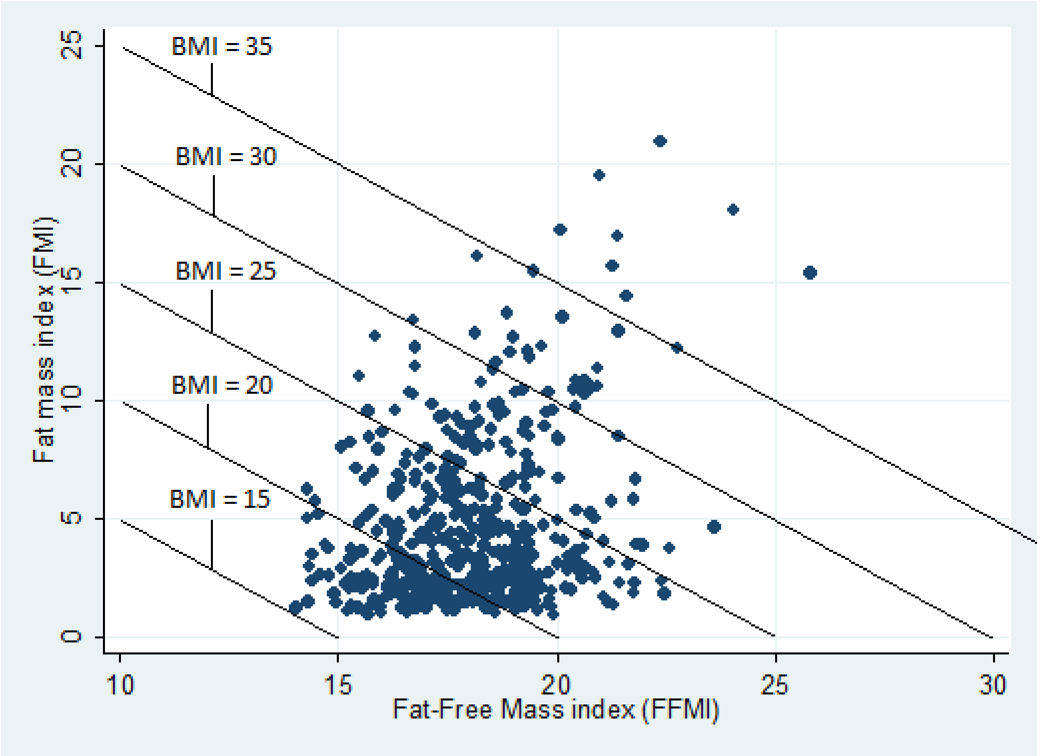

Figure 1. The relationship between Fat Mass Index (FMI) and Fat-Free Mass Index (FFMI) among boys participating in Fit Futures 1.*

**: The lines represent different values of BMI, which can occur at different combinations of FMI and FFMI.*

In principle, FMI and FFMI can be calculated using bio impedance, %fat or any other measure which provides an estimation of total fat mass. This is perhaps one reason why FFMI is more widely used than LMI, and LMI is often interchangeably used with FFMI. Strictly speaking though, LMI does not include bone mass [57], and is therefore more specific to muscle mass than FFMI. An extension to LMI is the use of Appendicular Lean Mass Index (aLMI), wherein soft tissue lean mass in the four extremities is summed and divided by height in meters^2. This measure has mostly been used in the study of age-dependent attrition of muscle mass in elderly, known as sarcopenia, but is also of interest in studies of muscle mass in children and adolescents [58].

1.2.2 Body composition in adolescents

The combined prevalence of overweight and obesity in European adolescents is in the range of 22-25% [10]. This figure has risen steadily over the last decades, but now appears to have levelled somewhat in Western countries [59]. However, evidence suggests that there are differences according to socioeconomic status (SES), with an increase observed in groups of children and adolescents with lower socioeconomic position [60, 61]. It is estimated that if the trends of the 2000's continue, the prevalence of global obesity in children and adolescents will exceed the prevalence of underweight [7].

Because they are in a phase of growth, changes in body composition are natural in healthy adolescents. For researchers, such natural changes in growth must be taken into account when interpreting research findings within this age group. In boys, increases in indices of muscle mass are expected, with sex hormones leading to substantial increases in lean mass up to the point of Peak Height Velocity (PHV) – the point in life where natural growth peaks and is subsequently reduced [62]. Conversely, in girls, pubertal development incurs a period of fat mass accrual [54]. This is often attributed to a physiological preparation for child bearing, wherein a certain level of surplus energy is required to conceive a child and nurture a new-born [63]. The substantial differences between sexes in adolescent body composition is an argument supporting sex-specific presentation of study results [64].

1.3 Physical activity

The World Health Organization defines physical activity as *"any bodily movement produced by skeletal muscles that require energy expenditure"* [65]. However, physical activity may be defined in a number of ways, each depending on what aspect or domain of physical activity that is of interest. The focus in the present thesis has been on physical activity during leisure time or outside of school hours. First a section on the measurement of physical activity is given, after which a discussion of the specific traits of physical activity during adolescence is provided.

1.3.1 Measuring physical activity

There are numerous methods available for measuring physical activity, with the historically most common being through self-report [66]. Questionnaires are inexpensive and easy to use, and has thus been applied in both population studies and in the clinic [67]. A number of questionnaires have been developed and validated, typically against direct observation, activity diary or doubly labelled water [66, 67]. In the Tromsø Study, the Saltin-Grimby Physical Activity Level Scale (SGPALS) [68] has been used multiple times [69], and was also included in the Fit Futures studies (Appendices 1&2). One of the most commonly used questionnaires in physical activity epidemiology research is the International Physical Activity Questionnaire (IPAQ), which was developed for use in adults and covers several domains of physical activity [70]. Different modified versions of the IPAQ for studies of adolescents have been developed and validated against accelerometry [71] and doubly labelled water [72]. Regardless of which questionnaire is used, concerns have been raised on the reproducibility and validity of self-reported physical activity [67], with recall bias and social desirability bias highlighted as prevalent sources of error [73]. Furthermore, concepts such as intensity and physical activity is perhaps neither fully understood by participants, nor precisely defined in questionnaires [74]. Also, the common exaggeration of self-reported physical activity may dilute associations with different health outcomes [75]. Despite these limitations, self-report instruments form the basis for the current guidelines [76] and, as of date, is the only means of comparing physical activity levels globally [77]. Furthermore, self-reported physical activity provides the opportunity of investigating specific types or domains of physical activity, and yields valid estimates of total amount of physical activity [78].

In an attempt to overcome the limitations of self-reported physical activity, objective measures such as accelerometers, have been developed and are now widely used in studies of physical activity [79]. An accelerometer is a small electronic device, worn by a participant at the hip or wrist, which registers acceleration of the body across 1-3 axes. This provides a measurement of counts (acceleration of the body) per minute (CPM), which can be translated to minutes spent in different intensities of physical activity using different cut-offs [80]. The cut-offs are typically developed in laboratory settings, in which CPM is registered while for instance walking/running on a treadmill and simultaneously measuring energy expenditure [81, 82]. Although widely used and considered superior to self-reported physical activity, there are limitations associated with accelerometer devices [82]. For instance is the ability of accelerometers to register non-ambulatory activities such as cycling or swimming not satisfactory [82]. Furthermore, different manufacturers use different software and different algorithms, thus affecting the opportunities for comparison of activity measured using different devices [80]. Lastly, accelerometers collect raw data, which does not directly translate to variables for data analyses. Physical activity variables are created by applying algorithms to remove noise and to separate inactivity from non-wear time, with differences between manufacturers and updates in software and models [80].

Because different cut-offs for CPM are used to classify the intensity of physical activity, there is substantial variation in the reported compliance with guidelines for MVPA [25]. As such, CPM is perhaps better suited for making comparisons between studies, but CPM is also affected by for instance wear-time definitions: if a period of sedentary activity is interpreted as non-wear time by the software it is excluded, and CPM is consequently inflated as the remaining counts is averaged over shorter time and not including the period of lower intensity. Another matter to consider is the individual perception of a given intensity of activity. What may be considered as moderate physical activity by a fit individual may be perceived as very strenuous activity by a less fit individual [83]. Thus, the actual effort of for instance 30 minutes of moderate activity may be substantially different between two individuals which differ in terms of physiological fitness. In such cases the difference in relative and absolute intensity may yield conflicting results when comparing self-report to device-based measurements [84].

1.3.2 Physical activity in adolescence

Physical activity in adolescence differs in character from that of children or adults. In children, physical activity is often characterized by free-play activities, but this type of physical activity declines with age, leading to a drop in total activity if replaced by sedentary behavior rather than structured physical activity [85]. In many adolescents, participation in organized sports represents a large share of total physical activity, but many quit and for a variety of reasons [86, 87]. Physical activity declines with age in both children [88] and adolescents [89], and is often substituted by increases in sedentary time [90]. The prevalence of physical inactivity in European adolescents is high [91], and it is estimated that less than 50% of adolescents meet the recommended 1 hour per day in MVPA [25]. This number should be interpreted with caution, as different measurement instruments and cut-offs produce large variation in the estimate. In a study by Van Hecke et al [25], the authors noted a difference of 150 minutes per day in MVPA in Portuguese children in two different studies, even though the same dataset was used in both studies [92, 93]. The difference was attributed to the different cut-offs used for classification of intensity, and illustrates the problem with lack of agreement on best cut-offs.

Determinants of physical activity during adolescence include factors such as SES, support from parents and peers, neighborhood environment, enjoyment of activity and self-efficacy

[32, 94-96]. In children and adolescents, habits change over shorter time than in adults. In adults, physical activity is a relatively stable habit between 25-65 years of age [23], with significant reductions at transition phases such as having children, relocation, retirement or with morbidity [31, 97]. In adolescence, changes can occur in both directions over relatively short time, but with a general pattern of decline. Thus, it remains questionable whether present level of physical activity is representative of future activity over the short term, because of change in habits during follow-up [78, 98]. The consequence, in analytic studies, may be regression dilution bias, wherein a true association is lost in the noise introduced by inaccurate measurement of the exposure variable [39].

1.4 The association between physical activity and body composition

In the discussion of causes of obesity, the debate has often been between whether physical inactivity or overfeeding is the most important contributor. This is logical, as a sustained positive energy balance is a prerequisite for excess adiposity [99]. However, behind inactivity and overfeeding lies a complex system of underlying factors such as genetic disposition and societal structures. The project report from the United Kingdom Government's Foresight Programme includes a map of these factors, which show the complexities of how overweight and obesity develops [100]. It is evident from this map that it is not a matter of either/or, but that all these factors contribute substantially and to various degree to the development of excess adiposity in both populations and individuals.

Despite these complex relationships, physical activity is an established remedy in both the prevention and treatment of excess adiposity [101], possibly because it is modifiable by the individual [38]. However, physical activity as a habit is in part a product of the environment in which an individual resides. Most inhabitants of Western societies are not required to be physically active at high levels in their daily lives [91, 102], with for instance labor saving devices affecting the amount of low intensity activity performed during household chores [103]. Studies of physical activity and body composition are therefore, in some respects, comparing little physical activity to a little less physical activity. The evolutionary drive of humans to rest when possible and consume food when it is abundant are traits which have negative consequences in the developed world [34, 104], as humans have been required to be physically active to a greater extent than in the present era [105]. Relevant to this issue, studies suggest genetic predisposition interacts with the obesogenic environment [106, 107], and the higher BMI in older than younger birth cohorts [108] may be explained by less lifetime exposure to environmental obesogenic factors.

While the cause of obesity is a complex matter, physical activity still has a direct effect on both muscular- and adipose tissue [51, 109]. Regular exercise increases fat mobilization, meaning that the ability to recruit energy from fat depots is improved [109]. Also, because lean mass is the primary driver of resting metabolic rate [110], higher lean mass will be associated with higher energy expenditure. Furthermore, high levels of physical activity has been identified as a key factor in maintaining new body weight after weight loss in formerly obese adults [111], but with less conclusive evidence in adolescents [112]. Still, the effects of physical activity in weight loss interventions are mixed [101, 113]. Some have attributed this to the dose of physical activity being too low, or to displacement of other physical activity, leading to only a moderate increase in total activity [109]. If an intervention aimed at increasing active commuting displaces evening walks, rather than TV-viewing, it is not surprising if the intervention is unsuccessful. Of particular relevance to studies of adolescent populations, is that body composition in adolescents is more heterogeneous than in adults, meaning that larger samples are needed to detect relatively smaller differences in body composition between different levels of physical activity [114].

1.5 Adolescents and pubertal development

The results of studies on adolescent populations must be interpreted in light of the bodily changes that takes place as a result of puberty. Adolescence constitutes a period of life where substantial changes in body composition, anthropometry and stature takes place in a short time. A challenge when looking at changes in body composition during this period is therefore to separate natural from unhealthy weight gain [30]. Because adolescents in general will increase in body height, body weight and waist circumference as an effect of natural growth, researchers are posed with the challenge of determining which- and how much of these gains are unhealthy. Because for instance BMI will increase during growth, the IOTF have developed age- and sex-specific cut-offs which correspond to the adult classifications of underweight, normal weight, overweight or obese.

A factor to consider in application of these cut-offs, is early maturation. In the early maturing 16-year old, healthy body composition may (by logic of established cut-offs) be higher than the chronological age would suggest is appropriate. This would wrongfully classify the adolescent as overweight, despite having a BMI below the adult classification of 25.0. As such, pubertal development has the potential to impact weight classification.

At birth, there is little difference in body composition between boys and girls, but with age and pubertal development sexual dimorphism increases as a result of hormones. Girls start their adolescent growth spurt in both height and weight approximately 2 years earlier than boys, and also stop growing in stature earlier (around 16 years of age) than boys [115]. During this growth spurt, increases in height and weight accelerate compared to that of childhood. Boys generally become taller than girls, which is a result of boys experiencing 2 years more of pre-pubertal growth [115]. In this regard, age at PHV is used as an indicator of maturity [116]. Height is relatively constant after adult stature is reached, whereas weight, fat mass and fat-free mass can be reduced or increased during adulthood. There are considerable differences in fat- and fat-free mass between the adolescent sexes. Girls reach their adult values of fat-free mass around the age of 15-16 years, whereas boys continue to increase in this parameter up to the age of 19-20 years [30]. Boys have around 50% more fat-free mass than girls in late adolescence, and girls have around 50% more fat mass than boys. While boys experience increases in both fat- and fat-free mass, the increase in fat-free mass is relatively higher, meaning that percent fat decreases. Conversely, for girls, increases in fat mass surpass that of fat-free mass, and percent fat therefore increases [115].

There are several ways to measure pubertal development in the individual. Both skeletal age and age at PHV may be used [116], but these necessitate annual x-rays of the hand or annual measurements of growth, respectively, requiring more resources and thus are not extensively used in large-scale population studies. The Tanner stages is considered the gold standard for measuring pubertal development [116], wherein the development of for instance pubic hair, breasts, genitalia and testicular volume is assessed and categorized according to development. This may be considered intrusive to use in population studies, and therefore self-report measures are more commonly used in such settings. In girls, age at menarche is a frequently used indicator, but changes in body composition occur also before this point [115]. In boys, questionnaire data on pubertal development are common indicators. One such instrument is the Pubertal Development Scale (PDS), which has acceptable validity and consists of questions on the development of secondary sex characteristics such as deepening of the voice and pubic-, body- and facial hair [116].

Given these natural changes to body composition, it is clear that boys will experience increases in lean mass independent of physical activity. Conversely, girls can expect increases in fat mass despite being physically active. This does not mean that level of physical activity is a negligible factor in the development of fat- and lean mass, but that during this period of life, the hormonal influence on these tissues may be more important than that of physical activity [30]. However, as habits developed during adolescence influence habits in adulthood [36, 37], a behavior such as physical activity will affect body composition over time.

1.6 Societal and clinical implications

Overweight and obesity have a large economic- and societal impact on many countries, with higher lifetime utilization of healthcare in those with excess adiposity [117]. Obesity is estimated to account for between 0.7% and 2.8% of the total expenditure on healthcare in different countries [118]. The costs of overweight to the healthcare system is apparent from as early as the age of 4 [119]. The societal costs go beyond the direct costs of increased healthcare utilization, because of the associated productivity loss of obesity [120]. This productivity loss, and excess utilization of healthcare associated with obesity, will inevitably be higher in individuals suffering from obesity from an early age. Physical inactivity also has substantial economic- and societal costs worldwide, with an estimated 53.8 billion international dollars (INT$) in direct costs to the healthcare system and 13.4 million Disability Adjusted Life Years (DALY's) lost as a result [121]. The clinical implications of low levels of physical activity [122] and excess adiposity [123] in adults are well documented, with even modest reductions in adiposity [124] or increases in physical activity [125] having positive health effects. In adolescents, physical activity positively affects insulin resistance [126], self-esteem and mental health [36]. Chronic disease morbidity is less prevalent in adolescents than in adults [36], and as such the effect of physical activity during adolescence on health outcomes may be more apparent later in life through the pathway of established habits.

Whether overweight and obesity is associated with physical inactivity or not, is to some extent of less importance in this respect, since each in their own have negative effects on population health and induce societal costs. Consequently, reducing levels of excess adiposity and increasing physical activity in the population will, independently, be favorable for population health. Nevertheless, a causal relationship between the two would provide evidence for larger health returns for an activity-focused approach to weight management, as there are considerable health gains associated with physical activity [36, 77, 122, 127, 128]. In this respect, physical activity as a remedy for excess adiposity can provide positive health effects beyond weight reduction.

2.0 Aims, objectives and hypothesis

At present there is a lack of knowledge on how physical activity affects body composition in adolescents. While cross-sectional studies are prevalent, less is known about how physical activity affects changes in body composition, both internationally [39, 40] and in Norway [42]. Studies addressing the relationship between the two are warranted [38] and required to reduce the burden of physical inactivity and excess adiposity in populations and individuals.

In the present thesis, the main objective was to investigate the association between physical activity and body composition in a cohort of Norwegian adolescents, the Fit Futures cohort study conducted first time in 2010-11 and repeated in 2012-13, including both cross-sectional and longitudinal analyses and using different measures of physical activity. The three papers address the specific hypotheses:

I. Is there a cross-sectional association between self-reported physical activity and four different indices of body composition?

II. Is there an association between self-reported physical activity at baseline or change in self-reported physical activity between baseline and follow-up and changes in four different indices of body composition?

III. Is there an association between different measures of objectively measured physical activity at baseline and changes in five indices of body composition?

We hypothesized that physical activity was associated with all measures of body composition, and that the magnitude of the associations would be higher for the more specific measures.

3.0 Methods and materials

3.1 Study population

The Fit Futures study is part of the Tromsø Study, which is a repeated population based health study of the adult population in the municipality of Tromsø, northern Norway. The first Tromsø study was performed in 1974, and since then six studies have been performed with the most recent one in 2015-16 [129, 130]. Because the Tromsø study only invites adults, a youth cohort study, the Fit Futures Study (FF1), was initiated in 2010-11. A follow-up study was performed in 2012-13 (FF2). The Fit Futures study was funded by UiT - The Arctic University of Norway, the University Hospital of North Norway and the Norwegian Institute of Public Health.

The first study (FF1) invited all students in their first year of upper secondary high school in the neighboring municipalities of Tromsø and Balsfjord to participate in a health examination and to answer a questionnaire (Appendix 1). The study invited 1,117 students from eight different schools, with 1,038 attending (93%). The second study (FF2) invited all students in their last year of upper secondary high school in the same schools and all those which had attended FF1, but had left school or started vocational training. In total, 1,130 students were invited, out of which 870 participated (77% participation rate). Of the 870 participants, 132 individuals had not attended FF1. Enrollment in the studies went in sequence according to school affiliation. Students were granted leave of absence from school to attend the clinical examination and to answer the questionnaire at the Clinical Research Unit at the University Hospital of North Norway. All measurements and examinations were performed by trained research nurses. Written, informed consent was obtained from all participants, and those under the age of 16 at the time of enrollment brought written, informed consent from their parent or legal guardian. In the present thesis we included only those under the age of 18 at the time of FF1 (n = 961). The flow charts for the participants included in the three papers are given in Figure 2.

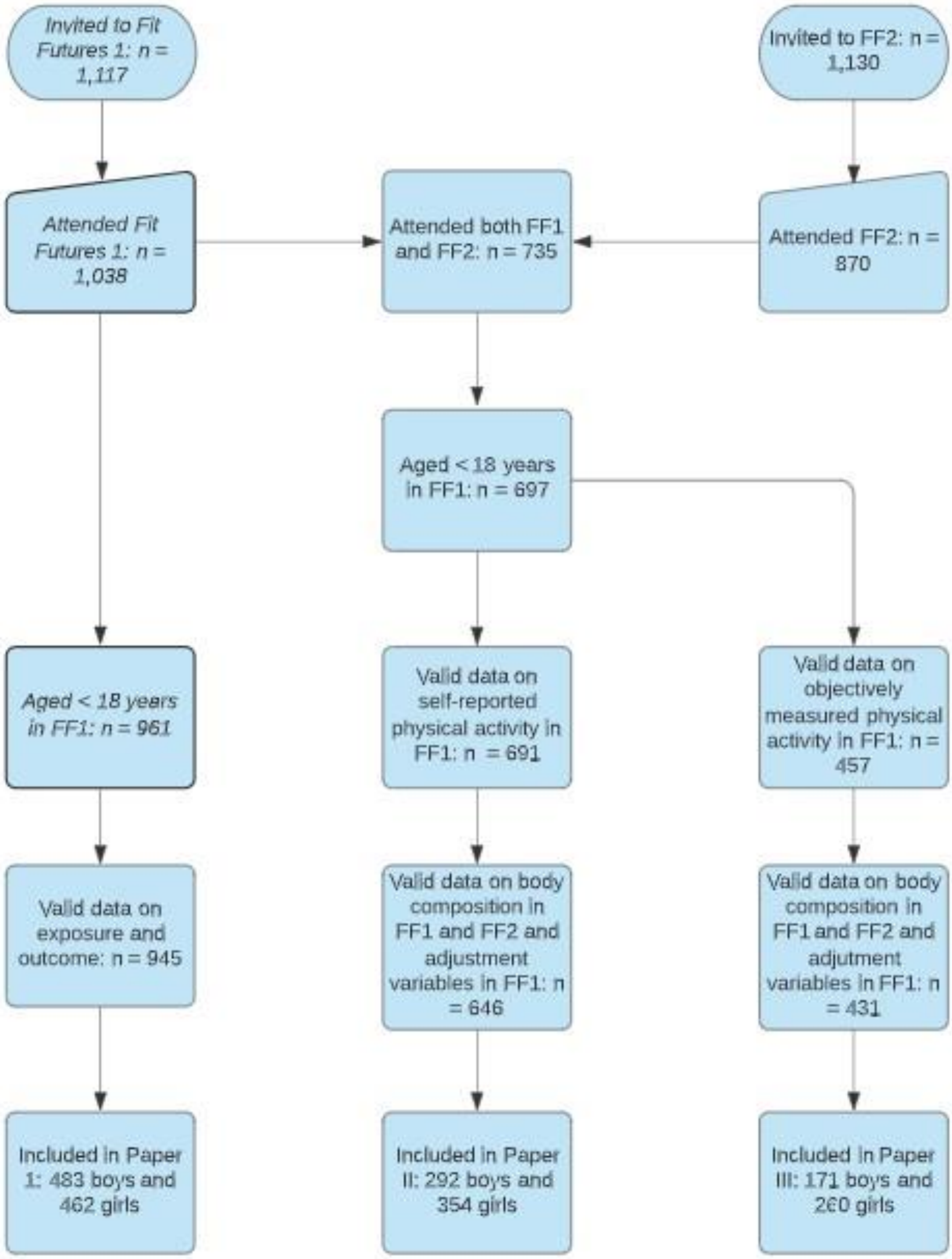

Figure 2. Flowchart of participants included in Papers I-III.

3.2 Measurements

Relevant to this thesis, the questionnaires used in the studies comprised questions on physical activity, screentime, demographic factors, parental education, psychosocial and health subjects (Appendices 1 and 2). While the questionnaire included several questions concerning the consumption and frequency of meals and of different types of foods, snacks and drinks, it did not include a validated global instrument for dietary habits such as a food frequency questionnaire. Both boys and girls were asked questions on pubertal development, and girls were also asked about age at menarche. Questions concerning puberty in boys were included 36 days after the data collection had commenced, and thus there were 102 boys with missing data on these variables in FF1.

The clinical examination included, *inter alia*, measurements of body weight in kg (measured to the nearest 100g) wearing light clothing, and body height in cm (measured to the nearest 0.1cm) on a Jenix DS 102 automatic electronic scale/stadiometer (Dong Sahn Jenix, Seoul, Korea). Waist circumference was measured to the nearest centimeter at the height of the umbilicus upon expiration. Following standardized procedures, all measurements and clinical examinations were performed by trained research nurses.

Fat mass, soft tissue lean mass and appendicular soft tissue lean mass were measured in grams using whole-body dual energy X-ray absorptiometry (DXA) (GE Lunar Prodigy, Lunar Corporation, Madison, WI, USA). Fat mass comprises all fat, while soft tissue lean mass comprises all bodily tissue except fat- and skeletal mass. Appendicular lean mass comprises the soft tissue lean mass of the extremities.

3.3 Variables

3.3.1 Self-reported physical activity

There were several questions on frequency, type and duration of physical activity in the Fit Futures studies (see Appendix 1), but a validated questionnaire for physical activity such as the IPAQ was not included. However, many of the questions were similar in wording as questions included in larger physical activity questionnaire batteries.

For the purpose of Paper I and Paper II, the primary exposure was hours of physical activity during leisure time. This was based on the question "*Are you physically active outside school hours? Yes/No"*. Those answering "*No"* were labelled as physically inactive. Those answering "*Yes*" were asked "*How many hours per week are you physically active outside of school hours?"*. This question was used in the Health Behavior in School Children study where it was validated as part of a larger instrument for an adolescent population [131]. There are six response categories, from none to more than 7 hours per week. Those reporting "*None"* when answering this question were also labelled as physically inactive. "*About half an hour*" and "*About 1 to 1.5 hours"* were combined, while the other responses were kept unaltered. Together they formed the physical activity variable used in the analyses included in Paper I and Paper II.

The available questions concerning physical activity from the questionnaires were substantially correlated (see Appendix 1 and Table 2). Norwegian adolescents are more physically active on weekdays than weekends [132], and therefore we considered the number of hours of physical activity per week as a good measure of total self-reported activity.

Table 2. Pearson correlation coefficients of self-reported physical activity variables in FF1.

	Hours per week	Days per week	SGPALS*
Hours per week	1.0		
Days per week	0.66	1.0	
SGPALS*	0.63	0.61	1.0

**: Saltin-Grimby Physical Activity Level Scale.*

3.3.2 Objectively measured physical activity

In Paper III, the exposures were objectively measured physical activity, by use of the GT3X ActiGraph accelerometer (ActiGraph, LLC, Pensacola, USA). The accelerometer was attached on the right hip of the participants at the clinic, and they were instructed to wear the device the rest of the day and for seven consecutive days from the following day. The participants were instructed to remove the device only when showering, swimming or sleeping. Afterwards the ActiGraphs were collected at the schools and returned to the research facility for downloading of data and charging of batteries. The ActiLife software was used to initialize the accelerometer and download data, which was imported into the Quality Control & Analysis Tool (QCAT) for data processing and creation of physical activity variables. This software was developed by the research group of professor Horsch in Matlab (The MathWorks, Inc., Massachusetts, USA) for processing of accelerometer data. The reason for not using the ActiLife software to process and extract variables, was to have complete control of the translation from raw data to variables, a process which is otherwise hidden in the software provided by the manufacturer. Because each manufacturer of accelerometers have developed their own algorithms to construct variables from the collected raw data, researchers and users do not know how this raw data is translated to physical activity variables. Complete control with this process was a strategic decision from the UiT, and allows full transparency of the construction of physical activity variables. There are plans to make the code behind QCAT publicly available as open source code in the near future [133].

For the data collection, the accelerometer was set in raw data mode, with a sampling frequency of 30 Hertz and with normal filtering epochs of 10 seconds. Data collection was initiated at 14:00 hours the first day, and concluded at 23:58 on the 8th day of measurement. We excluded data from the first day of measurement to reduce reactivity bias, wherein awareness of being monitored can affect the amount of physical activity performed [134]. The criteria for a valid measurement of physical activity was wear time of ≥ four consecutive days, with ≥ ten hours wear time per day. This has been demonstrated as representative of activity over a full week [135]. The triaxial algorithm developed by Hecht et al. was used to calculate wear time [136]. In this algorithm, a minute of collected data was considered as wear time if either the value of the vector magnitude unit (VMU) was > 5 VMU counts per minute (CPM) and there were at least 2 minutes >5 VMU CPM during the time span of 20 minutes before and / or after this epoch, or its value did not exceed 5 VMU CPM, but both on the preceding, and on the following 20 minutes there were 2 or more minutes >5 VMU CPM. There are limitations associated with all interval-based algorithms used in the calculation of wear time [133], and altering the parameters of an algorithm can affect the performance and precision considerably [137]. Although the Hecht algorithm was initially developed and validated for patients with Chronic Obstructive Pulmonary Disease (COPD), its performance was similar to those of other alternatives [137]. Furthermore, it had already been put to use in other cohort studies by some of the QCAT software developers [138], and thus it was reasonable to build upon previous work. Minutes per day in sedentary (0 – 99 CPM), light (100 – 1951 CPM), moderate (1952 – 5723 CPM) and vigorous (≥ 5724 CPM) physical activity was determined using the cut-offs developed by Freedson [81]. These cut-offs are widely used, but developed for adult- rather than adolescent populations, except the cut-off for sedentary which was validated in adolescent girls [139]. Despite this, the Freedson cut-offs were selected as they enabled comparison between the FF1 and FF2 (and in the future – FF3) cohorts. Furthermore, the acceleration of an adolescent body resembles more that of an adult than a child, and in the European Youth Heart Study the cut-off for MVPA was set at 2000 CPM – close to the Freedson cut-off at 1952 CPM [140]. In a study from 2019, Henriksen et al. showed that the intensity levels developed using QCAT correlated strongly with those from the ActiLife software [141] (Table 3).

Table 3. Pearson's correlation coefficient (95% confidence interval) between minutes spent in the different intensity levels calculated using QCAT and ActiLife software.*

Variable	Pearson's r
Steps	1.00
Sedentary	0.61 (0.39. 0.76)
Light	0.98 (0.96, 0.99)
Moderate	0.94 (0.89, 0.96)
Vigorous	0.99 (0.99, 0.99)
MVPA	0.96 (0.92, 0.98)

**: Adapted with permission from Henriksen et al [141].*

The device collected data in both uniaxial- and triaxial mode, but at the time of writing Paper III, only the uniaxial data had been processed and therefore available for analyses. Uniaxial data recorded from the GT3X correlate well with uniaxial data recorded from previous ActiGraph models [142].

3.3.3 Outcome variables

The primary outcome variables included in this thesis are listed in Table 4. Body mass index was computed as weight in kilograms/height in meters^2. We applied the IOTF body mass index reference values for adolescent populations to classify participants as either underweight, normal weight, overweight or obese in FF1, using age in half years. The classification terms for categories of body mass index correspond to the adult classifications [46, 47]. In FF2, all included participants were aged ≥ 17.75 years, and thus BMI was not adjusted for age in the classification of weight status in this survey.

Waist circumference was measured to the nearest cm at the height of the umbilicus after expiration. We classified participants to be abdominally normal weight, overweight or obese depending on age, using age in half years and the Norwegian reference values [143]. Abdominal obesity was defined as waist circumference at or above the 95th percentile in Norway [143].

We used DXA estimates of fat mass and soft tissue lean mass in grams to calculate Fat Mass Index (FMI, fat mass in kilograms/height in meters^2) and Lean Mass Index (LMI, lean mass in kilograms/height in meters^2). Region-specific estimates of lean mass in grams were used to calculate appendicular lean mass index (aLMI), which is the sum of lean mass in all four extremities divided by height in meters^2.

Table 4. List of outcome measures in the included papers.

Outcome	Paper I	Paper II	Paper III
Body Mass Index (BMI)	X	X	X
Waist Circumference (WC)	X	X	X
Fat Mass Index (FMI)	X	X	X
Lean Mass Index (LMI)	X	X	X
Appendicular Lean Mass Index (aLMI)			X

Appendicular LMI was included in Paper III only. The reason was that we only became aware of the possibility of including this outcome after Paper I had been published and Paper II submitted.

3.3.4 Other variables

From the literature we identified multiple variables that could confound an association between physical activity and body composition. The following variables were either included, or given consideration for inclusion, in the analyses.

<u>Age</u>

Age is an important confounder in the relationship between physical activity and body composition. Although different from biological age, the two are evidently closely related. In all analyses we opted to exclude those aged ≥18 years of age. The reason is that these participants would likely have a body composition resembling more that of adults and physical activity habits different from adolescents, despite attending upper secondary high school. Thus, within the included sample, age differed between 15.5 years and 17.5 years at the time of FF1. Within a period such as adolescence, 2 years constitute a substantial share.

However, because all participants attended first year of upper secondary high school, and because those aged ≥ 18 years were excluded from the analyses, age showed little variation (Mean age in FF1: 16.1, SD: 0.4 (girls)/0.5 (boys)).

Age was reported in years by respondents. Age in months was included in the data file and computed by subtracting date of birth from date of attendance. Age in half-years was used in the calculation of age-adjusted classifications of weight status.

Screentime on weekdays

In all three papers we adjusted for sedentary time as self-reported screentime on weekdays. There were 7 response alternatives, ranging from “none” to “10 hours or more”. In Paper I the alternatives were not altered, whereas in Papers II and III we merged some of the categories, creating a variable with 5 different response categories.

Dietary habits

In the questionnaires there were several questions on nutrition, dietary habits, frequency and type of meals, snacks or beverages consumed, but these were not part of a validated instrument to assess dietary habits. In all three papers we opted to adjust for frequency of breakfast consumption, on the presumption that this is an indication of healthy meal habits [144].

Study specialization

In the papers we intended to adjust for parental level of education as a measure of SES. However, around one third of participants had answered “don’t know” to this question. Not knowing is arguably something qualitatively different from any specified level of education. We therefore opted to adjust for study specialization as a measure of SES. Study specialization was associated with not knowing parental education, with significantly more among those studying vocational subjects than general- or sports reporting “don’t know”.

The question on study specialization had three possible responses; “general subjects”, “sports” or “vocational subjects”. Since the aim was to adjust for any socioeconomic differences between the different specializations, we merged “general subjects” and “sports” in Paper I, thus creating a dichotomous variable – study specialization. This was based on the observation that those attending sports or general subjects were similar in terms of level of parental education. In Papers II and III, we did not create a dichotomous variable, but used the categorical variable in its original format, acknowledging that study specialization is not merely a measure of SES but also associated with for instance participation in organized sports [145].

Time between measurements

Within the period that constitute adolescence, time is the most important factor in the development of body composition. Time between measurements was computed by subtracting the date of attendance in FF2 from date of attendance in FF1. Due to the design of the Fit Futures Studies, with rolling attendance, time between measurements among those included in Paper II ranged from 573 to 981 days with a mean of 736 and a standard deviation of 77. This means that the time available for both increases in body composition and positive or negative effects of low/high physical activity could differ substantially between individuals.

Device wear time

The precision of accelerometers in determining actual physical activity is dependent upon compliance from the user. Typically, a minimum of 10 hours per day over ≥ 3 or ≥ 4 days is considered the minimum to get a valid estimate of physical activity [135]. The latter was also the minimum requirement in the Fit Futures studies. Thus, in our data, device wear time had a theoretical range of 10-24 hours per day. Actual mean wear time per day ranged from 10.6 – 18.6 hours in Paper III. As noted previously, the raw data from the accelerometer is categorized into four different levels of intensity, with the majority of hours spent wearing the device falling into the categories sedentary- or light. This is natural, all the while the majority of humans waking hours are spent in these intensities [146]. However, this means that more hours of wear time may collect more hours of sedentary- or light activity [147], and thus adjustment for wear time was appropriate.

Seasonal variation

Physical activity varies according to season and time of year [148, 149]. In the present study, those taking sports specialization attended the survey in January. This is a time which normally is associated with less physical activity than during the summer months. A difference in level of activity between seasons would likely be the result of differences between schools or study specializations, rather than season itself, and thus we did not attempt to adjust- or stratify according to seasonal variation.

Pubertal development

Puberty and maturation are important factors to consider when studying physical activity and body composition in adolescents [22, 150]. In the present study questionnaire data on pubertal development existed for both boys and girls, in the form of the PDS (boys) and age at menarche (girls). However, there was a substantial number (n = 121) of missing data on PDS among boys in FF1. The reason was that the questions on PDS were included in the questionnaire on the 25th of October 2010, which was 36 days after the first participants had attended (20th September 2010). This left us with three options on how to handle maturation in boys; either perform complete case analyses, in which case a number of participants would be excluded (101/483 in Paper I), perform multiple imputation (MI), or not include PDS in the models. We considered MI to be slightly problematic, in part due to the study design with rolling attendance by schools. This design meant that the data from which imputation would be based would come from other schools, which could differ according to factors such as study specialization, demographics etc. Furthermore, the imputation in participants with missing pubertal data would have been based on data from those attending FF1 between 0-7 months later, at which point puberty may have reached later stages than what was the reality for those with missing data on puberty. As a result, we did not adjust for PDS and performed instead sensitivity analyses wherein the analyses were repeated in those with complete data on PDS only. Because we lacked data on boys, we did not include maturation in girls either, despite that data on age at menarche for the most part was available. As for boys, the analyses were repeated for girls with adjustment for maturation in complete case analyses.

3.4 Ethical considerations

The Regional Committee of Medical and Health Research Ethics (Rec North) approved Fit Futures 1 (2009/1282), Fit Futures 2 (2011/1702) and the present study (2014/1666) **(**Appendix 3). Both Fit Futures 1 (27.07.2010 (Ref. 07/00886-7/CGN)) and Fit Futures 2 (31.10.2012 (Ref. 07/00886-15/EOL)) were approved by the Norwegian Data Inspectorate. All participants received information about the purpose of the study in advance, and had the possibility to decline to take part in any specific measurement such as DXA or blood samples. In cases where the participants were aged <16 years, consent was obtained from the parent or legal guardian.

The present study, as well as both Fit Futures studies, were performed in accordance with the Helsinki Declaration [151], the Vancouver rules for co-authorship [152] and the Norwegian Health Research Act [153].

3.5 Statistical methods

All statistical analyses were performed using STATA, version 14 (StataCorp, Texas, USA). The level of significance was set at $p < 0.05$. All results were presented sex-specific, as decided a-priori. Descriptive statistics was used to determine means of continuous variables (with standard deviation (SD), while percentages (with number of subjects) was presented for categorical variables. We assessed normality of dependent variables by visual inspection of histograms. Multicollinearity was assessed by the variance inflation- and tolerance statistic, and model residuals were visually inspected in plots. The assumptions were considered met in all papers. We did not put emphasis on r-square or the r-square change associated with inclusion of a new variable in the model, as the objectives were not to build the best model for predicting outcomes, but to assess to what degree physical activity was associated with outcomes – adjusted for known confounders.

In Paper I we used linear regression to present estimates of body mass index, waist circumference, fat mass index and lean mass index, with 95% CIs, across the levels of physical activity, with crude and adjusted p-values for linear trend. The measure of physical activity chosen as the exposure was hours per week of physical activity outside school hours, coded to reflect the number of hours they represented. In the crude analysis we assessed the linear relationship between the physical activity variable and the body composition variables. In the second analyses we adjusted for screentime on weekdays, age in half-years, regularity of eating breakfast and study specialization.

In Paper II the associations between baseline physical activity and longitudinal changes in BMI, waist circumference, FMI and LMI were assessed using linear regression. The outcome variables were computed by subtracting the baseline measurement from the follow-up measurement of the respective body composition parameter. The same physical activity exposure as in Paper I was used, with a slight modification of how “2-3 hours” was coded. In Paper I this was coded as “3”, whereas in Paper II, this was coded as “2.5” to more accurately reflect the number of hours represented. The associations with changes in activity status were assessed by analysis of covariance. Change in physical activity between baseline and follow-up was determined by creating a dichotomous variable (active/inactive) based on the variable of hours per week of physical activity outside of school. Being physically active was defined as ≥ 2 hours per week. By combining the variable from FF1 and FF2, four different combinations were possible: active/active (consistently active), active/inactive (quitters), inactive/inactive (consistently inactive) and inactive/active (adopters). The consistently inactive were set as the reference category in the primary analyses, with a secondary analyses performed wherein those quitting were set as reference. In all analyses we adjusted for the baseline values of outcome. In the final adjusted models we also included baseline measurements of sedentary behavior (screentime), study specialization, regularity of eating breakfast and age in half years, in addition to the time between baseline and follow-up. We presented adjusted beta coefficients for change in outcome at each level of physical activity at baseline or change in activity status.

In Paper III the sex-specific difference in body composition between baseline and follow-up was tested using a paired samples t-test. The difference in physical activity between sexes was tested using a two-sample t-test, while sex differences in categories of minutes spent in MVPA was tested using a chi-square test. Difference in linear trend across categories of minutes spent in MVPA was tested using STATA's non-parametric test for trend, developed by Cuzick [154]. Linear regression was used to determine how baseline physical activity is associated with change in body composition, i.e. the change in BMI, waist circumference, FMI, LMI and aLMI between surveys, computed by subtracting the baseline measurement from the follow-up measurement. We used three different predictors of change in body composition, performing three sets of analyses, with first; minutes per day spent in sedentary activity, second; minutes per day spent in light activity, and third; minutes per day spent in MVPA. The continuous variables sedentary- and light activity were divided by 30 and the continuous variable MVPA by 15 before inclusion in the models, thus presenting the beta coefficient for change in outcome per 30 minutes of sedentary- or light activity, or per 15 minutes of MVPA, with 95% confidence intervals and a p-value. This was judged to be easier interpreted to the reader than presenting the beta coefficients for one unit change in the exposure variables. In model 1 we adjusted for the baseline measurement of the outcome. In the adjusted models (models 2) we also included time between measurements and baseline values of device wear time, age in half years and questionnaire data on screentime on weekdays, study specialization and regularity of eating breakfast. In the analyses of sedentary- and light activity we also adjusted for minutes spent in MVPA. In a subset of analyses we repeated the analyses, adjusting also for self-reported pubertal status measured by either pubertal development scale (boys) or age at menarche (girls). These analyses included the 143 boys and 258 girls with valid data on pubertal status.

4.0 Results and summary of papers

4.1 Paper I

The association between self-reported physical activity and body composition in adolescents has seen conflicting results, particularly because of a reliance on body mass index as the measure of body composition. In this paper we therefore aimed to examine the cross-sectional association between self-reported physical activity during leisure time and four measures of body composition, thus avoiding a reliance on a single measure of body composition which may also be unreliable.

Out of 961 eligible participants, there were 23.5% of boys and 20.5% of girls with overweight or obesity, as determined by the IOTF cut-offs. According to the Norwegian reference standard for waist circumference, there were 39.9% of boys and 55.9% of girls with abdominal overweight or obesity. More than 30% reported that they were not physically active outside school hours. Roughly 40% of both boys and girls reported being active more than 4 hours per week. Higher number of hours of physical activity was significantly and linearly associated with a lower fat mass index ($p = 0.004$) and higher lean mass index ($p < 0.001$) in boys. For girls the same association was observed ($p = 0.03$ and $p < 0.001$, respectively), but extended also to a lower waist circumference with higher level of activity ($p = 0.04$). There was no association between physical activity and body mass index in either sex.

We concluded that higher physical activity is associated with two complementary measures of body composition in this cohort of Norwegian adolescents, which in turn can explain why no association was observed with body mass index.

4.2 Paper II

The causal association between self-reported physical activity and changes in body composition in adolescents is disputed, illustrating a need for longitudinal studies which enable research on cause and effect. In Paper II we aimed to examine the relationship between self-reported physical activity in the first year of upper secondary high school and changes in four measures of body composition between first- and last year of upper secondary high school. Furthermore, we aimed to investigate whether change in level of physical activity between baseline and follow-up predicted changes in body composition.

There were 646 participants eligible for inclusion in the analyses. The proportion of adolescents classified as active in leisure time (active ≥ 2 hours per week) decreased by 6%-points in boys and 12.2%-points in girls. While both sexes experienced a mean increase in the included measures of body composition, the level of self-reported physical activity at baseline was not a significant predictor of these changes. One exception was the adjusted change in waist circumference in boys, which declined with higher activity ($p = 0.05$), and the statistically significant increase in both waist circumference and fat mass index in the most active girls. In boys, change in level of physical activity between baseline and follow-up was associated with changes in fat mass index ($p < 0.01$), with adopters and the consistently active increasing significantly less than the consistently inactive. Change in level of physical activity also predicted change in lean mass index in girls, with those adopting activity or remaining physically active having increases in lean mass index relative to those quitting activity between baseline and follow-up.

We concluded that change in the level of self-reported physical activity was associated with changes in fat mass index in boys and lean mass index in girls, and thus it appears that there are favorable consequences of remaining active or adopting activity during adolescence. A possible explanation for the difference between sexes may be the sexual dimorphism in body composition during adolescence, which occurs as a result of sexual hormones, and means that the relative increases in both fat- and lean mass index are to some extent biologically determined and therefore independent of physical activity. The fact that baseline level of physical activity to little extent predicted changes in the included measures of body composition may be explained by the analyses of change in physical activity, which illustrates that substantial changes in habitual physical activity takes place during adolescence.

4.3 Paper III

Physical activity may be measured in several different ways, and self-reported physical activity does perhaps not capture the true level of physical activity. Therefore, in Paper III we explored whether objectively measured physical activity was associated with changes in five different measures of body composition.

There were significant differences between the sexes in counts per minute and minutes spent in MVPA at baseline. Time spent in sedentary-, light- or moderate-to-vigorous physical activity did not predict changes in either measure of body composition in boys. In girls, minutes spent in sedentary- and light physical activity was significantly associated with changes in indices of lean mass. More time in sedentary activity predicted lower lean mass indexes, while more time in light activity predicted higher lean mass indexes.

We concluded that there appears to be a relationship between sedentary activity and low intensity physical activity and changes in indices of lean mass in girls, but not boys. Time spent in MVPA was not associated with change in either sex. The results are similar to some of the findings in Paper II, but we were not able to assess the possible impact of changes in objectively assessed physical activity.

5.0 Methodological considerations

The main objective of this thesis has been to investigate the association between physical activity and body composition in a cohort of Norwegian adolescents. Given the complexities of this field of research, it was always beyond the scope of a single thesis to provide a definite account of the relationship between physical activity and body composition in adolescents in general. We believe the results add to the body of knowledge within the field, and provide insight into how some measures of physical activity affect both general and specific measures of body composition. The results should nevertheless be interpreted with caution, and in light of the strengths and limitations of the study as a whole. This warrants a discussion of methodological considerations and sources of potential bias and confounding before proceeding to discussion of results.

5.1 Study design

There is an established cross-sectional association between physical activity and body composition in adolescents [38], where lower levels of physical activity are associated with for instance higher BMI. By design such studies cannot ascertain the direction of an association. This highlights a need for longitudinal studies, and previous research applying such designs have not been conclusive [155]. The present thesis included both cross-sectional and longitudinal analyses. While longitudinal studies in principle are better suited to determine causality, individuals may have, and report, high levels of physical activity because they try to lose weight, or they may have low (or high) body weight because of high activity. The problem of reverse causality therefore applies also to longitudinal studies, as overweight adolescents for instance may avoid engaging in physical activity on account of feeling inferior relative to their active peers [78, 156]. There is no straight-forward answer to this problem. In other fields of research the scientist aims to have control over every aspect of the research setting, and thus may isolate the exposure and exclude the effect of potential mediating factors. This is not possible in the case of physical activity epidemiology. There has been numerous intervention studies, wherein overweight subjects are assigned controlled physical activity exposure, and with various degrees of success [64, 157]. In contrast, it is problematic to assign normal weight subjects to gain weight, live with excess weight for some time, and then assign them to exercise – especially so for child- and adolescent populations. In real-life settings, individuals are exposed to numerous factors, which in their own regard or in interaction with others, have an effect on both physical activity and body composition [100]. Furthermore, changes to physical activity behavior can occur over both the short- and long term, and be caused by life-defining events such as transition to higher education [158] or becoming pregnant [159], or less visible factors such as changes in motivation [160]. Because of these issues, whether overweight precedes or succeeds physical activity is difficult to determine even in longitudinal studies [161]. In this regard, it should also be noted that the effects of a negative behavior such as physical inactivity takes time to manifest itself in excess adiposity. In the present study, follow-up time was around 2 years, but this may not be enough time to detect such changes given the influence of maturation on body composition.

5.2 Validity of measurements

The results of any research is dependent on how exposures and outcomes are measured. Considering physical activity and body composition, there are several issues concerning measurement which may have affected the results presented in this thesis.

5.2.1 Validity of physical activity measurements

In general, questionnaire data are prone to bias, and there is no exception to questionnaires on physical activity [162]. Informants may exaggerate or underestimate, for many different reasons, and it is therefore not certain that the respondent is as active as they say. Perhaps more relevant to this thesis is the diversity in motives for being physically active [32, 33]. This means that an individual with excess adiposity, however measured, can report a high level of physical activity if they currently wish to reduce body weight. Another individual with the same body composition may choose not to engage in physical activity for fear of stigmatization, and will perhaps seek other methods for weight loss than physical activity [78]. A question on motivation or reason for engaging in physical activity may be the solution to this particular problem, but reverse causality can still be a potential problem.

An underlying assumption behind using baseline exposure as a predictor for change in body composition is that the level of physical activity reported remains consistent over the study period. There is no guarantee that this assumption holds. This is particularly relevant since adolescence is a period of life where many people make changes to their activity habits. In fact, in Paper II, only 40% of participants reported the same number of hours of activity in FF2 as in FF1 (Table 5). This comes in addition to those who in FF1 had recently changed their physical activity levels – of which there is no information. In Table 5 the self-reported level of hours of physical activity in FF1 and FF2 is presented, with the associated non-weighted and weighted Kappa values. In the calculation of weighted Kappa, we assigned the default weights (wgt) included in the STATA package (which, for a 6-level variable represents a reduction factor in weight of 0.2 per level). The non-weighted Kappa was 0.224, and the weighted Kappa was 0.356, indicating that the agreement between self-reported activity in the two surveys represents "fair agreement", as suggested by Landis & Koch [163]. These are nevertheless Kappa values in the lower spectrum, something which implies that there are substantial changes in behavior between the surveys, in line with the known decline in activity throughout adolescence [164].

Table 5. Crosstabulation of hours per week of self-reported physical activity in Fit Futures 1 and Fit Futures 2 among the participants included in Paper II.*

	Fit Futures 2						
Fit Futures 1	None	0.5 hrs	1 – 1.5 hrs	2 – 3 hrs	4 – 6 hrs	≥ 7 hrs	Total
None	**108**	4	22	18	23	6	181
0.5 hrs	3	**1**	0	0	2	1	7
1 – 1.5 hrs	22	0	**4**	8	12	2	48
2 – 3 hrs	53	1	15	**26**	24	7	126
4 – 6 hrs	36	1	10	25	**58**	32	162
≥ 7 hrs	9	0	7	13	23	**55**	107
Total	231	7	58	90	142	103	631

* Kappa: 0.224, weighted Kappa: 0.356.

A possible solution to the problem of lack of consistency in habits throughout follow-up could be the inclusion of a question on past activity in addition to present activity, and to adjust for this variable in the analyses. This could eliminate some of the effect of past activity habits (if they differ from present levels) on present body composition and on the potential future increase in adiposity. Given the changing nature of adolescence, this may be appropriate in future studies, but was not an option here as the data collection was completed when this thesis was planned. Another solution might be to use change in activity from FF1 to FF2 as exposure, rather than baseline physical activity – an approach used in Paper II. A problem with this approach is that with only two measurements, it is not possible to determine when the increase or reduction of activity actually occurred. The individual may have changed their level of activity anytime during the study period, which again raises the problem of validity of the exposure. Further complicating the matter is the fact that adolescents (and particularly adolescent boys) increase their resting metabolic rate as a result of growth [78]. This means that the lower energy expenditure associated with a reduction in physical activity may be compensated through natural changes in energy expenditure or because of energy required for growth [78]. As a result, the boy who at baseline reports being inactive may not necessarily gain any more weight than his active peer, if maturation works favorably for him in terms of energy expenditure. Therefore energy expenditure as a result of factors other than physical activity may confound the association between level of physical activity and changes in adiposity [165].

A challenge associated with questionnaire data on physical activity is whether the questions pick up any meaningful difference in activity between participants. In other words, does the question truly separate the active from the inactive? One could hypothesize that leisure time activity (outside of school) may not constitute the biggest contributor to total activity during a regular day. For adolescents, transportation to school and friends, hiking or outdoors activities, other activities of daily living, as well as mandatory physical education in school hours can all contribute to total activity. In 2010 in Norway, mandatory physical education was 2 hours per week in upper secondary high school. This is not particularly high, but in FF1 around 60% of participants reported being physically active 3 hours or less per week outside of school. For them, 2 hours of physical education in school would amount to a substantial share of total activity. Regarding transportation, we had data on transportation to school, but not otherwise in leisure time. Still, in Paper I the vast majority either travelled by bus or was transported by car to school (Table 6). In any case it is likely that distance from home to school is a better predictor of mode of transportation than preference for activity. Active transportation to friends in the vicinity of home might contribute to more walking or bicycling than transportation to school, but no such data was available.

Table 6. Mode of transportation during summer and winter among participants in FF1.

	Summer		Winter	
Mode of transportation	n	%	n	%
By car/motor cycle/moped	103	10.9	67	7.2
By bus	642	67.9	725	78.0
By bike	54	5.7	10	1.1
On foot	146	15.5	128	13.8

In the present thesis we used hours of physical activity per day outside school hours as the exposure. Questions on volume, frequency and duration are included in most physical activity questionnaires, but they are validated as part of a larger questionnaire instrument. Other questions on physical activity were available (See Appendix 1), but we considered hours per week to be a good proxy for overall physical activity during leisure time, and this variable was also highly correlated with the alternatives in Paper I (Table 2). We acknowledge that choosing a different exposure, such as physical activity in days- rather than hours, or the SGPALS, might have brought about slightly different results.

Advances in technology has made accelerometers readily available and feasible for use in large population studies, but the technicalities of handling raw data from accelerometers have substantial impact on the variables produced. For instance can the selected epoch length have an impact on the measured level of physical activity [166, 167], and the lack of unanimous agreement on which intensity cut-offs for CPM to apply affects direct comparison of results between studies. This issue has been termed “cut-point non-equivalence”, and efforts have been made to construct mathematical equations which convert the estimates of time spent in for instance MVPA in different studies to a common standard (which have used different cut-offs), enabling comparison [168, 169]. Furthermore, the algorithms chosen to determine wear-time represents a trade-off between the quality of data and the number of participants with valid data [170]. Because stricter criteria for wear-time might omit periods of what is actually sedentary behavior, the result could be that more participants with overweight or obesity are excluded from the analysis [170].

At present, the WHO guidelines for time spent in MVPA in adults state that the activity should occur in bouts of minimum 10 minutes to be valid [76], but recently the United States guidelines for physical activity was updated to not require 10-minute bouts [171]. The consequence is that more adults appear to reach the goals of 22 minutes of MVPA per weekday, as short periods of higher intensity physical activity now is included [133]. This may explain why self-reported level of MVPA tends to be higher than what has been measured objectively, as people may include such shorter periods of high intensity physical activity in their total estimates [133]. These considerations on accelerometer data handling apply also to the present thesis, as the selected cut-offs, epoch lengths and wear-time definitions would have produced slightly different estimates of physical activity than what would have been the case if other criteria were used. This also illustrates that objective measurement of physical activity is bound by subjective judgement when it comes to the process of analyzing the data. As such, referring to accelerometers as "device-based methods of assessment" rather than "objectively measured" may be a more accurate choice of words.

5.2.2 Validity of body composition measures

In the present thesis we included four (five) different measures of body composition. As there are known limitations associated with BMI, both in general and in adolescents specifically, using this measure alone would be insufficient for the purpose of the study. This measure was included for sake of comparison with other studies, and to investigate how the association between physical activity and BMI compared to the association with the other included outcomes. For the same reason waist circumference was also included as an outcome, as this is a prevalent measure of body composition and included as a component in the metabolic syndrome [53].

We consider the DXA measurements to be of high quality compared to the alternatives, despite the inherent limitations of this instrument also. Lohman et al. have described the different body composition assessment methods as either “reference”, “laboratory” or “field”, with each category assigned a typical error [56]. Reference techniques (the gold standard) have a typical error of 1-2%, but are costly and requires highly skilled technicians and advanced equipment. Laboratory methods include DXA, and has an error of 2-3%. On average, the sum of bone-, fat- and soft tissue lean mass as derived by DXA, differs from that measured on a scale weight by around 1 kilogram [56]. DXA has good ability to determine bone- and lean mass, but is slightly less precise in determining fat mass (3%) – particularly in very lean or very obese people [56]. Furthermore, the precision of DXA varies between manufacturers and software, to such extent that care should be taken in comparing estimates of fat mass performed using different equipment. The estimates of fat- and lean mass are furthermore based on algorithms built into the software of manufacturers, which is considered the intellectual capital of producers and thus not readily available to researchers [56].
In the present thesis we used lean mass index as one of the outcomes. In the literature, lean mass index is often interchangeably used with fat-free mass index, and frequently includes skeletal mass. We did not include skeletal mass in the lean mass index, but when comparing results with other studies the reader should be aware that lean mass index then could include bone mass. We considered our definition of lean mass index (comprising only soft tissue lean mass) to be more specific to muscular tissue than FFMI, but as lean mass is associated with

skeletal mass [172, 173] the difference in magnitude of an association with FFMI would likely be small.

Lastly, fat mass index is not the most specific measure of fat available from DXA measurements, as DXA provides options of assessing amount of region-specific adipose tissue. Abdominal fat consists of visceral adipose tissue (VAT) and sub-cutaneous adipose tissue (SAT), of which the former is considered more hazardous to health [174] and considered as an important risk factor for cardiovascular disease [175]. This measure was not available at the time of writing the included papers, and has been validated in adults [174, 176], but not adolescents. Associations with physical activity would still be of interest, and may have provided different results than what we observed with FMI.

In conclusion, although a valid technique for estimation of body composition, different measurements performed by DXA should be compared in light of the population under study, the definitions used, the software version applied and the manufacturer of the apparatus. This means that other studies, using different software versions or equipment from different DXA manufacturers, might have found slightly different associations from what we observed. Also, it should be noted that associations between physical activity and BMI might be different, had BMI been self-reported rather than measured. Considering waist circumference, different methods of assessment (placement of measuring band on abdomen) in other studies might restrict comparison with our results [52].

5.3 Statistical procedures and adjustments

As a general principle, the statistical methods chosen should reflect the research question. We were interested in the linear associations between the exposure and the outcome, in which case linear regression is appropriate if the assumptions are met. These were generally met, but some issues warrant further discussion and clarification.

In Paper I, one of the dependent variables, Fat Mass Index, appeared right skewed, and log-transformation of this variable was considered. This did not alter the association with physical activity, and FMI was therefore included in its original form for ease of interpretation. Also, in Paper I physical activity was coded to reflect the number of hours they represented, but due to a mistake in the coding of variable, the category "about 2-3 hours" was coded as "3", rather than "2.5". In the writing of this thesis, the analyses were repeated with the same procedures regarding this issue as in Paper II and III, but this did not substantially influence the results and the reported associations remained. In Paper II, this category of physical activity was coded as "2.5".

In the case of Paper II, we were interested in whether change in a dichotomous variable was associated with changes in body composition. To this end we combined the dichotomous variables in FF1 and FF2, giving four possible combinations. Based on the questionnaire data, an individual was classified as physically active if he/she reported being physically active ≥ 2 hours per week outside of school. This may appear an arbitrary cut-point to categorize people as active or not, as it does not imply for instance fulfilment of recommendations for physical activity. However, the objective was to separate the active from the inactive, and the two categories which were combined spanned 0 - 1.5 hours weekly activity and therefore constitute little physical activity over the course of one week.

In analyses of accelerometry-derived physical activity, the variables used are typically minutes spent in different intensities of physical activity. Due to the closed structure of the derived variables, wherein only 24 hours of the day is available, this can cause problems with multicollinearity in regression analyses because the number of minutes spent in a given intensity can in theory be derived from the minutes spent in the other intensities. This would depend on wear time being 24 hours, but in Paper III mean wear time was 14 hours and no participants exceeded 18.6 hours. Other methods exist to overcome the limitation of multicollinearity, but are still in their early development. Aadland et al.[177] suggest that the evidence base for physical activity requirements is not flawed, but that linear regression currently is the second-best option for analyzing accelerometer data. They argue that future studies should apply multivariate pattern analysis without transformation of physical activity data. This method handles collinear variables, and may provide more robust results than multiple regression. In Paper III, multicollinearity did not appear to be a problem, based on evaluation of the variance inflation factor and tolerance statistic. Regarding the previously noted translation of raw accelerometer data to physical activity variables, this was handled in-house and using software developed at UiT – The Arctic University of Norway. Although prevalent cut-offs were applied, we do not know whether results would have been replicated using ActiLife software instead. However, the study by Henriksen et al. [141] showed that estimates of intensities of physical activity by QCAT was strongly correlated with those from the ActiLife software (≥ 0.94), with the exception of sedentary time, where the correlation was lower at 0.61 (Table 3).

The association between physical activity and body composition could be assessed using categories of weight class (based on BMI) as the outcome, but to our mind, this provides limited information, as even small differences in BMI can affect which category of BMI an individual is assigned. Furthermore, given the influence of biological age, individuals may be wrongfully classified as normal weight or overweight which may affect results in a relatively small sample such as ours. The size of the sample is particularly important in the study of body composition in adolescents, because this age group shows more heterogeneity in body composition than adults. As a result, larger samples are necessary to detect differences in body composition between levels of physical activity [114]. In the present thesis, study samples ranged from 431 in Paper III to 945 in Paper I, which means that there may not have been statistical power to detect small differences between subgroups that could have been meaningful on a population level, despite being too small for any clinical relevance to the individual.

The precision of measurements of body composition and physical activity must also be considered, and in light of the statistical methods applied. When the more precise measure (body composition) is used as the outcome and the less precise measure (physical activity) is used as the exposure, the magnitude of effect is attenuated because of measurement error in the exposure. In contrast, the precise measure (body composition) predicts physical activity (outcome) [155]. Reverse causation (whether higher adiposity predicts changes in physical activity) was not investigated in the present thesis, but could arguably have shed some more light on the relationship between these two.

5.3.1 Validity of covariates

The advantages of multiple regression analyses include the possibility of adjusting for potential confounders, meaning that the effect of an exposure on an outcome can be assessed while holding the effect of the confounders equal. After exploring the literature and investigating which options were available in our dataset, we included in the analyses a set of variables known to affect the association between physical activity and body composition. The use of some of these variables, and also some not included, deserve a further discussion.

Screentime

Screentime is a widely used proxy for sedentary behavior, but not necessarily the best proxy of sedentary time (the very active participants also have a high amount of screentime). However, screentime is also associated with increased consumption of energy-dense foods and snacking [178, 179], which is a confounder in the association between sedentary time and adiposity. The amount of screentime was also the only viable option for sedentary time among the questions included in the surveys. The latter years has seen an increased focus on sitting time, rather than screentime per se. This is perhaps a consequence of screentime as a behavior in adolescents having changed with the increased use of mobile phones [180]. When the first Fit Futures study was conducted, mobile phones were not used to this end in the same degree as today, and therefore not included in the question as an example of a screentime device. Thus, screentime as understood in the questionnaire is likely a better indicator of sedentary behavior than screentime as understood today, since mobile phones are presently used for multimedia purposes to a greater extent than before.

Screentime was included as a confounder in all three papers, but was handled differently in Paper I than in Papers II & III. In Paper I, screentime was included in the models in its original format, but in Papers II and III this variable was coded to more correctly reflect the number of hours they represented. Furthermore, some of the response categories were merged, creating a variable with 5 rather than 7 possible alternatives.

Breakfast consumption

Breakfast consumption is a frequently used indicator of healthy meal patterns, but it has been proposed that the association between frequency of breakfast consumption and obesity is a spurious one [181]. Diet is in any case an important confounder in the relationship between physical activity and body composition, but the Fit Futures Study did not include a validated food frequency questionnaire or similar. Other options were available, such as frequency of consumption of chocolate/sweets, sugar sweetened beverages, consumption of dinner etc., but frequency of breakfast consumption was nevertheless chosen as this is a prevalent indicator of dietary habits which is associated with obesity in children and adolescents [144].

Socioeconomic status

A limitation in the papers is the apparent lack of adjustment for SES. The most prevalent indicator of SES in adolescents is parental level of education or parental occupation. Because there were a considerable number of participants reporting "don't know" on these questions, these data could not be included without significantly reducing the number of participants eligible for analyses. Reassuringly though, studies have shown that study specialization is correlated with parental education, and inclusion of this variable in the model therefore likely adjusts for some of the variance in SES [182, 183]. Because the categories "general subjects" and "sports" were merged in Paper I, we have explored whether keeping them as individual categories in the models would have an impact on the results. For boys, the overall significance and associations remained, whereas for girls, the association between physical activity and waist circumference ($p = 0.052$) and with FMI ($p = 0.072$) no longer remained significant.

Baseline values of outcome

In Papers II and III we adjusted for baseline values of the outcome in all prospective analyses. Some have suggested that adjustment for baseline measure of the outcome is problematic, but according to a recent systematic review it is recommended in this particular case, as baseline measure of the outcome is the strongest confounder in prospective analyses [184]. This is because physical activity may have different effects on future body composition depending on current body composition [41]. As far as we have observed in the literature, both options are prevalent, but to our mind it seemed natural to adjust for the starting point. Considering floor- and ceiling effects, those with for instance a low initial lean- or fat mass, have more potential for increases over the course of follow-up, which would otherwise be lost information had this not been adjusted for.

Puberty

In adolescents, pubertal development can influence both level of physical activity and measures of body composition [22, 62, 115, 150, 185]. Pubertal development also has a potential influence on participation in organized sports. In Norway, and many other countries, participation in sports is organized according to birth cohorts, meaning that boys and girls practice and compete with children and adolescents born the same year. In sports, this can naturally favor those who experience early maturation, as they develop muscular tissue and physique earlier than their slower maturing peers. This can lead to situations where the more physically developed subconsciously is favored or experience success, and as such maturational status can potentially have a direct impact on the level of physical activity in an individual [115]. In the analyses of the relationship between physical activity and body composition, it would therefore seem appropriate to adjust for the influence of pubertal development.

In complete case analyses, adjusting for PDS made no change to the overall conclusions or level of significance in either of the three included papers. This could be a result of the PDS score not differentiating much in a population with a mean age of 16, and where 82% of boys in Paper I with valid data had reached the PDS stage “underway” or “complete”. Multiple imputation of maturation was considered, but this was judged to be somewhat problematic because MI uses the information available in complete cases to predict the missing value based on the observed data [186]. The problem in this situation was that puberty is not something fixed, but a physiological factor in constant development until completion. This means that participants attending the examination in for instance March 2011 would have matured physiologically more than participants had in September 2010. In MI the results from examinations later on would be used to estimate the PDS score at an earlier time point – when PDS levels perhaps were lower. Another reason is that the gold standard for measuring maturation in boys it not PDS, but the Tanner Stages [116], and this was not performed in the Fit Futures. Other studies using data from Fit Futures have performed MI, and considered that the assumptions for imputation of the included variables were met [187, 188]. We acknowledge that we might be wrong in our judgement, and that MI could have been an appropriate method of handling missing data on pubertal maturation in this case. However, as the results did not change with adjustment for maturation in neither boys nor girls in complete case analyses in all three papers, we consider our results valid despite lack of adjustment for this important confounder, and higher sample size was therefore prioritized.

5.4 Sensitivity analyses and generalizability of results

The validity of the results of any study depends, among other things, on how representative the sample is of its source population. The Fit Futures Cohort Studies invited all students attending first- and last year, respectively, of upper secondary high school in two municipalities in Northern Norway, and participation was high. As more than 90% of 16-18 year olds in Norway attended upper secondary high school in 2010 [189], this means that those attending the Fit Futures surveys could be expected to be quite representative of its source population: youth residing in Tromsø and Balsfjord. However, due to strategic decisions and inclusion criteria, not all participants were included in the analyses in the different papers of the present thesis. This can lead to selection bias and affect the generalizability of results, and must be explored. The sensitivity analyses conducted for Papers II and III include only those under the age of 18 years at the time of FF1.

Paper I

Of the 1,038 participants in FF1, there were 77 participants aged 18 years or older. These were excluded from all analyses, as this group would be aged higher than the age period which is considered to constitute adolescence. In both boys and girls, the group of excluded participants had significantly higher mean values of all included measures of body composition than those under the age of 18. This is as expected, given the natural increases in these measures in the immediate years following adolescence. Furthermore, among the excluded participants, 95% of boys and 100% of girls attended vocational programs.

Paper II

Of the 961 individuals which attended FF1 and were under the age of 18 at that time, we included 292 boys and 354 girls with valid baseline data on physical activity, body composition and adjustment variables and follow-up data on body composition. This sample differed slightly from those without data on body composition at follow-up, with for instance more boys than girls lost to follow-up (200 boys vs. 115 girls). There were no significant differences in measures of baseline body composition between these two groups among boys, whereas girls lost to follow-up had slightly higher BMI (23.0 vs. 22.2, $p = 0.03$), waist circumference (79.4 vs. 76.6, $p < 0.01$) and FMI (8.2 vs. 7.3, $p < 0.01$). The amount of physical activity differed significantly, with both boys and girls lost to follow-up being less active. Regarding study specialization, more of those choosing vocational subjects were lost to follow-up than those choosing sports- or general subjects for both sexes.

Paper III

In Paper III we included 171 boys and 260 girls with valid data on objectively measured physical activity, baseline- and follow-up data on body composition and complete data on variables used in the regression analyses. Significantly more boys than girls were lost to follow-up (321 vs. 209, $p < 0.001$). With the exception of baseline FMI (4.9 vs. 4.2, $p = 0.02$ (boys) and 7.8 vs. 7.3, $p = 0.05$ (girls)), there were no significant differences in baseline body composition between those included and those lost to follow-up for either sex. In girls, but not boys, those lost to follow-up had slightly less light- (222.1 vs. 236.2, $p = 0.02$) and moderate-to-vigorous physical activity (37.4 vs. 43.1, $p = 0.03$). For both sexes, among those lost to follow-up, there were more students choosing vocational subjects and fewer students choosing general subjects, whereas the proportion choosing sports were similar.

It has been proposed that wear time criteria for accelerometers might exclude more overweight/obese participants, if this group has larger amounts of very sedentary time, which then becomes wrongly classified as non-wear time [170]. In Paper III, there were 643 participants with valid follow-up data on body composition and adjustment variables, out of which 212 were lacking valid data on objectively measured physical activity at baseline. This group of participants did not differ significantly in any measure of baseline body composition, except FMI in boys which was significantly higher in those without a measurement of physical activity (5.0 vs. 4.2, $p = 0.02$).

In summary, the sample invited to attend the Fit Futures surveys could be expected to be quite representative of its source population. However, the sample actually included in the analyses, particularly in Paper II and Paper III, differed slightly from those lost to follow-up or those with missing data. The included sample was slightly more physically active at baseline, and had lower levels of adiposity according to some measures. More students attending vocational programs were lost to follow-up than those attending general- or sports programs, with the former also associated with having parents with lower level of education. If participants lost to follow-up were less physically active at baseline, they may in theory also have increased more in measures of adiposity during the study period, potentially confirming our hypothesis if they could be included. This remains speculation, but we must acknowledge that the reported associations may have differed slightly if data were available from those lost to follow-up or excluded from the analyses, and that the generalizability of results perhaps does not extend to all subgroups.

Considering generalizability of results to adolescents in Norway or the rest of Europe, some environmental factors should be mentioned. While the sample included in Fit Futures 1 were comparable to other Norwegian data in terms of weight status [24, 190, 191], they resided in the north of Norway. Arguably, adolescents living in this part of Norway are exposed to other environmental factors than adolescents growing up in larger cities and further south. These factors include longer winters, more snow, polar nights during two winter months and midnight sun during two summer months. This may affect the types- and volume of physical activity performed, which may have an impact on the associations reported. However, according to national data on 15-year olds physical activity there were no differences in counts per minute between the regions in Norway [192]. According to national data from 2019, the number of 15-year olds meeting guidelines on MVPA was considerably higher (40% of girls and 51% of boys) than we observed in the present thesis [24]. Whether this difference represents actual difference in level of physical activity, or is a result of the minor difference in age or handling of accelerometer variables is unknown.

6.0 Discussion of main findings

The three papers included in this doctoral thesis have sought to investigate the associations between physical activity and body composition. To this end we have determined: i) that there is an association between self-reported physical activity during leisure and tissue-specific measures of body composition on a cross sectional level; ii) that self-reported physical activity was not associated with changes in body composition (except waist circumference in boys) over two years of follow up, but that changes in level of activity was associated with changes in lean mass in girls and fat mass in boys, and iii) objectively measured physical activity was not associated with changes in body composition in boys, but time spent in sedentary- and light activity was associated with changes in indices of lean mass in girls. These results add to the body of knowledge within the field, and using outcome measures that are more robust than those commonly reported.

6.1 The cross-sectional association between physical activity and body composition.

In Paper I we observed significant associations between self-reported level of physical activity and fat mass index and lean mass index in both boys and girls, and a significant association with waist circumference in girls. With higher levels of physical activity, lower levels of fat mass index and higher levels of lean mass index was observed, which potentially explains why there was no association with BMI as this measure does not separate fat- from lean mass. Lack of an association between self-reported physical activity and BMI has been observed previously [193], whereas associations with weight status (categories of BMI) appears to be more common [194, 195].

The results in Paper I complement each other, and shows how physical activity is inversely associated with different types of bodily tissue. Similar inverse associations between physical activity and lean body mass and fat mass have been reported in Swedish adolescents [196, 197]. The prevalence of abdominal overweight and obesity (as measured by waist circumference, using Norwegian adolescent reference standards [143]) was substantially higher than the prevalence of overweight and obesity as measured using the BMI cut-offs proposed by IOTF [46, 47]. In a longitudinal study of British youth, the increase in waist circumference surpassed that of BMI, with the authors concluding that the prevalence of obesity as determined by BMI systematically underestimated the actual presence of obesity [198]. In a study of Norwegian 11-year olds, a similar discrepancy between overweight and obesity as determined by cut-offs for waist circumference or BMI was noted [199]. This study was performed before the Norwegian age-specific cut-offs for waist circumference had been published [143], and therefore used available cut-offs developed in Dutch children [200].

In girls, but not boys, physical activity was associated with waist circumference in Paper I, with more hours of physical activity associated with a lower waist circumference. Because girls mature earlier and accrue more fat mass during adolescence than boys, this cross-sectional association is potentially explained by waist circumference in girls having advanced more towards adult values than in boys. It is plausible that the physiological effects of physical activity on muscular- and adipose tissue are present in a cross-sectional study, but whether such associations are present over time is less certain given the natural changes in body composition in this age-group.

In recent years, the use of objective measures of physical activity has surpassed that of self-reported measures in epidemiological studies. Systematic reviews of the association between physical activity and weight status show conflicting results, but include studies using different measures of physical activity and different indices of body composition [201, 202]. Furthermore, in the included studies, the measure of adiposity has for the most part been BMI or categories of BMI, which is slightly problematic as physical activity has opposite effects on the different tissues of the human body.

In summary, the results of Paper I demonstrate that physical activity is associated with tissue-specific measures of body composition in Norwegian adolescents, and is an argument for why more specific measures than BMI are needed to study the association between physical activity and adiposity. The inability to ascertain a causal relationship between physical activity and body composition, and the limitations of self-reported physical activity, warrants Paper II and Paper III.

6.2 The association between physical activity and changes in body composition

In Paper II, we drew upon the results in Paper I by assessing whether self-reported physical activity in Fit Futures 1 predicted changes in measures of body composition between Fit Futures 1 and Fit Futures 2. Our hypothesis was that higher level of physical activity at baseline would protect against increases in unhealthy measures of body composition. However, the results from this part of Paper II did not support this hypothesis and suggest that changes in body composition was mainly independent of the level of self-reported physical activity at baseline. The exception was a significant adjusted linear trend in waist circumference in boys and an increase in waist circumference and fat mass index in the most active girls (≥7 hours per week of leisure time physical activity), which was significantly higher than in the girls who were inactive at baseline. Similar results have been observed previously [165]. This apparently paradoxical association could possibly be explained by a reduction in physical activity between baseline and follow-up in the most active girls, but this was not the case.

Change in level of physical activity from baseline to follow-up was a significant predictor of changes in fat mass index in boys and lean mass index in girls. In a study of slightly younger adolescents in Brazil, change in self-reported physical activity between ages 11- and 13 predicted changes in fat mass index, but not lean mass index [203]. As these participants were younger, and the study was performed in a different cultural- and socioeconomic setting, one would anticipate slightly different findings than those of Paper II. In our study we observed that the consistently inactive did not differ significantly in terms of changes to body composition from those consistently active (except waist circumference and FMI in boys). In general, for these two groups, physical activity has less potential to affect changes to body composition because the habit remains unchanged. This can be considered as floor- and ceiling effects of physical activity, and means that the greatest potential for activity-related changes in adiposity occurs in groups who make changes to this habit. In boys, those who increased their level of physical activity between surveys experienced a reduction in FMI and had the highest increase in LMI (although not significantly different from the reference), indicating that positive changes in physical activity is potentially favorable for body composition. Lack of an apparent association with BMI is likely explained by the inability of this measure to separate lean- from fat mass. The consistent, but not statistically significant, pattern of the largest increases in BMI, waist circumference (not in boys) and FMI occurring in those quitting activity would suggest negative effects of reducing activity during this period of life. Whether such changes result in significant differences over time must be investigated in follow-up studies of the same cohort, but is nevertheless of concern given both the secular- and longitudinal reduction in physical activity in adolescents [204]. In the epidemiology of physical activity and body composition, the possible bidirectional associations must be considered in the interpretation of results, as these apply both to cross-sectional and longitudinal study designs. It is not certain that excess adiposity succeeds inactivity, as the opposite is also plausible with overweight individuals avoiding activity for instance on account of feeling inferior relative to their active peers [78, 156]. In this regard, change in physical activity may be a more valuable predictor of changes in body composition, given the lack of consistency in physical activity habits during adolescence. However, a systematic review noted little evidence for a relationship between changes in objectively measured sedentary behavior and changes in adiposity [40]. It would nevertheless be of interest to investigate which factors are associated with remaining physically active, increasing level of physical activity and quitting physical activity during adolescence. This was not an aim in Paper II, but previous research has identified sports participation, parental level of education, parental level of physical activity [205], having physically active friends and support from friends [206] as significant factors in remaining- or becoming physically active. These issues deserves further exploration, and may explain why some adolescents remain active while others do not.

In Paper III we investigated the association between objectively measured physical activity and changes in body composition, this time expanding the outcomes by including change in appendicular lean mass index. In general, we did not observe substantial evidence for a prospective association with changes in either outcome between baseline- and follow-up. The exception was time spent in sedentary- and light activity, which predicted small but significant changes in lean mass index and appendicular lean mass index in girls. Time spent in MVPA was not associated with changes in body composition, a finding which in part is confirmed in a recent systematic review [184], but where MVPA was found significantly associated with clustering of cardio metabolic risk factors. In a prospective study of British 12 year-olds, time spent in MVPA significantly predicted fat mass at age 14, but this study did not adjust for baseline fat mass [207]. There are good reasons for why time spent in MVPA could be expected to affect changes in adiposity in adolescents, and while systematic reviews generally conclude that physical activity does not predict adiposity, the evidence is mixed [79, 113, 155]. In the analyses of sedentary- and light activity, adjustment for time spent in MVPA did not substantially attenuate the associations with outcomes, but research has shown that being highly sedentary does not exclude a high volume of MVPA [55]. It has previously been suggested that the vigorous part of MVPA could be diluted because of epoch settings [167], wherein short bursts of vigorous activity are averaged over the selected epoch periods together with otherwise moderate, light or even sedentary intensities. This was most likely not the case in the present study, as the data was collected in 10-second epochs – meaning that time spent in different intensities stem from the average intensities of 10-second periods during wear time. Furthermore, epoch settings is perhaps an even more important consideration in accelerometer studies of children, where activity is more sporadic and in bursts rather than dedicated time for exercise.

The results in Paper III are supported, and may be explained, by findings in Paper II. However, in Paper II the exposure was hours per week of physical activity outside of school, whereas in Paper III the exposure was the mean time spent in different intensities of physical activity during the day as a whole. Thus, the two exposures measured slightly different aspects of physical activity, and are therefore not directly comparable. The self-reported level of physical activity used in the present thesis and the measures of objectively measured physical activity were nevertheless highly correlated. These particular results are included in a manuscript scheduled for submission to a journal in early 2021, and indicate that the hierarchy of the self-reported hours of physical activity during leisure time is reflected in the time spent in different objectively measured intensities in this particular cohort.

The results of both Paper II and Paper III conform to the findings of systematic reviews which found physical activity is not an important predictor of change in adiposity in adolescents [79, 113, 155]. One prospective study ascribed this to body composition showing more tracking than physical activity [208], which again implies that changes in habits play a role in this relationship. The findings in the present thesis suggests that a baseline measurement of physical activity in adolescents is perhaps less predictive of changes in body composition than changes in behavior itself. However, physical activity undoubtedly has physiological effects on body composition. The results must therefore be interpreted in light of two important traits of adolescence: i) the natural changes in body composition, and ii) the prevalent reduction in physical activity and changes to this habit that occur during this period.

6.3 Discussion of the association between physical activity and adiposity

6.3.1 Energy balance and the obesogenic environment

In considering the development of overweight and obesity, an understanding of the human physiology is necessary. Through natural selection and evolutionary processes, humans are highly adapted to conserving energy [34]. This is not specific to humans, as several other species rely on an ability to fill up energy stores when food is abundant and to conserve energy for times when the availability of food is limited. Furthermore, the human body is well adapted for energy-efficient locomotion, thus giving us a potential to walk long distances while expending relatively little energy [209]. The consequence, from a mathematical point of view, is that a relatively low mass of energy-dense food may take a long duration of relatively high-intensity activity to reach an equilibrium. In light of this, studies have shown that weight maintenance might be easier at high- than low energy flux [210-212]. In terms of efficiency, caloric restriction produces more weight loss in shorter time than increased calorie expenditure, but commonly advocates larger reductions in caloric intake than the usual goals for caloric expenditure in physical activity interventions [213]. While a diet-induced 500 calorie deficit is quite feasible, a substantial amount of physical activity is required to achieve the same deficit [214] and this has proven difficult to adhere to [215, 216]. However, the weight lost from calorie restriction is difficult to maintain [217]. A potential explanation might be that a strategy of caloric restriction for weight loss requires refraining from foods that are very appealing to most of us, and for long periods. Furthermore, the human body reacts rationally to calorie restriction. The dominant source of energy expenditure in humans is the basal metabolic rate, which is largely a product of the amount of lean mass in an individual [218]. By increasing energy expenditure through physical activity, there is potential for sustained weight loss because of the energy expenditure associated with increased physical activity, but also because of any increased lean mass and thus increased basal metabolic rate [210]. The human physiology exerts substantial pressure to regain weight lost [219], but the effects of these incentives to increase weight might be deterred by a simultaneous increase in energy expenditure. This allows for the individual to increase energy consumption after a diet has ended, while achieving energy balance at higher energy flux [217]– at which it is easier to maintain weight than at lower energy flux [210].

However, upholding changes to lifestyle is difficult over the long-term. In two school-based intervention studies [220, 221], the positive effects of physical activity on BMI had diminished at long term follow-up. This exemplifies the difficulties of maintaining habits once an intervention has ended, and illustrates why considerable resources must be devoted to follow-up should an intervention prove efficient.

The observed decline in level of physical activity from childhood/adolescence to adulthood are in some ways accepted and expected, given the different guidelines for level of physical activity between the two age groups. As such, the age of 18 years is a crude point at which recommended level of physical activity changes substantially, and it would be arbitrary to expect a sudden drop in physical activity corresponding to guidelines at this given age. As a result of the substantial changes that occur in both habits and body composition during adolescence, the association between physical activity and unhealthy weight gain is perhaps less apparent than in adults, and excessive energy intake may instead be the main driver of overweight and obesity in youth [184]. Natural, hormonally driven physiological changes may produce a situation where the amount of physical activity becomes relatively less significant on changes in body composition. This is not to say that physical activity is not important, but that it takes time (beyond adolescence) for a persistent low level of physical activity to manifest in fat mass accrual beyond that which is naturally expected. This is in contrast to for instance middle-aged adults, where the negative effects of sedentary behavior can have accumulated over decades [222]. Furthermore, physical activity is undertaken for a multitude of purposes; for transport, recreation, exercise, occupation and during activities of daily living. In the obesogenic environment there is less need to be physically active for many of these purposes, and the responsibility for low levels of physical activity in the population therefore lies not with individuals alone, but also on the societal structures that promote sedentariness. Evidence suggests that use of domestic labor saving devices has increased over the past decades [103]. In the same period there has been reductions in the amount of active transportation [223, 224] and occupational physical activity [69, 225]. While these transitions are the result of individual choices, the environment in which choices are made have changed and present individuals with a wide range of tempting energy saving options.

6.3.2 Displacement of physical activity

In most adults, the energy expelled through physical activity amounts to 15-30% of total energy expenditure [51], but physical activity can be divided into Non-Exercise Activity Thermogenesis (NEAT) and Exercise Activity Thermogenesis (EAT). In any study of physical activity and health outcomes, one should consider not only the isolated effect of exercise itself (EAT), but also what the exercise displaces. In a fixed time frame of 24 hours, of which approximately 8 hours is bound to sleep, any individual has 16 hours at disposal in their daily lives. The positive health effects of increasing time for exercise, may be limited by a simultaneous reduction in other activities than sedentary time [226]. However, a systematic review provided little evidence for displacement between sedentary behavior and physical activity [55]. In adolescents, a high level of sedentary time can occur also among those with a high level of MVPA [227]. This is not surprising, since adolescents are seated for the better part of school hours and sedentary activities are prevalent during leisure time. Indeed, in those meeting the MVPA guidelines in FF1, 67% had 2 or more hours per day of screentime outside of school. One might hypothesize that, in active adolescents, the amount of higher intensity activity does not displace sedentary time, but light activity such as passive- rather than active transportation to the gym or to practice. Similarly, in intervention studies, lack of an effect may be attributed to the intervention displacing activity of equal intensity [228]. In any case, as time is finite and restricted to 24 hours per day, it is obvious that different activities compete with each other. Preference for one activity over another naturally displaces the latter if they compete for the same time, but not if they are mutually exclusive. For instance, sleep is less likely to be displaced by exercise than by time spent playing computer games or other sedentary behavior [229], and the difference in energy expenditure between sleep and sedentary activities is negligible compared to that of sleep and vigorous exercise. Despite the logical mathematical association between adiposity and energy expenditure, in real world settings the relationship is not straightforward, and the association is perhaps more correct in theory than in practice.

6.3.3 Population versus high-risk strategy

For a continuous variable associated with mortality, such as BMI, the prevalence of people at risk of for instance cardiovascular disease will differ substantially according to where the cut-point for risk is set. Furthermore, according to Geoffrey Rose, the tails of the distribution of a variable, be it blood pressure, BMI, cholesterol etc., could be predicted by the mean of the same variable [4]. This implies that in a population with a mean BMI of 24, more people will be at risk for disease (as defined by a BMI > 25), than in a population with a mean BMI of 22. Rose argues that focusing on lowering the mean will be more effective than the strategy of focusing on the high-risk groups, i.e. the tails of the distribution.

Conversely, considering physical activity, a strategy of increasing the general level of physical activity in the population in order to prevent obesity may prove more efficient than getting the already obese to exercise. The latter point is particularly relevant, considering that no countries so far have experienced significant public health achievements concerning obesity prevention on a population level [230]. This is in contrast to for instance smoking cessation or infectious diseases, where many countries have delivered results in the latter decades [230]. One exception stems from Cuba, which experienced societal changes in the aftermath of the dissolution of the Soviet Union and the trade embargoes from the United States in the early 1990's. The consequences of less availability of fuel for transportation and lower food availability included an increase in the proportion of physically active adults (from 30% to 67%) and a 1,036 kcal reduction in per capita energy intake per day [231]. Faced with lack of mechanized transportation options, the Cuban government imported over one million bicycles. The mean BMI declined by 1.5 units, and the prevalence of obesity halved [231]. This so called "special period" in Cuba affected the entire population, and so was not a "high-risk" strategy targeting the obese alone. Therefore, the Cuban case is one of few examples of a population strategy, although unintended, for overweight and obesity, and thus confirms the theories of Geoffrey Rose [232]. Accordingly, implementation of population strategies to overweight and obesity may have considerable potential.

6.4 Perspectives on future research

The discussion of how physical activity may affect body composition in adolescence calls for further research, particularly using longitudinal data. Researchers interested in examining these associations should seek to employ validated and robust data on pubertal status and dietary habits, as these are two major confounders in the development of excess adiposity during adolescence. Furthermore, given that physical activity is a habit in constant decline throughout both childhood and adolescence, future cohort studies would benefit from including data on: past levels of physical activity; the motivational aspects of engaging in physical activity; barriers and promotors of physical activity, and; the different arenas in which physical activity is conducted. Because people engage in physical activity for various reasons, such aspects would be of high value in designing interventions and prevention strategies for a successful halt to the obesity epidemic. Understanding these complex patterns, and why some remain physically active while others do not, require data and research using both quantitative and qualitative methods. As a consequence of the variability of physical activity during adolescence, future research should seek to gather data on both exposure (physical activity) and outcome (body composition) at several time points during the study period.

Because excess adiposity is the result of prolonged calorie surplus [2] a lag-effect may be present, in which low levels of physical activity need time to manifest in excess adiposity. This may be particularly true for adolescent populations, where sex-hormones drive changes in both fat- and lean mass. This could potentially deter increases in fat mass which would otherwise be associated with caloric surplus, simply as an effect of increased resting metabolic rate because of natural increases in lean mass. The consequence is that low levels of physical activity perhaps does not lead to development of excess adiposity during a limited time frame of two years. Currently there are plans for a third Fit Futures survey, starting in late 2020 or early 2021. Data from this survey will enable researchers to assess how low levels of physical activity during upper secondary high school is associated with increases in body composition up to young adulthood. This is a research area of great potential, because the transition from adolescence to adulthood is also associated with substantial changes in lifestyle [158]. To what extent lifestyle habits persist into adulthood are important areas of research to assess the long-term efficacy of interventions and behavioral policies during adolescence.

7.0 Conclusions

This thesis has demonstrated that the included measures of physical activity is consistently unrelated to body mass index. At the cross-sectional level, both fat- and lean mass indexes were linearly associated with self-reported physical activity for both sexes: fat mass index was reduced and lean mass index increased with higher levels of physical activity.

These associations did generally not remain in longitudinal analyses, with a lack of clear linear associations between self-reported physical activity at baseline and changes in body composition. Changes in self-reported physical activity between the two surveys did however predict changes in fat mass index in boys and lean mass index in girls. The latter finding may partly explain why a baseline measurement of physical activity was not associated with changes in body composition.

In girls, objectively measured sedentary- and light physical activity was associated with changes in indices of lean mass: higher amount of sedentary time predicted lower increases in indices of lean mass, and conversely did more time in light activity predict higher increases. No significant associations were observed in boys.

In conclusion, there is only minor evidence for a prospective association between physical activity and changes in body composition over two years of follow-up in Norwegian adolescents, whereas changes in physical activity during follow-up appears to be associated with changes in some of the indices of body composition.

8.0 Implications for public health

This thesis has shown that the level of physical activity in Norwegian adolescents is lower than desired, but perhaps not lower than expected. In the field of public health the merit of a preventive measure is judged by its efficacy and its cost-efficiency, but a key assumption for its effective application is that the population for which the measure is intended complies. For physical activity, the problem lies perhaps not in costs or effectiveness, but in compliance among groups at risk of disease. Given the breadth of morbidity for which physical activity is a remedy or a preventive measure, these groups include much of the population. However, whether physical activity is part of the solution for reducing excess adiposity is not a prerequisite for action. Because inactivity takes time to manifest itself in excess adiposity, the link between reduced activity and weight gain may not be that apparent to adolescents. The positive effect of physical activity on future health may not be a sufficient argument for this age group [233], as adolescents likely emphasize or perceive the health effects of physical activity differently from adults [14, 234]. Individuals who put less emphasis on potential health benefits in the distant future may be less inclined to be physically active for health purposes, or to avoid consumption of sweets because the immediate gratification outweighs the possible future health rewards associated with restraint [235]. For adolescents the period of life where the negative health effects of a sedentary lifestyle occur are less proximal than in adults. This is a challenge when promoting physical activity to adolescents, and means that health officials may have more success with other arguments than those of increased life expectancy or better health in the distant future. The health benefits of physical activity may therefore be a better selling point to those individuals where lifelong effects of inactivity has manifested itself in health problems or adiposity. From a public health perspective, physical activity should be encouraged at all ages, but for the individual the reasons- and possibilities for engaging in physical activity are subject to variation, and may partly explain why an association with changes in body composition is less apparent in adolescents.

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Papers I-III

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REGULAR ARTICLE

Self-reported physical activity during leisure time was favourably associated with body composition in Norwegian adolescents

Nils Abel Aars (nils.a.aars@uit.no)[1,2], Bjarne K. Jacobsen[1], Anne-Sofie Furberg[1,3], Sameline Grimsgaard[1]

1.Department of Community Medicine, UiT The Arctic University of Norway, Tromsø, Norway
2.Nordland Hospital, Bodø, Norway
3.Department of Microbiology and Infection Control, University Hospital of North Norway, Tromsø, Norway

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Correspondence
NA Aars, Department of Community Medicine, UiT The Arctic University of Norway, 9037 Tromsø, Norway.
Tel: +47 77 64 48 16 |
Fax: +47 77 64 48 31 |
Email: nils.a.aars@uit.no

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ABSTRACT

Aim: We studied the cross-sectional association between self-reported physical activity and body composition in adolescents.

Methods: The Norwegian Fit Futures Cohort Study was conducted in the Tromsø and Balsfjord municipalities during 2010–2011. All 1,117 students in their first year of upper secondary high school were invited to attend an examination at the Clinical Research Unit at the University Hospital of Northern Norway and 93% agreed. After exclusions, we analysed 945 participants (51% boys) with a mean age of 16.1 years (range 15.5–17.5 years) with valid measurements. The associations between self-reported weekly hours of physical activity during leisure time and four measures of body composition were explored using linear regression.

Results: Self-reported physical activity was significantly associated with the fat mass index ($p < 0.03$) and lean mass index ($p < 0.001$) in both genders. The lean mass index increased with higher levels of activity and the fat mass index decreased. Physical activity was not associated with body mass index for either gender, but there was an inverse association with waist circumference in girls ($p = 0.04$).

Conclusion: Physical activity was favourably associated with body composition in Norwegian adolescents and showed contrasting associations with the fat mass and lean mass indexes.

INTRODUCTION

High body mass index is the fourth largest contributor to disability-adjusted life years worldwide (1) and represents a major challenge for the public health of adults, children and adolescents. Adolescents who are overweight or obese have higher rates of several cardiovascular risk factors (2) and are more likely than normal weight adolescents to develop type 2 diabetes and cardiovascular disease in early adulthood (3). In 2001–2004, the prevalence of overweight and obesity was 14% among Norwegian adolescents aged 15–16 years (4), with a higher prevalence in the northernmost regions. In the Nord-Trøndelag county in central Norway, the prevalence of overweight and obesity was 26% for boys and 23% for girls in 2006–2008 (5).

In simple terms, overweight and obesity results from an energy imbalance, where the calorie intake exceeds caloric expenditure. This emphasises the importance of physical activity, which is a habit that has been reported to decline throughout adolescence. Despite this, the relationship between physical activity and overweight and obesity in adolescents is complex. Studies have shown that genetics (6), social and demographic characteristics (7) and lifestyle factors (8) are all major determinants of overweight and obesity in this age group. The prevalence of physical inactivity has been reported to increase with age and has emerged as an independent risk factor for non-communicable diseases and premature mortality (9). Adolescents are particularly at risk, as their activity habits tend to persist from adolescence into adulthood (10). Developing a better understanding of the relationship between physical activity and body composition in adolescents is necessary to prevent future overweight and obesity.

Key notes

- This study examined the cross-sectional association between self-reported physical activity and body composition in 945 Norwegian adolescents with a mean age of 16.1 years.
- The lean mass index increased with higher levels of activity and the fat mass index decreased in both genders.
- Physical activity was not associated with body mass index for either gender, but there was an inverse association with waist circumference in girls.

Several measures of anthropometry and body composition may be used to investigate adiposity, and body mass index is arguably the most common. However, the specificity of body mass index is limited by an inability to distinguish fat mass from fat-free mass. This has been a problem in studies on the association between physical activity and adiposity, because both high fat mass and high muscle mass can produce a high body mass index (11). The inclusion of measures of adiposity other than the body mass index in studies of adolescent populations has therefore been advocated. These include the fat mass index, which is fat mass in kilograms divided by height in meters squared, and the lean mass index, which is lean mass in kilograms divided by height in meters squared (12). Studies of the association between leisure time physical activity and more specific measures than body mass index are generally less common. Theoretically, such tissue-specific measures of body composition may be more relevant to an association with physical activity, but no studies have investigated this relationship in Norwegian adolescents.

Our aim was to study the associations between self-reported physical activity during leisure time and four different measures of adiposity in adolescents, with a mean age of 16.1 years, who participated in the first survey of the Tromsø Study Fit Futures.

METHODS AND MATERIALS

Study population

The Tromsø Study Fit Futures was a population-based study conducted among adolescents in northern Norway in 2010–2011. All students in their first year of upper secondary high school in the neighbouring municipalities of Tromsø and Balsfjord were invited to take part, providing a possible cohort of 1,117 boys and girls. Altogether 1,038 (93%) answered questionnaires and attended the examination at the Clinical Research Unit, University Hospital of North Norway, where trained research nurses performed all the clinical measurements. Written, informed consent was obtained from all participants and those aged less than 16 years brought written, informed consent from their parents. The study was approved by the Regional committee for medical and health research ethics. We excluded 77 participants aged 18 years or above and 16 participants without a valid measurement of physical activity, body height, body weight, waist circumference or dual-energy x-ray absorptiometry from the analyses. Thus, 945 adolescents (51% boys) were included in the present study.

Variables and measurements

Body weight was measured to the nearest 100 g with light clothing and height to the nearest 0.1 cm on a Jenix DS 102 automatic electronic scale/stadiometer (Dong Sahn Jenix, Seoul, Korea). We applied the International Obesity Task Force body mass index reference values for adolescent populations to classify participants as either underweight, normal weight, overweight or obese, using ages in half years. The classification terms for categories of body mass index corresponded to the adult classifications (13,14).

Waist circumference was measured to the nearest centimetre at the height of the umbilicus after expiration. We classified participants to be abdominally normal weight, overweight or obese, depending on their age, using age in half years and the reference values defined by Brannsether et al. (15). Abdominal obesity was defined as a waist circumference at or above the 95th percentile in Norway (15).

The Fit Futures Study used the GE Lunar Prodigy dual-energy x-ray absorptiometry scanner (Lunar Corporation, Wisconsin, USA) to measure total body fat mass and lean mass in the participants. These measures were divided by height in metres squared to calculate the fat mass index and lean mass index.

The participants were asked whether they were physically active outside school hours and those that said no were labelled as physically inactive. Those that said yes were asked how many hours per week they were physically active outside school, with possible answers ranging from none to more than seven hours. This question was identical to the one used for duration of physical activity in the Health Behaviour in School Children study, which has been validated for an adolescent population (16). Two of the participants answered none and were included in the group of inactive participants. Those who reported being active for about half an hour or about one to one and a half hours were combined, while the other responses remained unaltered. Together they formed the categorical exposure variable of physical activity used in the analyses.

As a measure of socio-economic status, we used their high school specialisation, which was either vocational subjects or general subjects. Participants were asked about their parents' education, which is a more common measure of socio-economic status, but 26.1% and 29.1% reported not knowing either their maternal or paternal level of education, respectively. Participants specialising in vocational subjects were more likely to say they did not know. We also adjusted the data for food habits, based on how often they ate breakfast: rarely/never, one to three times per week, four to six times per week or every day. Because body composition is closely connected to age, we also adjusted for their age in half years, which ranged from 15.5–17.5 years of age. Lastly, we also adjusted for screen time on weekdays, asking participants how many hours per day they spent on their computer, watching television and screen-based activities outside school hours. The possible responses ranged from none to 10 hours or more. Altogether, there were three boys and six girls with missing data on one or more of the adjustment variables and they were excluded from the regression analyses.

Statistical methods

All analyses were stratified by gender. We used descriptive statistics to determine the prevalence of overweight and obesity in the study population, as well as mean body mass index, waist circumference, fat mass index and lean mass index, with 95% confidence intervals (95% CI). Descriptive characteristics were reported as means and standard deviations (SD) for continuous variables and number of subjects and percentages for categorical variables. In the analyses, we have presented estimates of body mass index, waist circumference, fat mass index and lean mass index, with 95% CIs, across the levels of physical activity, with crude and adjusted p values for linear trend. A two-sided p value of <0.05 was considered statistically significant.

All statistical analyses were performed using STATA, version 14 (StataCorp, Texas, USA).

RESULTS

The characteristics of the study population are shown in Table 1. The mean age was 16.1 years and the mean body mass index was 22.4 kg/m^2 for both boys and girls. Approximately 6% were underweight, 70% had normal weight, around 15% were overweight and around 6% were classified as obese. Waist circumference was lower in girls than boys, but according to age-specific cut-offs for waist circumference, the prevalence of abdominal obesity was lower in boys (22%) than in girls (34%). The mean fat mass index in boys was lower than in girls (4.7 and 7.5 kg/m^2, respectively), while the mean lean mass index was higher in boys than in girls (17.1 and 14.1 kg/m^2, respectively). Approximately one-third of both the boys and girls were not physically active during their leisure time.

Table 2 displays the mean body mass index, waist circumference, fat mass index and lean mass index for boys and girls, according to the number of hours per week they were physically active during their leisure time. There was no linear relationship between self-reported physical activity and body mass index for either gender. In the unadjusted analyses, waist circumference in boys was inversely associated with physical activity with borderline statistically significance ($p = 0.05$). This association was attenuated after adjustments ($p = 0.25$). In girls, there was a statistically significant, inverse relationship between physical activity and waist circumference in both the unadjusted ($p = 0.001$) and adjusted ($p = 0.04$) analyses, with the more active subjects having a lower waist circumference than the inactive subjects. In both the unadjusted and adjusted models, and for both genders, there was a significant linear association between physical activity and the fat mass index ($p \leq 0.03$), with a lower fat mass index associated with increasing levels of activity. Conversely, a significant linear positive relationship ($p < 0.001$) was found between activity levels and the lean mass index in both boys and girls.

Table 1 The characteristics of the participants aged 15–17 years in the Tromsø Fit Futures Cohort Study from 2010-11†

	Boys (n = 483)	Girls (n = 462)
Age, years	16.1 (0.5)	16.1 (0.4)
Height, cm	176.9 (6.7)	164.9 (6.5)
Body weight, kg	70.2 (14.4)	60.9 (11.5)
Body mass index, kg/m^2	22.4 (4.2)	22.4 (4.0)
Body weight category‡		
Underweight	7.9 (38)	5.2 (24)
Normal weight	68.7 (332)	74.2 (343)
Overweight	16.2 (78)	14.9 (69)
Obese	7.3 (35)	5.6 (26)
Waist circumference, cm	82.0 (11.3)	77.2 (10.1)
Waist circumference category§		
Normal	60.0 (290)	44.2 (204)
Abdominal overweight	18.4 (89)	21.7 (100)
Abdominal obesity	21.5 (104)	34.2 (158)
Fat mass index, kg/m^2¶	4.7 (3.4)	7.5 (3.2)
Lean mass index kg/m^2††	17.1 (1.7)	14.1 (1.3)
Leisure time activity, hours per week		
Inactive	34.4 (166)	31.8 (147)
About 0.5–1.5 hours	9.9 (48)	9.1 (42)
About 2–3 hours	15.7 (76)	19.3 (89)
About 4–6 hours	20.1 (97)	26.0 (120)
≥7 hours	19.9 (96)	13.9 (64)

†Values are means with standard deviations (SD) or prevalence in percentages (number of subjects).
‡Categories of body mass index (body mass in kg/height in metres^2) according to the International Obesity Task Force reference-standard for adolescent populations (13,14).
§Waist circumference categories according to adult classifications, using reference populations developed by Brannsether (15).
¶Fat mass index is calculated as fat mass in kg/height in metres^2.
††Lean mass index is calculated as lean mass in kg/height in metres^2.

DISCUSSION

We carried out a cross-sectional, population-based study of the relationships between self-reported physical activity and measured body composition among adolescents. This showed that there was a consistent relationship between hours per week of physical activity during leisure time and the fat mass and lean mass indexes. As activity rose, the fat mass index decreased while the lean mass index increased. Fat mass and lean mass index data have not been published previously on adolescents in Norway. Our findings show that high levels of physical activity during leisure time were associated with a favourable body composition in adolescents. There was no significant linear trend in body mass index across hours of physical activity in boys or girls, and only a borderline relationship ($p = 0.04$) was found for waist circumference in girls.

Physical activity has contrasting effects on the fat mass and lean mass indexes (17). Thus, both high and low levels of physical activity may result in the same body mass index through the opposing effects on the two indexes. This relationship is demonstrated in a Hattori chart, which illustrates how the same percentage of body fat or body mass index may be present at different combinations of the fat mass and lean mass indexes (12). In normal weight individuals, a higher body mass index may reflect either a high fat mass or a high lean mass. This may explain the lack of association between physical activity and the body mass index in our study. Such an effect is less likely with a lower body mass index, since both the lean mass and fat mass have to be at low levels to arrive at a body mass index in the

Table 2 Mean body mass index, waist circumference, fat mass index and lean mass index†, with 95% confidence intervals among boys and girls aged 15–17 years in the Tromsø Fit Futures Cohort Study from 2010 to 2011, according to hours per week of physical activity in leisure time

	n	Body mass index	Waist circumference	Fat mass index	Lean mass index
Boys					
Hours per week of physical activity	480				
None (0 hours)	166	22.7 (21.9–23.4)	83.1 (81.1–85.1)	5.4 (4.8–6.0)	16.6 (16.4–16.9)
0.5–1.5 hours	47	21.9 (20.8–22.9)	82.0 (78.7–85.3)	4.8 (3.9–5.7)	16.5 (16.2–16.9)
2–3 hours	75	22.1 (21.2–23.1)	81.0 (78.6–83.4)	4.6 (3.9–5.4)	16.9 (16.6–17.2)
4–6 hours	96	23.0 (22.2–23.9)	83.4 (81.2–85.7)	4.8 (4.2–5.5)	17.7 (17.3–18.0)
≥7 hours	96	21.7 (21.2–22.2)	79.4 (78.0–80.9)	3.3 (2.9–3.7)	17.9 (17.6–18.2)
p value for linear trend		0.27	0.05	<0.001	<0.001
Adjusted p value for linear trend‡		0.90	0.25	0.004	<0.001
Girls					
Hours per week of physical activity	456				
None (0 hours)	143	22.6 (21.9–23.2)	78.9 (77.1–80.8)	8.0 (7.5–8.6)	13.8 (13.6–13.9)
0.5–1.5 hours	42	22.6 (21.2–23.9)	77.3 (74.3–80.3)	7.8 (6.8–8.8)	14.0 (13.6–14.4)
2–3 hours	89	22.7 (21.8–23.7)	77.9 (75.6–80.2)	7.9 (7.2–8.7)	14.0 (13.7–14.3)
4–6 hours	118	22.2 (21.6–22.9)	76.1 (74.6–77.6)	7.1 (6.6–7.6)	14.4 (14.2–14.7)
≥7 hours	64	21.8 (21.1–22.5)	74.1 (72.1–76.1)	6.3 (5.7–6.9)	14.8 (14.4–15.1)
p value for linear trend		0.18	0.001	<0.001	<0.001
Adjusted p value for linear trend‡		0.86	0.04	0.03	<0.001

†Body mass index equals body mass in kg/height in m^2, waist circumference measured in cm, fat mass index equals fat mass in kg/height in m^2, lean mass index equals lean mass in kg/height in m^2.
‡Adjusted for screen time on weekdays, age in half years, regularity of eating breakfast and study specialisation.

lower range (18). The influence of sex steroid hormones on sex differences in body composition during adolescence is important. During adolescence, girls experience more fat mass accrual than boys and boys experience greater increases in lean mass than girls (19,20). In accordance with this, we found a higher mean fat mass index in girls than boys and a higher lean mass index in boys than girls. However, it has been reported that even a small difference in lean mass may have a substantial effect on increase in fat mass, since muscles are particularly important for oxidisation of fat (21). Another study found that those with higher lean mass could have higher resting metabolism through the effect of increased muscle mass (22). The effect of regular physical activity on lean mass is, therefore, important when it comes to preventing overweight and obesity. This is because of the immediate effect of activity itself and also because of the long-term effects of having an increased resting metabolic rate (23). It has also been suggested that higher levels of physical activity can ease the maintenance of energy balance (24), as a sustained caloric surplus will lead to increased adiposity over time (21). Our results showed a linear association between physical activity and both the fat mass and lean mass indexes, confirming previous findings that leisure time activity was favourably associated with body composition in adolescents on a cross-sectional level (25).

We found that the prevalence of general overweight and obesity in this group of adolescents was similar to other regions in Norway (26). The prevalence of obesity was approximately 6%, with no difference between boys and girls, which was close to results from a survey performed in central Norway in 2006–2008 (5). The prevalence of abdominal obesity was 22% in boys and 34% in girls in the present study, which was higher than the prevalence of obesity, as defined by the body mass index. The large differences between measures of body composition suggest that the prevalence of abdominal and general obesity is not directly comparable. A longitudinal study of adolescents showed that the increase in waist circumference surpassed that of the body mass index and concluded that the body mass index systematically underestimated the prevalence of obesity in adolescents (27). The authors proposed that an increase in fat mass had been obscured by a reduction in muscle mass, suggesting waist circumference was a better measure of fat mass than the body mass index.

A study of Swedish adolescents reported a mean fat mass index of 5.8 in girls and 3.8 in boys (28). This was slightly lower than our results, but this cohort had a mean age of 15.2 and the fat mass index was calculated using bioimpedance rather than dual-energy x-ray absorptiometry. Nordic data on the lean mass index in adolescents have not been published. According to American reference curves for the lean mass index, the age-specific and gender-specific 50th percentiles were 16.9 for boys and 14.4 for girls, which were similar to our results (29).

Our findings suggest that more precise measures of overweight and obesity than body mass index or waist circumference are preferable when studying associations between physical activity and body composition. This lack of precision may explain the conflicting results that have previously been reported on these associations (30). In addition, the diversity in methodology and chosen measures of exposure and outcomes may have led to variations in the reported associations between physical activity and body composition (17). The multifactorial causes of adiposity must also be considered. Higher levels of activity have been associated with higher energy expenditure, but the influence of demographics, lifestyle and genetic factors makes it challenging to study the isolated effect of physical activity on body composition. The ability of self-reported physical activity to predict body mass index or other measures of body composition may also be questionable, as people are active for different reasons. Lastly, adiposity can be the result of relatively small imbalances in energy intake and expenditure over time, which may cause substantial differences in the body composition. Whether this is the case in the present study could be examined by a follow-up study of the Fit Futures cohort.

Our study had some limitations. There are inherent challenges in studying the relationship between physical activity and body composition using cross-sectional designs, particularly in adolescent populations, because they are subject to natural body changes during puberty. We were unable to ascertain the direction of the associations reported, meaning reverse causality may have been present. If that was the case, a high level of adiposity could have caused either lower or higher levels of physical activity. Questionnaire data on physical activity are prone to measurement errors and may lead to inaccurate estimates of the activity habits of participants. Other aspects of physical activity, such as the intensity of the activity or exertion, may result in a different relationship with body composition than we observed with self-reported hours per week. The Fit Futures study did not include a validated comprehensive questionnaire on food, and we were unable to fully adjust for this potential confounder. We did adjust for regularly eating breakfast, which may influence weight status through consumption of energy-dense foods later in the day.

The study also had several strengths. The participation rate of 93%, before exclusions, was high and ensures that the results were representative of the study population. All the clinical measurements were performed by trained staff, thereby reducing reporting bias and measurement errors. We also included four different measures of body composition in our analyses, which enabled us to carry out comparisons between the instruments and produce a more detailed description of the anthropometry of the cohort.

CONCLUSION

In this cross-sectional study of 945 adolescents, the prevalence of obesity was approximately 6% and more than 30% of both the boys and girls were inactive during their leisure time. The fat mass index declined, and the lean mass index increased significantly in both genders when the self-reported number of hours of activity increased. This means that physical activity during leisure time was correlated with both the fat mass index and lean mass index. We also found that the fat mass index provided a more specific measure of unhealthy weight than the body mass index.

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CONFLICTS OF INTEREST

The authors declare that they have no competing interests.

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Longitudinal changes in body composition and waist circumference by self-reported levels of physical activity in leisure among adolescents: the Tromsø study, Fit Futures

Nils Abel Aars[1,2*], Bjarne K. Jacobsen[1,3], Bente Morseth[1,4], Nina Emaus[5] and Sameline Grimsgaard[1]

Abstract

Background: It is not clear how physical activity affects body composition in adolescents. Physical activity levels are often reduced during this period, and the relative proportion of body fat mass and lean mass undergo natural changes in growing adolescents. We aimed to examine whether self-reported physical activity in leisure time at baseline or change in activity during follow-up affect changes in four measures of body composition; body mass index (kg/m^2), waist circumference, fat mass index (fat mass in kg/m^2) and lean mass index (lean mass in kg/m^2).

Methods: We used data from the Tromsø Study Fit Futures, which invited all first year students in upper secondary high school in two municipalities in northern Norway in 2010–2011. They were reexamined in 2012–2013. Longitudinal data was available for 292 boys and 354 girls. We used multiple linear regression analyses to assess whether self-reported level of physical activity in leisure time at baseline predicted changes in body composition, and analysis of covariance to assess the effects of change in level of activity during follow-up on change in body composition. All analyses were performed sex-specific, and a *p*-value of < 0.05 was considered statistically significant.

Results: There were no associations between self-reported leisure time physical activity in the first year of upper secondary high school and changes in any of the considered measure of body composition after 2 years of follow up, with the exception of waist circumference in boys ($p = 0.05$). In boys, change in fat mass index differed significantly between groups of activity change ($p < 0.01$), with boys adopting activity or remaining physically active having less increase in fat mass index than the consistently inactive. In girls, change in lean mass index differed significantly between groups of activity change ($p = 0.04$), with girls adopting physical activity having the highest increase.

Conclusions: Self-reported leisure time physical activity does not predict changes in body composition in adolescents after 2 years of follow up. Change in the level of physical activity is associated with change in fat mass index in boys and lean mass index in girls.

Keywords: Adolescence, Body composition, Longitudinal study, Physical activity

* Correspondence: nils.a.aars@uit.no
[1]Department of Community Medicine, UiT The Arctic University of Norway, 9037 Tromsø, Norway
[2]Nordland Hospital, Bodø, Norway
Full list of author information is available at the end of the article

Background

Overweight or obesity in adolescence is a major risk factor for the same conditions as an adult [1], and therefore a risk factor for cardiovascular disease, type II diabetes, several types of cancer and musculoskeletal disorders in adulthood [2]. More than 20% of adolescents in Norway were in 2010 classified as overweight or obese [3]. Among adolescents in the Western world there is evidence for a plateauing of the obesity epidemic at a high level [4]. In Norwegian men and women, the prevalence of both overweight and obesity is increasing [5–7]. Studies have shown that adolescent lifestyle tend to persist into adulthood [8, 9], emphasizing the importance of preventing overweight and obesity in this period of life. A systematic review on the relationship between body composition and physical activity in adolescents showed conflicting results, with reverse causality suggested as a possible explanation – meaning that overweight and obesity could be both a cause and an effect of low physical activity [10]. The relationship is further complicated by associations with sedentary behavior, nutrition, socioeconomic status and genetics [11–14].

There are several ways to quantify physical activity in adolescents. The use of direct observation of individuals or doubly labelled water has been suggested as gold standards, but questionnaire data are more feasible, domain specific and common in observational studies [10]. However, it must be acknowledged that self-reported physical activity tends to exaggerate the true amount of physical activity when compared to data from, for instance, accelerometers [15].

Arguably, the most common measure of body composition is body mass index (BMI, body weight in kg/m^2), but its ability to identify changes in adiposity is limited as it does not distinguish between changes in fat mass and changes in lean mass [16]. This is a challenge when studying body composition in growing adolescents because boys naturally tend to gain more muscle mass than girls, while girls naturally gain more fat mass [17]. In addition to BMI, we therefore included waist circumference, fat mass index (FMI, fat mass in kg/m^2) and lean mass index (LMI, lean mass in kg/m^2) as measures of body composition in the present study. Waist circumference is an anthropometric measure which is specific to abdominal fatness [18]. FMI and LMI has been advocated as good measures of changes in adiposity in longitudinal studies because they measure fat mass and lean mass in relation to height [17, 19]. There are few studies investigating the longitudinal association between self-reported physical activity and tissue specific measures of body composition in adolescents [10], with a majority of those available using BMI as the primary outcome. To our knowledge, no studies modelling the association between physical activity and changes in FMI or LMI have been performed in Norway. Some international evidence points to a positive association between physical activity over the course of adolescence and LMI at age 18, but a less clear relationship with FMI [20]. Furthermore, higher self-reported physical activity has been associated with a positive change in lean mass [21], but not in fat mass [22].

We examined whether self-reported physical activity during leisure time was associated with change in measures of body composition after 2 years in upper secondary school in a cohort of adolescents in northern Norway; from a first measurement in 2010–2011 to a second measurement in 2012–2013. We further investigated whether changes in body composition differ between adolescents who are persistently inactive, persistently active, adopt activity or quit activity over the same period.

Methods

The Tromsø Study Fit Futures is a population-based cohort study, conducted in 2010–2011 (Fit Futures 1) and repeated in 2012–2013 (Fit Futures 2). The study invited all students in their first (Fit Futures 1) and third (Fit Futures 2) year of upper secondary school in the neighboring municipalities of Tromsø and Balsfjord in northern Norway. Fit Futures 1 invited 1117 students, with 1038 (93%) attending. Fit Futures 2 invited 1130 students and 870 (77%) attended. The participants in both studies answered a questionnaire and underwent a clinical examination at the clinical research unit at the University Hospital in Northern Norway, as detailed previously [23]. The present study includes only those participating in both Fit Futures 1 and Fit Futures 2. We excluded participants aged 18 years or older at baseline (Fit Futures 1), those without valid measurements of BMI, waist circumference, FMI and LMI at baseline and follow-up, and participants without information on physical activity at baseline. Altogether 292 boys and 354 girls were eligible for analyses.

Body weight was measured to the nearest 100 g with light clothing and height was measured to the nearest 0.1 cm on a Jenix DS 102 automatic electronic scale/stadiometer (Dong Sahn Jenix, Seoul, Korea). Waist circumference was measured to the nearest cm after expiration and at the height of the umbilicus. Total body fat mass and total body lean mass was measured using GE Lunar Prodigy dual-energy x-ray absorptiometry scanner (Lunar Corporation, Madison, Wisconsin, USA). Lean mass is comprised of all bodily tissue except fat and bone. Based on these measurements, Fat Mass Index (FMI, fat in kg/height in meters^2) and Lean Mass Index (LMI, lean mass in kg/height in meters^2) was calculated.

The prevalence of overweight or obesity in Fit Futures 1 was determined by applying the International Obesity Task Force body mass index reference values for adolescent populations, using age in half years [24, 25]. The participants were classified as underweight, normal weight, overweight or obese. These reference values correspond to an adult (aged 18 and above) BMI of < 18.5 kg/m^2, 18.5 ≤ BMI < 25 kg/m^2, 25.0 ≤ BMI < 30 kg/m^2, and BMI ≥ 30.0 kg/m^2, respectively.

The outcomes in this study were change in BMI, waist circumference, FMI and LMI between Fit Futures 1 and Fit Futures 2. The other variables included in the analyses were derived from the questionnaires. Our primary exposure was self-reported physical activity in leisure time, measured using the question "*Are you physically active outside school hours? Yes/no*". Those answering "*No*" were labelled as physically inactive. Those answering "*Yes*" were asked "*How many hours per week are you physically active outside of school hours?*". This question was used in the Health Behavior in School Children study and was validated for an adolescent population [26]. There are six response categories, from none to more than 7 h per week. One person in Fit Futures 1 reported "*none*" on this question, and was therefore also labelled as physically inactive. "*About half an hour*" and "*About 1 to 1.5 hours*" were combined, while the other responses were maintained unaltered. Together they formed the categorical physical activity variable used in the analyses.

Change in physical activity from baseline to follow up was defined by a dichotomous variable – "Active/inactive" – created based on the physical activity variable as described above. Being active was defined as physical activity ≥2 h per week. Those who were active in both surveys were labelled "consistently active" and those who were inactive in both were labelled "consistently inactive". The participants who became active between surveys (increased level of activity from < 2 h to ≥2 h per week) were labelled "adopters". Participants who reduced their level of activity from ≥2 h to < 2 h per week were labelled "quitters". A similar approach has been used in other studies [27, 28]. In addition to the primary exposures, we included baseline measurements of hours per weekday outside of school hours spent in front of a computer or TV (screen time), age in half years, study specialization (which was either general, sports or vocational subjects) and regularity of eating breakfast in the analyses as possible confounders.

Puberty is associated with body composition in adolescents, but in this particular cohort, data from the Pubertal Development Scale (PDS) was missing in a substantial number (17.8%) of boys. We explored the effect of adjusting for PDS or age at menarche (in girls) in complete case analyses, but as this had no substantial impact on results, we did not include the variables in the final model.

Statistics

Results are presented sex-specific. We used descriptive statistics to determine the prevalence of overweight and obesity, levels of physical activity, mean values of BMI, waist circumference, FMI and LMI at baseline and follow-up as well as changes in BMI, waist circumference, FMI and LMI. Categorical variables were presented as proportions in percentages with number of subjects (n), while continuous variables were presented as means with standard deviation (SD) (Table 1). The associations between baseline physical activity and longitudinal changes in BMI, waist circumference, FMI and LMI were assessed using linear regression, with hours of physical activity coded to reflect the number of hours they represent. The associations with changes in activity status were assessed by analysis of covariance. As current body composition may affect the associations between physical activity and change in body composition, we adjusted all analyses for the baseline values. In the fully adjusted model we also included baseline measurements of sedentary behavior (screen time), study specialization, regularity of eating breakfast and age in half years, in addition to the time between baseline and follow-ups. We have presented adjusted beta coefficients for change in outcome at each level of physical activity at baseline (Table 2) or change in activity status (Table 3 and Table 4 in Appendix). A p-value of less than 0.05 was considered significant.

All statistical analyses were performed using STATA, version 14 (StataCorp, College Station, Texas, USA).

Results

Table 1 shows the descriptive characteristics of the study population. Mean BMI increased by 1.2 units for boys, and 0.8 units for girls between the surveys. On average, boys experienced a larger increase of both body height and body weight than girls. In boys, the combined prevalence of overweight and obesity (BMI ≥ 25) increased from 21.2 to 28.1%, while for girls it increased from 18.9 to 20.9%. Waist circumference increased less in girls (1.1 cm) than in boys (3.2 cm). Both sexes experienced a similar increase in FMI (0.7 kg/m^2 in boys and 0.6 kg/m^2 in girls). Boys experienced a small increase in LMI (0.4 kg/m^2), whereas in girls there was no change. The proportion of adolescents classified as active in leisure time (active ≥ 2 h per week) decreased by 6%-points for boys and 12.2%-points for girls between the surveys.

There was no statistically significant linear effect of physical activity levels reported in 2010–2011 on change in neither BMI, FMI nor LMI during the following 2 years (Table 2). This was true for both sexes and also after adjustments. There were indications of a linear, inverse relationship with waist circumference in boys (p = 0.05), whereas a non-significant positive relationship was seen in girls. The most active boys gained less in BMI, waist circumference and FMI relative to the inactive, albeit not statistically significant. In contrast, the most active girls experienced a statistically significant higher adjusted increase in BMI (0.74 (95% CI: 0.04, 1.44)),

Table 1 Characteristics of the longitudinal cohort of the Tromsø Study; Fit Futures 2010–11 and Fit Futures 2012–13[a]

	Boys (*n* = 292)		Girls (*n* = 354)	
	FF1	FF2	FF1	FF2
Age (years)	16.1 (0.4)	18.2 (0.4)	16.1 (0.4)	18.2 (0.4)
Height (cm)	177.3 (6.5)	179.1 (6.5)	165.0 (6.5)	165.7 (6.6)
Body weight (kg)	69.9 (13.7)	75.3 (14.7)	60.4 (10.7)	63.1 (12.0)
Body mass index (BMI)	22.2 (3.9)	23.4 (4.2)	22.2 (3.8)	23.0 (4.2)
Body weight category[b]				
Underweight (BMI < 18.5)	8.6 (25)	8.2 (24)	5.9 (21)	4.5 (16)
Normal weight (18.5 ≤ BMI < 25)	70.2 (205)	63.7 (186)	75.1 (266)	74.6 (264)
Overweight (25 ≤ BMI < 30)	14.7 (43)	19.9 (58)	14.1 (50)	14.7 (52)
Obese (BMI ≥ 30)	6.5 (19)	8.2 (24)	4.8 (17)	6.2 (22)
Waist circumference (cm)	81.5 (11.0)	84.7 (11.8)	76.6 (9.6)	77.7 (11.1)
Total Body Fat Mass (kg)	14.3 (10.6)	16.7 (11.6)	19.8 (8.2)	21.6 (9.3)
Fat Mass Index (FMI)	4.5 (3.3)	5.2 (3.5)	7.3 (3.1)	7.9 (3.4)
Total Body Lean Mass (kg)	53.8 (6.6)	56.1 (7.0)	38.6 (4.5)	39.2 (4.8)
Lean Mass Index (LMI)	17.1 (1.6)	17.5 (1.8)	14.2 (1.3)	14.2 (1.4)
Regularity of eating breakfast				
Rarely/never	12.1 (35)	14.0 (39)	11.1 (39)	11.7 (41)
1–3 times weekly	14.8 (43)	15.8 (44)	15.0 (53)	17.1 (60)
4–6 times weekly	20.3 (59)	25.5 (71)	19.8 (70)	24.2 (85)
Daily	52.8 (153)	44.8 (125)	54.1 (191)	47.0 (165)
Screen time (hours per weekday)				
0–0.5 h	3.8 (11)	5.0 (14)	3.7 (13)	4.6 (16)
1–1.5 h	12.3 (36)	14.2 (40)	24.7 (87)	27.9 (98)
2–3 h	38.4 (112)	31.0 (87)	40.3 (142)	37.3 (131)
4-6 h	37.0 (108)	38.1 (107)	25.0 (88)	21.9 (77)
≥ 7 h	8.6 (25)	11.7 (33)	6.3 (22)	8.3 (29)
Leisure time physical activity (hours per week)				
Inactive	30.5 (89)	37.1 (104)	27.4 (97)	36.2 (127)
0.5–1.5 h	8.9 (26)	8.2 (23)	8.5 (30)	12.0 (42)
2 to 3 h	16.8 (49)	11.4 (32)	22.6 (80)	16.5 (58)
4 to 6 h	23.6 (69)	21.8 (61)	27.1 (96)	23.1 (81)
≥ 7 h	20.2 (59)	21.4 (60)	14.4 (51)	12.3 (43)
Activity status: active[c]	60.6 (177)	54.6 (153)	64.1 (227)	51.9 (182)
Change in activity status				
Consistently inactive		27.1 (76)		25.1 (88)
Quitters		18.2 (51)		23.1 (81)
Adopters		11.8 (33)		11.1 (39)
Consistently active		42.9 (120)		40.7 (143)

[a]Values are means with standard deviation (SD) or prevalence in percentages (n). *BMI* Body weight in kg/height in meters^2, *FMI* Fat mass in kg/height in meters^2, *LMI* Lean mass in kg/height in meters^2
[b]BMI (kg/m^2) categories according to the International Obesity Task Force reference-standard [24, 25]
[c]Participants with 2 h or more of physical activity in leisure time per week

waist circumference (2.80 (95% CI: 0.02, 5.57)) and FMI (0.90 (95% CI: 0.27, 1.53)) compared to the inactive girls. Stratified analyses including only girls who were active more than 6 h per week at baseline showed no difference in mean increase of BMI, FMI or waist circumference in consistently active girls compared to girls who reduced

Table 2 Difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2) and LMI (lean mass in kg/m^2) between Fit Futures 1 (2010–2011) and Fit Futures 2 (2012–2013), according to hours per week of physical activity in leisure time at baseline[a]

		Beta for ΔBMI (95% CI)				Beta for Δwaist circumference (95% CI)				Beta for ΔFMI (95% CI)				Beta for ΔLMI (95% CI)			
Boys	n	Model 1		Model 2		Model 1		Model 2		Model 1		Model 2		Model 1		Model 2	
Baseline physical activity	290	Beta	95% CI	Beta	95% CI	Beta	95% CI	Beta	95% CI	Beta	95% CI	Beta	95% CI	Beta	95% CI	Beta	95% CI
Inactive[b]	89	0		0		0		0		0		0		0		0	
About 0.5–1.5 h	26	0.30	− 0.54, 1.13	0.18	− 0.65, 1.01	0.61	−2.25, 3.47	0.49	−2.38, 3.35	0.04	− 0.74, 0.82	− 0.02	− 0.80, 0.76	0.30	− 0.05, 0.65	0.26	− 0.09, 0.61
About 2 to 3 h	48	0.12	− 0.56, 0.80	0.12	− 0.55, 0.80	− 0.11	− 2.43, 2.21	−0.11	− 2.44, 2.23	0.01	− 0.62, 0.64	0.01	− 0.63, 0.64	0.07	− 0.21, 0.35	0.09	− 0.20, 0.37
About 4 to 6 h	68	0.10	− 0.50, 0.71	− 0.09	− 0.70, 0.53	− 0.67	− 2.74, 1.40	− 0.84	− 2.96, 1.27	0.07	− 0.49, 0.64	− 0.06	− 0.64, 0.52	0.01	− 0.25, 0.27	− 0.05	− 0.31, 0.22
≥ 7 h	59	− 0.07	− 0.70, 0.57	− 0.48	− 1.24, 0.29	− 0.98	−3.16, 1.19	− 2.54	− 5.19, 0.12	−0.30	− 0.91, 0.30	− 0.52	− 1.25, 0.21	0.20	− 0.08, 0.48	0.05	− 0.28, 0.38
P for linear trend		0.77		0.20		0.25		0.05*		0.41		0.22		0.41		0.75	
Girls																	
Baseline physical activity	351																
Inactive[c]	95	0		0		0		0		0		0		0		0	
About 0.5–1.5 h	30	0.26	− 0.50, 1.01	0.40	− 0.37, 1.17	0.91	−2.07, 3.89	1.29	−1.76, 4.34	0.38	− 0.31, 1.06	0.56	− 0.13, 1.25	0.03	− 0.25, 0.30	− 0.01	− 0.29, 0.27
About 2 to 3 h	80	0.03	− 0.52, 0.57	0.09	− 0.47, 0.64	0.01	− 2.15, 2.17	0.14	− 2.06, 2.33	0.14	− 0.36, 0.63	0.21	− 0.28, 0.71	− 0.02	− 0.22, 0.18	− 0.03	− 0.23, 0.17
About 4 to 6 h	95	− 0.40	− 0.93, 0.12	− 0.25	− 0.82, 0.32	− 0.10	− 2.17, 1.97	0.23	−2.02, 2.49	− 0.30	− 0.78, 0.17	− 0.12	− 0.63, 0.39	− 0.05	− 0.24, 0.15	− 0.08	− 0.29, 0.13
≥ 7 h	51	0.51	− 0.12, 1.14	0.74	0.04, 1.44*	2.16	− 0.33, 4.64	2.80	0.02, 5.57*	0.60	0.03, 1.18*	0.90	0.27, 1.53*	0.01	− 0.22, 0.24	− 0.04	− 0.30, 0.22
P for linear trend		0.69		0.34		0.23		0.15		0.48		0.14		0.88		0.60	

*Significantly different from the reference ($p < 0.05$)
[a]Model 1 adjusted for baseline measurement of outcome. Model 2 adjusted for baseline measurement of outcome, screen time on weekdays, regularity of eating breakfast, age in half years at baseline and days between measurements
[b]Inactive boys had a mean increase of 1.1 BMI units, 3.2 cm waist circumference, 0.6 FMI units and 0.3 LMI units
[c]Inactive girls had a mean increase of 0.8 BMI units, 0.6 cm waist circumference, 0.5 FMI units and 0.1 LMI units

Table 3 Difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2) and LMI (lean mass in kg/m^2) between Fit Futures 1 (2010–2011) and Fit Futures 2 (2012–2013) according to change in activity status between the surveys[a]

Boys	n	Beta for ΔBMI (95% CI)		Beta for Δwaist circumference (95% CI)		Beta for ΔFMI (95% CI)		Beta for ΔLMI (95% CI)	
Change in activity status	278	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Consistently inactive[b]	76	0	0	0	0	0	0	0	0
Quitters	50	0.15 (− 0.53, 0.82)	0.06 (− 0.61, 0.73)	− 0.11 (−2.44, 2.21)	−0.29 (− 2.63, 2.04)	0.08 (− 0.54, 0.70)	0.02 (− 0.61, 0.64)	0.02 (− 0.27, 0.30)	− 0.01 (− 0.29, 0.28)
Adopters	33	− 0.54 (− 1.32, 0.24)	− 0.72 (− 1.49, 0.06)	− 2.00 (− 4.67, 0.66)	−2.39 (− 5.08, 0.30)	− 0.93 (− 1.64, − 0.22)*	− 1.04 (− 1.76, − 0.32)*	0.33 (− 0.00, 0.66)	0.29 (− 0.04, 0.62)
Consistently active	119	− 0.17 (− 0.71, 0.38)	− 0.47 (− 1.07, 0.13)	− 1.46 (− 3.33, 0.41)	− 2.32 (− 4.40, − 0.24)*	− 0.42 (− 0.92, 0.09)	− 0.62 (− 1.17, − 0.06)*	0.22 (− 0.03, 0.46)	0.13 (− 0.13, 0.40)
ANOVA F-test		0.40	0.13	0.26	0.08	0.03	< 0.01	0.11	0.29
Girls									
Change in activity status	348								
Consistently inactive[c]	86	0	0	0	0	0	0	0	0
Quitters	80	0.14 (− 0.43, 0.70)	0.14 (− 0.43, 0.72)	0.48 (−1.75, 2.70)	0.39 (− 1.88, 2.65)	0.30 (− 0.21, 0.81)	0.31 (− 0.21, 0.82)	− 0.10 (− 0.30, 0.11)	− 0.09 (− 0.30, 0.12)
Adopters	39	0.05 (− 0.66, 0.75)	0.05 (− 0.66, 0.77)	− 0.36 (− 3.14, 2.41)	− 0.52 (− 3.33, 2.30)	− 0.09 (− 0.73, 0.54)	− 0.09 (− 0.73, 0.55)	0.23 (− 0.02, 0.47)	0.23 (− 0.02, 0.49)
Consistently active	143	− 0.22 (− 0.72, 0.28)	− 0.14 (− 0.69, 0.41)	− 0.04 (− 2.01, 1.92)	− 0.02 (− 2.19, 2.16)	− 0.30 (− 0.75, 0.15)	− 0.22 (− 0.72, 0.27)	0.13 (− 0.05, 0.31)	0.13 (− 0.06, 0.33)
ANOVA F-test		0.54	0.76	0.94	0.94	0.09	0.19	0.02	0.04

*Significantly different from the reference ($p < 0.05$)
[a]Change in outcome in categories of activity status relative to consistently inactive as reference, and with an F-test for difference between groups. Model 1 adjusted for baseline measurement of outcome. Model 2 adjusted for baseline measurement of outcome, screen time on weekdays, regularity of eating breakfast, age in half years at baseline and days between measurements
[b]Consistently inactive boys had a mean increase of 1.3 BMI units, 3.9 cm waist circumference, 0.9 FMI units and 0.3 LMI units
[c]Consistently inactive girls had a mean increase of 0.8 BMI units, 0.9 cm waist circumference, 0.6 FMI units and 0.1 LMI units

their level of physical activity. In boys, LMI increased most in those who at baseline were active between 0.5 and 1.5 h per week, but the increase was not significantly different from that observed among the inactive (0.26 (95% CI: − 0.09, 0.61)). In girls, change in LMI differed little across level of activity.

Table 3 presents changes in BMI, waist circumference, FMI and LMI according to change in activity status from 2010 to 2011 to 2012–2013. In both sexes, neither quitting activity nor adopting activity, relative to remaining inactive, was significantly associated with change in BMI or waist circumference. The consistently active boys had a significantly lower increase in waist circumference compared to the consistently inactive (− 2.32 (95% CI: − 4.40, − 0.24)). The largest increase in BMI and FMI (and for girls, also waist circumference) was observed among those quitting activity during follow-up, but this was not statistically significantly different from change among those who remained inactive.

In boys, changes in FMI were significantly different between activity groups ($p < 0.01$), with adopters (− 1.04 (95% CI -1.76, − 0.32)) and the consistently active (− 0.62 (95% CI: − 1.17, − 0.06)) gaining significantly less FMI than the consistently inactive. The difference in change in FMI comparing adopters and quitters was also statistically significant (− 1.06 (95% CI: − 1.83, − 0.28)) (Table 4 in Appendix). In girls there was no statistically significant difference in change of FMI between categories of activity, with the exception of the consistently active which gained less than those quitting activity (− 0.53 (95% CI: − 1.00, − 0.05)) (Table 4 in Appendix).

In boys, there was no statistically significant difference in change in LMI between the groups. In girls, change in LMI differed significantly between groups ($p = 0.04$). Girls who adopted activity between surveys experienced greater increase in LMI than the consistently inactive, but the difference was not of statistical significance (0.23 (95% CI: − 0.02, 0.49)). Compared to those quitting activity, girls who were consistently active (0.22 (95% CI: 0.03, 0.41)) or adopted physical activity (0.32 (95% CI: 0.07, 0.58)) experienced a statistically significantly higher increase in LMI (Table 4 in Appendix).

Discussion

In this population-based longitudinal study of changes in body composition in adolescents, there was, with the exception of waist circumference in boys, no linear association between self-reported leisure time physical activity and 2-year changes in indices of body composition. Change in physical activity was associated with statistically significant different changes in FMI. Boys who increased their physical activity during follow-up decreased their FMI compared to groups of boys quitting or remaining inactive, while consistently active girls experienced less increase than those reducing activity. Change in physical activity in girls was associated with statistically significant different changes in LMI. Girls who adopted physical activity increased their LMI compared to girls quitting activity.

Body weight, BMI and waist circumference increase during natural growth in children and adolescents, and it is therefore challenging to separate healthy- from unhealthy body development. Although the direction and magnitude of change will vary between individuals, a general increase in all the included measures of body composition is expected during this phase of life given the bodily- and hormonal changes that naturally takes place in adolescents [21]. Physical activity has positive health effects, but the associations with changes in adiposity among adolescents is complicated and conflicting results have been reported [29]. We found weak relationships between the frequency of leisure time physical activity at baseline and change in body composition, suggesting that change in body composition in this age group was mainly independent of level of self-reported physical activity. Girls who were most active at baseline had put on adipose tissue after 2 years (Table 2). A possible explanation could be that the increase occurred in girls who were active at baseline, but reduced their activity during follow up. Stratified analyses in categories of girls who were active more than 6 h per week at baseline did not support this explanation. Our findings are, however, in line with those of Kettaneh et al., who found that girls in the highest category of activity also experienced the largest increase in BMI, waist circumference, sum of skinfolds and percent body fat [17]. LMI remained unaltered between Fit Futures 1 and Fit Futures 2 (Table 1), suggesting that LMI changes little in females during late adolescence.

Lean mass is comprised of muscles and all bodily tissue except fat mass and skeletal mass. Since muscles are particularly important for oxidization of fat, they are also determinants of energy balance [30], and although physical activity increases muscle mass it is not the sole component of energy expenditure. Total energy expenditure is comprised of resting metabolic rate, the thermic effect of food, bodily movement and, for children and adolescents; energy required for growth [31]. This means that although physical activity declines, the effect on total energy expenditure is modest [17]. Adiposity is the result of a whole range of lifestyle-, sociocultural- and genetic factors. It is therefore difficult to pinpoint the impact of one behavior, and it is possible that factors other than physical activity – and changes in these, exert more influence on change in body composition [32].

Physical activity levels change rapidly in adolescents [33], thus challenging our ability to measure and capture the effect of physical activity on body composition in adolescents. Thus, a baseline measurement may be only modestly associated with prior- or future physical activity [31]. For instance, O'Loughlin et al. reported effects of physical activity on changes in adiposity after 1 year, but not 2 years in girls, and only after 2 years in boys. The authors hypothesized that change in levels of physical activity over follow-up may have contributed to the differences [34].

Boys adopting activity experienced a slight decrease in FMI between surveys. This finding differs from the observed increase in all other measures of body composition in both sexes, and in all other sub-groups of activity change. With the exception of waist circumference and FMI in boys, change in all measures of body composition among the consistently active did not differ statistically significantly from changes in the consistently inactive. Physical activity has a limited potential to affect the difference between these groups [32]. In the consistently inactive, there is less room for unhealthy weight gain as a result of inactivity. Conversely, among the consistently active there is less potential for preventing unhealthy weight gain through increased activity. These groups may be more susceptible to unhealthy weight gain through factors other than, or in addition to, physical activity. This can be considered as floor- and ceiling effects of physical activity, and means that the potential for activity related changes in adiposity is greatest among those who change their level of activity. The prevalence of physically active adolescents declined in our study, and for both sexes there was a rather consistent, albeit not statistically significant, pattern of the highest increase in BMI, waist circumference (not in boys) and FMI in those quitting activity. These findings indicate that those who reduce their level of activity over the course of adolescence are susceptible to unhealthy weight gain. This is of concern, since total activity decreases by 7% annually in adolescents [33]. Boys who adopted physical activity reduced their FMI between surveys and had the highest increase in LMI, indicating that the inactive may profit from increasing level of physical activity. In girls, we observed a statistically significant difference in change of FMI between those who were consistently active and those quitting activity, suggesting that there are negative consequences of reducing level of physical activity. However, girls naturally increase fat mass over the course of adolescence, whereas the same is true for lean mass in boys [17]. It is therefore possible that an increase in FMI in girls occurs regardless of activity level, whereas for boys, this may be prevented through activity. This can also explain why there was no significant associations between change in activity and change in BMI, as BMI does not distinguish between the overweight inactive (with high FMI) and the overweight active (with high LMI) [35].

Individuals may have, and report, high levels of physical activity because they try to lose weight, or they may have low (or high) body weight because of high activity. The problem of reverse causality applies also to longitudinal studies, as overweight adolescents may avoid engaging in physical activity on account of feeling inferior relative to their active peers [31, 36]. Self-reported physical activity is prone to information bias [26] and individuals tend to overestimate the true amount of their physical activity. This can potentially dilute an association with measures of body composition [15]. Furthermore, self-reported physical activity in leisure time does not capture the total level of activity, which can include active transportation to school and friends, physical education and other types of leisure time activity. Objective measures of physical activity can produce more accurate estimates, but are not necessarily associated with changes in adiposity [37]. Finally, studies have suggested that the intensity of activity is more important than the total amount of activity for adiposity [38, 39]. In our study, complete data on perceived physical activity intensity were not available, but in complete case analyses the inclusion of self-reported intensity did not affect results.

This study had several strengths, including the longitudinal design, the high participation rate and the inclusion of four objective measures of body composition. A limitation is the use of self-reported physical activity and the lack of full adjustment for dietary habits, since a validated food-frequency questionnaires or similar was not included in the study. Another limitation is the lack of adjustment for pubertal development due to missing data. However, in boys, the vast majority (≈73%) of complete cases reported pubertal maturation to be "underway", meaning that the effect of adjusting for PDS would likely be small. Inclusion of PDS in complete case analyses did not indicate confounding by pubertal development. Another limitation is lack of adjustment for socioeconomic status. In the Fit Futures survey, a substantial number of participants reported not knowing parental level of education, thus limiting the possibilities for adjusting for this variable. However, the inclusion of study specialization in the analyses likely adjusts for some of the variance in socioeconomic status in adolescents [40, 41]. Lastly, in our study the length of follow-up was approximately 2 years, but in a population undergoing natural changes in body composition, it may take more time before physical inactivity manifests in body composition. The 3rd survey of the Fit Futures Study is in planning and will enable further research on how physical activity in late adolescence affects changes in body composition in early adulthood.

Conclusion

In this longitudinal study of changes in objectively measured body composition, we found that consistently inactive boys increased significantly more in fat mass index compared to those adopting physical activity or remaining consistently active, and that girls adopting physical activity increased their lean mass index significantly more than those who reduced physical activity. Adolescence is a time of transformation and it is challenging to pinpoint the effect of one behavior on change in body composition. Physical activity should nevertheless be encouraged because of the health benefits other than the prevention of adiposity.

Appendix

Table 4 Difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2) and LMI (lean mass in kg/m^2) between Fit Futures 1 (2010–2011) and Fit Futures 2 (2012–2013) according to change in activity status between the surveys[a]

Boys	n	Beta for ΔBMI (95% CI)		Beta for Δwaist circumference (95% CI)		Beta for ΔFMI (95% CI)		Beta for ΔLMI (95% CI)	
Change in activity status	278	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
Quitters[b]	50	0	0	0	0	0	0	0	0
Consistently inactive	76	– 0.15 (–0.82, 0.53)	– 0.06 (– 0.73, 0.61)	0.11 (– 2.21, 2.44)	0.29 (– 2.04, 2.63)	– 0.08 (– 0.70, 0.54)	–0.02 (– 0.64, 0.61)	– 0.02 (– 0.30, 0.27)	0.01 (– 0.28, 0.29)
Adopters	33	– 0.69 (– 1.53, 0.15)	–0.78 (– 1.61,0 0.05)	–1.89 (– 4.79, 1.00)	–2.10 (– 5.00, 0.81)	– 1.01 (– 1.78, – 0.23)*	–1.06 (– 1.83, – 0.28)*	0.32 (– 0.04, 0.67)	0.29 (– 0.06, 0.65)
Consistently active	119	–0.31 (– 0.94, 0.31)	–0.54 (– 1.19, 0.11)	–1.35 (– 3.49, 0.80)	– 2.02 (– 4.28, 0.24)	– 0.50 (– 1.07, 0.08)	–0.63 (– 1.24, – 0.03)*	0.20 (– 0.07, 0.47)	0.14 (– 0.14, 0.42)
Girls									
Change in activity status	348								
Quitters[c]	80	0	0	0	0	0	0	0	0
Consistently inactive	86	– 0.14 (–0.70, 0.43)	– 0.14 (– 0.72, 0.43)	– 0.48 (–2.70, 1.75)	– 0.39 (– 2.65, 1.88)	– 0.30 (– 0.81, 0.21)	–0.31 (– 0.82, 0.21)	0.10 (– 0.11, 0.30)	0.09 (– 0.12, 0.30)
Adopters	39	– 0.09 (– 0.80, 0.63)	– 0.09 (– 0.80, 0.63)	– 0.84 (– 3.64, 1.96)	– 0.90 (– 3.71, 1.90)	– 0.39 (–1.04, 0.25)	–0.40 (– 1.04, 0.24)	0.32 (0.07, 0.58)*	0.32 (0.07, 0.58)*
Consistently active	143	– 0.36 (– 0.87, 0.16)	– 0.29 (– 0.82, 0.24)	– 0.52 (– 2.53, 1.49)	– 0.41 (– 2.49, 1.68)	– 0.60 (– 1.06, – 0.14)*	–0.53 (– 1.00, – 0.05)*	0.23 (0.05, 0.41)*	0.22 (0.03, 0.41)*

*Significantly different from the reference ($p < 0.05$)
[a]Change in outcome in categories of activity status relative to quitting activity as reference. Model 1 adjusted for baseline measurement of outcome. Model 2 adjusted for baseline measurement of outcome, screen time on weekdays, regularity of eating breakfast, age in half years at baseline and days between measurements
[b]Boys quitting activity had a mean increase of 1.5 BMI units, 4.1 cm waist circumference, 1.0 FMI units and 0.3 LMI units
[c]Girls quitting activity had a mean increase of 1.0 BMI units, 1.4 cm waist circumference, 0.9 FMI units and – 0.1 LMI units

Abbreviations
BMI: Body Mass Index; FMI: Fat Mass Index; LMI: Lean Mass Index; PDS: Pubertal Development Scale

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Authors' contributions
NAA wrote the draft of the manuscript, which was revised and edited by BKJ, BM, NE and SG several times during the process. BKJ contributed to the statistical analyses, and BM specifically contributed to the discussion of physical activity. NE was the principal investigator in Fit Futures 2 and contributed significantly to the acquisition of data. SG formulated the research question and conceived the study. All authors have substantially contributed to the study, and have read and approved the final manuscript.

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Availability of data and materials
The data that support the findings of this study are available from UiT – The Arctic University of Norway, but restrictions apply to the availability of these data, which were used under license for the current study, and so are not publicly available. Data are, however, available from the authors upon reasonable request and with permission of UiT – The Arctic University of Norway.

Ethics approval and consent to participate
This study was approved by The Regional Committee of Medical and Health Research Ethics in northern Norway (REK North), as part of the Tromsø Study Fit Futures cohort. Written consent was obtained from all participants aged ≥16 years. Those under 16 years of age brought signed, written consent from their parent or legal guardian.

Consent for publication
Not applicable

Competing interests
The authors declare that they have no competing interests.

Author details
[1]Department of Community Medicine, UiT The Arctic University of Norway, 9037 Tromsø, Norway. [2]Nordland Hospital, Bodø, Norway. [3]Centre for Sami Health Research, Department of Community Medicine, UiT The Arctic University of Norway, Tromsø, Norway. [4]School of Sport Sciences, UiT The Arctic University of Norway, Tromsø, Norway. [5]Department of Health and Care Sciences, UiT The Arctic University of Norway, Tromsø, Norway.

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Association between objectively measured physical activity and longitudinal changes in body composition in adolescents: the Tromsø study fit futures cohort

Nils Abel Aars ,[1,2] Sigurd Beldo,[3] Bjarne Koster Jacobsen,[1,4] Alexander Horsch,[5] Bente Morseth ,[1,3] Nina Emaus,[6] Anne-Sofie Furberg,[7,8] Sameline Grimsgaard[1]

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For numbered affiliations see end of article.

Correspondence to
Nils Abel Aars;
nils.a.aars@uit.no

ABSTRACT

Objectives Physical activity may be important in deterring the obesity epidemic. This study aimed to determine whether objectively measured physical activity in first year of upper secondary high school predicted changes in body composition over 2 years of follow-up in a cohort of Norwegian adolescents (n=431).

Design A longitudinal study of adolescents (mean age of 16 (SD 0.4) at baseline, 60.3% girls) participating in the Fit Futures studies 1 (2010–2011) and 2 (2012–2013).

Setting All eight upper secondary high schools in two municipalities in Northern Norway.

Participants Students participating in both studies and under the age of 18 at baseline and with valid measurement of physical activity at baseline and body composition in both surveys.

Primary and secondary outcomes Change in objectively measured body mass index and waist circumference and change in dual-energy X-ray absorptiometry measured fat mass index, lean mass index (LMI) and appendicular LMI (aLMI) between baseline and follow-up.

Results At baseline, boys had significantly higher physical activity volume (p=0.01) and spent on average of 6.4 (95% CI 2.1 to 10.6) more minutes in moderate-to-vigorous physical activity (MVPA) than girls (p<0.01). In girls, multivariate regression analyses showed that more sedentary time was negatively associated with changes in LMI (p<0.01) and aLMI (p<0.05), whereas more light activity had opposite effects on these measures (p<0.01 and p<0.05, respectively). No significant associations between measures of baseline physical activity and changes in body composition parameters were observed in boys.

Conclusions In this cohort of Norwegian adolescents, sedentary and light physical activity was associated with changes in LMI and aLMI in girls, but not boys. Minutes spent in MVPA in first year of upper secondary high school was not associated with changes in measures of body composition in neither sex after 2 years.

Strengths and limitations of this study

- ► This study used objective measures of physical activity.
- ► The study included objectively measured weight, height and waist circumference and dual-energy X-ray absorptiometry measures of fat and lean mass.
- ► We were not able to fully adjust for nutrition and not for pubertal development.
- ► The 431 participants with complete data from both baseline and follow-up represent 41% of those attending Fit Futures 1, indicating a degree of selection.

BACKGROUND

The potential of physical activity to prevent or treat a number of diseases has been highlighted by the WHO,[1] with inactivity accounting for 9% of worldwide premature mortality.[2] Public health guidelines state that adolescents should engage in moderate-to-vigorous physical activity (MVPA) ≥60 min/day,[3] but in 2011, only 50% of Norwegian, 15-year olds, met these recommendations.[4] During adolescence, there is a decline in both total physical activity and MVPA,[5 6] and many quit or reduce participation in organised sports.[7] As of 2013, the prevalence of overweight and obesity (body mass index (BMI) ≥25 kg/m^2) in Norwegians aged <20 years appears to be stabilising at around 20% in boys and 16% in girls—comparable to the Nordic countries.[8] This is lower than in the USA (around 29% in boys and girls),[8] but the health effects for those concerned may still be substantial over the long term.[9]

While physical activity has many positive health effects, its relationship with adiposity is less clear and it has proven difficult to determine causality, direction and magnitude of this relationship.[10] Cross-sectional research typically shows a strong inverse association between physical activity and weight status,[11] but temporality cannot be ascertained using such study designs.[12] Longitudinal studies may ascertain if lower physical activity precedes excess weight gain, but a review found no evidence for a relationship between objectively measured physical activity and body fat gain in adolescents.[12] The lack of congruent results may in part be explained by the diverse and inadequate measures of both exposure and outcome used in research of the association between physical activity and body composition.[10 11]

Although many methods to measure physical activity are available, the most common and most feasible is self-report, which commonly overestimates the total amount of physical activity.[13] Body composition is most commonly assessed using BMI, but BMI does not distinguish between fat and muscle mass.[14] This has the potential to cause misclassification of overweight status and may attenuate a true association between physical activity and fat or muscle mass. Thus, in the current study, we sought to overcome these limitations by applying objective measures of both physical activity and specific measures of body composition. Our aim was to investigate the association between objectively measured physical activity and changes in five different measures of body composition (BMI, waist circumference, fat mass index (FMI), lean mass index (LMI) and appendicular LMI (aLMI)) over 2 years of follow-up in a cohort of Norwegian adolescents.

METHODS AND MATERIALS

We used data from the first and second Fit Futures cohort studies, performed in 2010–2011 and 2012–2013, respectively. In the first study, we invited all students (n=1117) in their first year of upper secondary high school in the neighbouring municipalities of Tromsø and Balsfjord in Northern Norway, and 93% participated. The study was repeated 2 years later, when the students were in their last year of upper secondary high school or had started as apprentices if they studied vocational subjects. The second study included 868 participants, giving an attendance of 77%. All eight upper secondary high schools in the two municipalities participated in both studies. Altogether, 735 adolescents attended both surveys. For the present study, we excluded those aged ≥18 years of age at baseline (n=38). Some participants (n=240) did not have valid measurements of physical activity at baseline and were therefore not included in the study. We also excluded those with missing data on change in body composition parameters or variables included in the model (n=26). Thus, 431 participants were included in the present study (60.3% girls). Online supplemental appendix table 1 includes descriptive characteristics of the boys and girls with a valid baseline measurement of physical activity and variables included in the analyses, but who were missing follow-up data on body composition parameters (n=133).

Students were granted leave of absence from school to attend an examination at the Clinical Research Unit at the University Hospital of Northern Norway in both surveys. The participants attended a clinical examination where they also completed a questionnaire, which included questions on lifestyle, screen time, dietary habits and so on. The participants signed a letter of informed consent, and those under the age of 16 brought a letter of consent signed by their parent or guardian.

All measurements were performed by trained personnel. Height was measured to the nearest centimetre and weight to the nearest 100 g, wearing light clothing and using an automatic electronic scale/stadiometer (Jenix DS 102 stadiometer, Dong Sahn Jenix, Seoul, Korea). BMI was calculated as body weight in kilograms per height in meter square. Waist circumference was measured to the nearest 0.1 centimetre at the height of the umbilicus. Fat and soft tissue lean mass in grams was estimated by whole-body dual-energy X-ray absorptiometry (DXA) (GE Lunar Prodigy, Lunar Corporation, Madison, Wisconsin, USA). Fat mass comprises all fat, while soft tissue lean mass comprises all bodily tissue except fat and skeletal mass. These variables were used to calculate FMI, fat mass in kilograms per height in meter square and LMI, lean mass in kilograms/height in meter square. In addition, we calculated aLMI, which is the sum of soft tissue lean mass in kilograms in all four extremities divided by height in meter square. Although most commonly used in studies of sarcopenia in elderly,[15] this body composition parameter is arguably more specific to skeletal muscle mass than total LMI. The ability of DXA to detect changes in appendicular lean mass in young adolescents is good and has been validated against MRI.[16]

Physical activity was objectively measured using the ActiGraph GT3X accelerometer (ActiGraph, LLC, Pensacola, USA). Participants were instructed to wear the device on their right hip for 7 consecutive days and to remove it only when showering, swimming or sleeping. The ActiLife software was used to initialise the accelerometer and download data, which was imported into the Quality Control & Analysis Tool for data processing. This software was developed by the research group of professor Horsch in Matlab (The MathWorks, Massachusetts, USA) for processing of accelerometer data. The accelerometer was set in raw data mode, with a sampling frequency of 30 Hz and with normal filtering epochs of 10 s. Data collection was initiated at 14:00 hours the first day and concluded at 23:58 on the eighth day of measurement. We excluded data from the first day of measurement to reduce reactivity bias. The criteria for a valid measurement of physical activity was wear time of ≥4 consecutive days, with ≥10 hours wear time per day. This has been demonstrated as representative of activity over a full week.[17] The triaxial algorithm developed by Hecht *et al* was used to calculate wear time.[18] Minutes per day in sedentary (0–99 cpm), light (100–1951 cpm), moderate (1952–5723 cpm) and vigorous (≥5724 cpm) physical activity was determined using the cut-offs developed by Freedson.[19] The choice of these cut-offs enables direct comparisons as the cohort ages, although these cut-offs are not commonly used for adolescents, we consider the bodily proportions of an adolescent to resemble that of an adult in terms of measured acceleration. The device collected data in both uniaxial and triaxial modes, but in the present study, only the uniaxial data had been processed and therefore available. Studies have shown that uniaxial data recorded from the GT3X correlate well with uniaxial data recorded from previous ActiGraph models.[20] Data on objectively measured physical activity were only available from Fit Futures 1.

Baseline characteristics were presented as means with SD or prevalence in percentages with number of subjects (n). Sex-specific difference in body composition between baseline and follow-up was tested using a paired samples t-test. The difference in physical activity between sexes was tested using a two-sample t-test, while sex differences in categories of minutes spent in MVPA was tested using a χ^2 test. Difference in linear trend across categories of minutes spent in MVPA was tested using STATA's non-parametric test for trend, developed by Cuzick.[21] Linear regression was used to determine the effect of baseline physical activity on change in body composition, that is, the change in BMI, waist circumference, FMI, LMI and aLMI from the first to the second Fit Futures Study.

We used three different predictors of change in body composition, performing three sets of analyses, with first; minutes per day spent in sedentary activity second; minutes per day spent in light activity and third; minutes per day spent in MVPA . We divided the continuous variables sedentary and light activity by 30 and the continuous variable MVPA by 15 before inclusion in the models, thus presenting the beta coefficient for change in body composition parameter per 30 minof sedentary or light activity, or per 15 min of MVPA, with 95% CIs and a p value. In model 1, we adjusted for the baseline measurement of the body composition parameter. In the adjusted models (model 2), we also included time between measurements (mean (SD): 730 (74) days) and baseline values of device wear time, age in half years and questionnaire data on screen time on weekdays (how many hours per weekday the students spent in front of a computer or television—answers ranged from none to more than 10 hours per weekday) and regularity of eating breakfast as an indicator of healthy meal patterns (answers ranging from rarely/never to everyday). In the analyses of sedentary and light activity, we also adjusted for minutes spent in MVPA (model 3). In a subset of analyses (online supplemental appendix tables 2–4), we repeated the analyses performed in tables 2 and 3, adjusting also for self-reported pubertal status measured by either pubertal development scale (boys) or age at menarche (girls). These analyses included the 143 boys and 256 girls with valid data on pubertal status. In all the analyses, a p value of <0.05 was considered statistically significant.

All analyses were performed sex specific as decided a priori, using STATA V.14 (StataCorp. 2015. Stata Statistical Software: Release 14. College Station, Texas, USA: StataCorp LP.).

Patient and public involvement

Participating schools were consulted and included in the design phase of the study.

RESULTS

Table 1 displays the participants' body composition measurements at baseline and follow-up as well as physical activity measurements at baseline. Boys had a statistically significant increase in all measures of body composition. Girls had a statistically significant increase in body weight, BMI, fat mass in kilogram and FMI, but not in LMI and appendicular lean mass. Boys were statistically significantly more physically active than girls in some aspects, with higher mean counts per minute (p=0.01) and more minutes in MVPA (p<0.01). Time spent in sedentary or light intensities did not differ significantly between sexes. Twenty-seven per cent of boys and 17% of girls complied with the recommendations of 60 min/day MVPA.

Table 2 displays the association between minutes spent in sedentary activity at baseline and changes in body composition between baseline and follow-up. There was no association between sedentary activity and changes in BMI, waist circumference and FMI in neither boys nor girls. In girls, but not in boys, more minutes spent in sedentary activity at baseline was associated with lower LMI (p<0.01) and aLMI (p=0.02). Adjustment for covariates and MVPA slightly attenuated the association with aLMI (p=0.05).

Table 3 displays the association between minutes spent in light activity at baseline and changes in body composition between baseline and follow-up. There was no association between the exposure and either body composition parameter in boys. In girls, there was some evidence to suggest an association with change in waist circumference (p=0.05), but the association was attenuated after adjustments (p=0.17). More minutes spent in light physical activity was associated with higher LMI (p<0.01 (models 2 and 3)) and aLMI (p=0.04 (model 2) and 0.05 (model 3)).

Table 4 displays the association between minutes in MVPA at baseline and changes in body composition between baseline and follow-up. There was no association between time spent in MVPA and changes in either measure of body composition for either sex.

Online supplemental appendix table 1 shows the descriptive characteristics of the participants with valid baseline measurements of physical activity and adjustment variables, but who were lost to follow-up. Both boys and girls lost to follow-up had significantly higher mean BMI, waist circumference, fat mass and FMI at baseline as well as significantly less minutes per day spent in light-to-vigorous and moderate-to-vigorous (girls only) physical activities. In online supplemental appendix tables 2–4, we present subanalyses restricted to those with complete data on pubertal development, confirming the results displayed in tables 2–4 also after adjustments for pubertal development. Overall, adjustment for pubertal

Table 1 Characteristics of the longitudinal cohort of the Tromsø study; Fit Futures 2010–2011 and 2012–2013*

	Boys (n=171)		Girls (n=260)	
	FF1	FF2	FF1	FF2
Age (years)	16.0 (0.4)	18.2 (0.4)	16.1 (0.4)	18.1 (0.4)
Height (cm)	177.1 (6.6)	179.0 (6.5)*	165.4 (6.6)	166.1 (6.6)*
Body weight (kg)	69.0 (12.3)	74.3 (13.0)*	60.8 (10.8)	63.4 (11.6)*
Body mass index (BMI kg/m2)	22.0 (3.5)	23.2 (3.7)*	22.2 (3.7)	23.0 (4.0)*
Waist circumference (cm)	81.0 (10.3)	83.9 (10.9)*	76.7 (9.8)	78.0 (10.8)*
Total body fat mass (kg)	13.3 (9.4)	15.6 (10.4)*	19.9 (8.3)	21.7 (9.1)*
FMI (kg/m^2)	4.2 (3.0)	4.9 (3.2)*	7.3 (3.0)	7.9 (3.3)*
Total body lean mass (kg)	54.0 (6.5)	56.4 (6.9)*	38.9 (4.5)	39.3 (4.7)*
LMI (kg/m^2)	17.2 (1.6)	17.6 (1.8)*	14.2 (1.3)	14.2 (1.4)
Appendicular lean mass (kg)	25.3 (3.4)	26.2 (3.6)*	17.4 (2.3)	17.4 (2.3)
aLMI (kg/m^2)	8.1 (0.9)	8.2 (0.9)*	6.4 (0.7)	6.3 (0.7)*
Accelerometer variables				
Wear time per valid day	14.2 (1.2)		14.1 (1.1)	
Counts per minute	362.9 (137.5)		334.0 (111.9)‡	
Minutes per day in different intensities				
Sedentary (cpm 0–99)	573.3 (77.3)		565.3 (63.2)	
Light (cpm 100–1951)	230.5 (58.8)		236.2 (48.4)	
Moderate (cpm 1952–5723)	45.8 (20.6)		40.2 (17.7)‡	
Vigorous (cpm ≥5724)	3.7 (5.8)		2.9 (4.1)‡	
MVPA§ (cpm ≥1952)	49.5 (23.4)		43.1 (19.6)‡	
Meeting MVPA guidelines per day				
0–29 min	35 (20.5)		69 (26.5)	
30–59 min	90 (52.6)		146 (56.2)	
≥60 min	46 (26.9)		45 (17.3)¶	

*Values are means with SD or n (prevalence in percentages). BMI: body weight in kg/height in meters^2, FMI: fat mass in kg/height in meters^2, LMI: lean mass in kg/height in meters^2, aLMI: appendicular lean mass in kg/height in meters^2. Data on physical activity in FF2 was not available.
†Significantly different from baseline measurement (p<0.05).
‡Significantly different from boys (mean).
§MVPA: moderate to vigorous physical activity, using cut-offs suggested by Freedson.[19]
¶Significantly different linear trend from boys (p<0.05).

development had no substantial impact on an association between sedentary, light and MVPA and changes in body composition for either sex in complete case analyses. However, the association between minutes spent in sedentary activity and light activity and changes in aLMI were no longer significant for girls in model 3. The point estimates did not differ from those from analyses without adjustments for pubertal development, however.

DISCUSSION

In this longitudinal population-based study of Norwegian adolescents, there were in both boys and girls no associations between objectively measured physical activity at baseline and 2-year changes in BMI, waist circumference and FMI. Both boys and girls had statistically significant increases in the measures of body composition (except LMI and appendicular lean mass in girls). Objectively measured physical activity did not predict changes in boys. In girls, there was a significant association between minutes spent in sedentary and light physical activity and changes in indices of lean mass.

Although the magnitude of change differed, both sexes experienced increases in measures of body composition. In boys, FMI increased by 0.7 units (+16.7%), whereas LMI increased by 0.4 units (+2.3 %) from baseline. Similar relative changes were observed in girls, (FMI+8.2 %) and (LMI+0.7%), indicating that FMI increases relatively more than LMI during late adolescence. We observed statistically significant differences in minutes spent in moderate (p<0.01) and vigorous (p=0.04) intensity between boys and girls, but time spent in other intensity levels did not differ. Differences in physical activity by sex are consistent

Table 2 Association between minutes per day spent in sedentary activity (cpm 0–99) at baseline and changes in body composition*

	Boys (n=171)			Girls (n=260)		
	Beta	95% CI	P value	Beta	95% CI	P value
Δ BMI						
Model 1	–0.02	–0.13 to 0.09	0.76	–0.05	–0.15 to 0.05	0.33
Model 2	–0.02	–0.17 to 0.12	0.75	–0.11	–0.24 to 0.03	0.12
Model 3	0.01	–0.17 to 0.20	0.88	–0.11	–0.27 to 0.05	0.16
Δ waist circumference						
Model 1	0.17	–0.21 to 0.56	0.37	–0.01	–0.41 to 0.40	0.96
Model 2	0.27	–0.24 to 0.78	0.30	–0.33	–0.87 to 0.20	0.22
Model 3	0.42	–0.23 to 1.07	0.20	–0.44	–1.06 to 0.18	0.17
Δ FMI						
Model 1	0.00	–0.10 to 0.10	0.99	–0.01	–0.11 to 0.08	0.83
Model 2	–0.02	–0.16 to 0.11	0.74	–0.06	–0.18 to 0.07	0.36
Model 3	0.00	–0.17 to 0.17	0.98	–0.05	–0.20 to 0.09	0.48
Δ LMI						
Model 1	0.00	–0.05 to 0.05	0.88	–0.06	-0.09, to 0.02	<0.01
Model 2	0.01	–0.06 to 0.07	0.77	–0.07	-0.12, to 0.02	<0.01
Model 3	0.02	–0.06 to 0.10	0.63	–0.08	-0.13, to 0.03	<0.01
Δ aLMI						
Model 1	0.00	–0.03 to 0.03	0.84	–0.02	-0.04, to 0.00	0.02
Model 2	0.00	–0.03 to 0.04	0.81	–0.03	-0.05, to 0.01	0.02
Model 3	0.01	–0.04 to 0.05	0.71	–0.03	–0.06 to 0.00	0.05

*The table displays the association between minutes spent in sedentary activity and difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2), LMI (lean mass in kg/m^2) and aLMI (appendicular lean mass in kg/m^2) between Fit Futures 1 (2010–2011) and Fit Futures 2 (2012–2013). The models give the beta coefficient for 30 min increase in sedentary activity. All models were adjusted for baseline values of the body composition parameter. In model 2 also adjusted for time between measurements and baseline values of screen time on weekdays, study specialisation, age in half-years, regularity of eating breakfast and device wear time. In model 3 adjusted also for minutes spent in moderate-to-vigorous physical activity (cpm≥1952).
aLMI, appendicular LMI; BMI, body mass index; FMI, fat mass index; LMI, lean mass index .

with the previous research.[22 23] Differences in changes in body composition by sex are biologically determined during adolescence, with sex hormones resulting in fat mass accrual in girls and lean mass accrual in boys.[24 25] The observation that sedentary and light activity-predicted changes in indices of lean mass in girls, but not boys, may be explained by these expected biological differences. Physical activity may have somewhat greater potential to influence lean mass accrual in girls than in boys during this period, as fat-free mass is relatively stable in girls in late adolescence, whereas it increases up to 18 years of age in boys.[26]

In the present study, sedentary and light activity had opposing effects on lean mass in girls. In a study using isotemporal substitution models, positive prospective effects on fat mass were found when substituting 30 min of sedentary activity with MVPA, but not when substituted with light activity.[27] It is reasonable that sedentary and light physical activity has opposing effects on lean mass.[28] In the present study, sedentary and light activity was inversely correlated (r=–0.39), but minutes spent in different intensity levels is not directly a function of each other as wear time in the participants varies between individuals. Based on wear time inclusion criteria, the theoretical time span for wear time lies between 10 and 24 hours. Thus, minutes spent in sedentary activity may not be deduced from the sum of minutes spent in other intensities and vice versa, but it is plausible that higher wear time results in more sedentary time. This was evident in an exploratory analyses on the same cohort (not included in the present study), where higher wear time was significantly associated with more sedentary activity and less light activity (p<0.01). Adjusting for wear time (model 2) did not change the associations substantially for sedentary activity (table 2), but had some effect on the associations with light physical activity (table 3). Because of the inverse relationship between minutes spent sedentary and in light activity, it is not possible to determine whether it is sedentary time or light activity time that is associated with change in LMI. The practical consequences are nevertheless that being active increases lean mass in girls.

Table 3 Association between minutes per day spent in light activity (cpm 100–1951) at baseline and changes in body composition*

	Boys (n=171)			Girls (n=260)		
	Beta	95% CI	P value	Beta	95% CI	P value
Δ BMI						
Model 1	0.04	−0.11 to 0.18	0.60	0.05	−0.09 to 0.19	0.47
Model 2	0.01	−0.17 to 0.18	0.93	0.12	−0.04 to 0.27	0.13
Model 3	−0.01	−0.20 to 0.17	0.88	0.11	−0.05 to 0.27	0.16
Δ waist circumference						
Model 1	−0.11	−0.62 to 0.40	0.68	0.54	0.01 to 1.07	0.05
Model 2	−0.38	−1.00 to 0.23	0.22	0.43	−0.19 to 1.05	0.17
Model 3	−0.42	−1.07 to 0.23	0.20	0.44	−0.19 to 1.06	0.17
Δ FMI						
Model 1	0.03	−0.10 to 0.16	0.67	0.02	−0.10 to 0.15	0.71
Model 2	0.01	−0.15 to 0.18	0.87	0.06	−0.09 to 0.20	0.43
Model 3	−0.00	−0.17 to 0.17	0.98	0.05	−0.09 to 0.20	0.49
Δ LMI						
Model 1	−0.01	−0.07 to 0.06	0.84	0.04	−0.01 to 0.09	0.08
Model 2	−0.02	−0.09 to 0.06	0.67	0.08	0.03 to 0.13	<0.01
Model 3	−0.02	−0.10 to 0.06	0.63	0.08	0.03 to 0.13	<0.01
Δ aLMI						
Model 1	0.00	−0.03 to 0.04	0.87	0.02	−0.01 to 0.04	0.16
Model 2	−0.01	−0.05 to 0.04	0.73	0.03	0.00 to 0.06	0.04
Model 3	−0.01	−0.05 to 0.04	0.70	0.03	−0.00 to 0.06	0.05

*The table displays the association between minutes spent in light activity and difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2), LMI (lean mass in kg/m^2) and aLMI (appendicular lean mass in kg/m^2) between Fit Futures 1 (2010–2011) and Fit Futures 2 (2012–2013). The models give the beta coefficient for 30 min increase in light activity. All models were adjusted for baseline values of the body composition parameter. In model 2 also adjusted for time between measurements and baseline values of screen time on weekdays, study specialisation, age in half-years, regularity of eating breakfast and device wear time. In Model 3 adjusted also for minutes spent in moderate-to-vigorous physical activity (cpm≥1952).
aLMI, appendicular LMI; BMI, body weight index; FMI, fat mass index; LMI, lean mass index.

When interpreting results, we must acknowledge the limitations of DXA in the estimation of lean mass, which can be affected by both biological factors and measurement error.[29] Because the relative increase in lean mass was small, only slight differences in, for instance, individual hydration status at the two time points may influence estimates and thus the association.

There were no associations between objectively measured physical activity and change in BMI, waist circumference and FMI for either sex. It may be that the negative effects of less physical activity have not yet had time to manifest themselves in a population still undergoing physiological changes as a result of natural growth, especially considering the relatively short 2-year follow-up. Our results are in line with a systematic review suggesting that objectively measured physical activity (PA) is not an important predictor of change in adiposity in children, adolescents and adults.[12] In contrast, another systematic review found a protective effect of physical activity on adiposity in adolescents.[10] There were however several methodological weaknesses in the studies included in this review, particularly regarding the validity of the measurement of both physical activity and body composition. In contrast, our study employed robust measures of both these exposures and outcomes, a combination of which is lacking in much past research on the association between the two.[10–12]

In adolescents, physical activity is influenced by friends, family and other social support[30] and is less stable than in adults.[31–33] Follow-up data on objectively measured physical activity were not available in the present study, but some evidence suggest that the decline in physical activity is steeper prior to the onset of adolescence.[34] Reductions in level of physical activity during the transition from adolescence to young adulthood nevertheless often occur.[35] Prior observations from the same cohort showed that change in self-reported physical activity between baseline and follow-up was a stronger predictor of change in body composition than self-reported baseline physical activity.[36] Other studies have suggested that change in activity during follow-up might obscure an association with body composition.[37 38] In a subanalyses,

Table 4 Association between minutes per day spent in MVPA (cpm≥1952) at baseline and changes in body composition*

	Boys (n=171)			Girls (n=260)		
	Beta	95% CI	P value	Beta	95% CI	P value
Δ BMI						
Model 1	0.11	–0.07 to 0.30	0.22	–0.00	–0.17 to 0.16	0.97
Model 2	0.08	–0.13 to 0.29	0.47	0.07	–0.11 to 0.25	0.47
Δ waist circumference						
Model 1	0.25	–0.39 to 0.89	0.44	–0.03	–0.68 to 0.63	0.94
Model 2	–0.02	–0.75 to 0.71	0.95	0.02	–0.70 to 0.74	0.96
Δ FMI						
Model 1	0.02	–0.15 to 0.19	0.83	–0.01	–0.17 to 0.14	0.86
Model 2	0.06	–0.14 to 0.25	0.57	0.05	–0.12 to 0.22	0.54
Δ LMI						
Model 1	0.07	–0.02 to 0.15	0.11	0.03	–0.03 to 0.09	0.33
Model 2	0.01	–0.08 to 0.10	0.86	0.02	–0.04 to 0.09	0.44
Δ aLMI						
Model 1	0.03	–0.02 to 0.08	0.19	0.02	–0.01 to 0.05	0.13
Model 2	0.00	–0.05 to 0.05	0.92	0.02	–0.01 to 0.05	0.18

*The table displays the association between minutes spent in moderate-to-vigorous physical activity (MVPA) and difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2), LMI (lean mass in kg/m^2) and aLMI (appendicular lean mass in kg/m^2) between Fit Futures 1 (2010–2011) and Fit Futures 2 (2012–2013). The models give the beta coefficient for 15 min increase in MVPA. Both models were adjusted for baseline values of the body composition parameter. In model 2 also adjusted for time between measurements and baseline values of screen time on weekdays, study specialisation, age in half-years, regularity of eating breakfast and device wear time.
aLMI, appendicular LMI ; BMI, body mass index; FMI, fat mass index ; LMI, lean mass index .

one of four in both the highest and lowest categories of MVPA at baseline reported decreased (high MVPA at baseline) and increased (low MVPA at baseline) self-reported physical activity at follow-up, thus indicating that physical activity in adolescents is fluctuant. These two observations, assuming that measurement of both MVPA and self-reported hours per week of physical activity, are representative of actual physical activity behaviour at the time, work in opposing directions with regards to the effect of physical activity on changes in adiposity. This phenomenon is known as regression dilution bias and may flatten the regression slope and cause an underestimate of the actual association.[39] With an annual decline in total physical activity of 7% in adolescents, researchers must consider the possibility that measured physical activity has a 'best before-date'. It remains questionable whether baseline measurements of a fluctuant behaviour such as physical activity is representative of actual habits during the period of follow-up. It may be that the measurement represents current, but not future (or even prior) habits.[12 40] This has implications for longitudinal studies of the relationship between physical activity and body composition.[38]

Strengths and limitations

The primary strength of this study is objective measures of both physical activity and body composition parameters and the inclusion of tissue-specific measures of body composition. Some limitations have to be considered. As the Fit Futures study did not include a validated food frequency questionnaire or similar instrument for nutritional assessment, we were not able to fully adjust for the potential confounding effects of nutrition and changes in food habits of adolescents on changes in body composition. Accelerometer-measured physical activity has limitations. A hip worn accelerometer such as the ActiGraph GT3X is not able to correctly measure cycling and swimming.[41] Furthermore, accelerometers are dependent on user compliance, and non-wear time therefore affects the amount of activity that is actually measured. Subjective judgement determines data management and analyses, for example, the decision to exclude participants with wear time <10 hours and <4 consecutive days is a trade-off between quality of data and the number of participants with valid data. We lacked complete data on physical activity and adjustment variables in 212 participants, but changes in BMI, waist circumference, FMI, LMI (except in girls, p=0.04) and aLMI were not significantly different between those with and without complete exposure data. Furthermore, of those with valid data concerning both physical activity and body composition parameters at baseline, close to 25% did not attend the follow-up (online supplemental appendix table 1). This group differed significantly from those included in the main analyses with respect to both physical activity and body composition parameters. The prospective associations between physical activity and changes in body composition parameters in this group (n=133) may be different from those observed in the group of participants included in the main analyses (n=431), and the associations in all the 564 participants with valid baseline data may therefore be different from what we find in the main analyses. This is however not possible to determine given the lack of follow-up data.

Although longitudinal observational studies are superior to cross-sectional studies to examine causation, they are also susceptible to directional bias, since participants may avoid physical activity because they are overweight, and not be overweight because they are inactive.[42–44] Finally, as the participants were 16 years old, much may already have happened both to the level of physical activity and the different measures of body composition prior to participation. In light of this, 2 years of follow-up may be a short time frame to determine the potential effects of physical activity on changes in the different body composition parameters.

CONCLUSION

Objectively measured physical activity was not significantly associated with change in objectively measured BMI, waist circumference or FMI after 2 years in this cohort of Norwegian adolescents. There was evidence to suggest that sedentary and light activity affected indices of lean mass in girls, but not boys.

Author affiliations
[1]Department of Community Medicine, UiT The Arctic University of Norway, Tromso, Troms, Norway
[2]Nordlandssykehuset HF, Bodø, Norway
[3]School of Sport Sciences, UiT Arctic University of Norway, Alta, Finnmark, Norway
[4]Centre for Sami Health Research, UiT The Arctic University of Norway, Tromso, Troms, Norway
[5]Department of Computer Science, UiT The Arctic University of Norway, Tromso, Troms, Norway
[6]Department of Health and Care Siences, UiT The Arctic University of Norway, Tromso, Troms, Norway
[7]Department of Microbiology and Infection Control, Universitetssykehuset Nord-Norge, Tromsø, Norway
[8]Faculty of Health and Social Sciences, Molde University College, Molde, Norway

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Contributors NAA wrote the draft of the manuscript, which was revised and edited by all authors several times during the process. SB produced the accelerometer variables in close collaboration with AH, who wrote the software which converted raw accelerometer data to variables. BKJ contributed to the statistical analyses, and BM specifically contributed to the discussion of physical activity. NE and A-SF were among the principal investigators in FF1 and FF2 and contributed significantly to the acquisition of data. SG formulated the research question and conceived the study. All authors have substantially contributed to the study, and have read and approved the final manuscript.

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ORCID iDs
Nils Abel Aars http://orcid.org/0000-0002-0447-2668
Bente Morseth http://orcid.org/0000-0002-7973-0342

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Supplementary file

Appendix Table 1. Descriptive characteristics of participants lost to follow-up (n = 133), with p-value for difference from sample in Table 1*.

	Boys (n = 79)	P for difference	Girls (n = 54)	P for difference
Age (years)	16.1 (0.4)	0.26	16.1 (0.4)	0.42
Height (cm)	176.7 (13.8)	0.31	164.5 (5.9)	0.18
Body weight (kg)	73.3 (18.0)	0.01	63.5 (1.9)	0.06
Body mass index (BMI kg/m2)	23.4 (5.2)	0.01	23.4 (4.4)	0.02
Waist circumference (cm)	85.1 (13.9)	<0.01	80.0 (12.4)	0.02
Total Body Fat Mass (kg)	17.6 (12.8)	<0.01	22.8 (10.3)	0.01
Fat Mass Index (FMI kg/m2)	5.6 (4.0)	<0.01	8.4 (3.5)	0.01
Total Body Lean Mass (kg)	53.9 (7.8)	0.46	38.6 (4.6)	0.33
Lean Mass Index (LMI kg/m2)	17.2 (1.9)	0.43	14.2 (1.4)	0.42
Appendicular Lean Mass (kg)	25.3 (4.1)	0.49	17.4 (2.5)	0.48
Appendicular Lean Mass Index (aLMI kg/m2)	8.1 (1.0)	0.41	6.4 (0.76)	0.29
Accelerometer variables				
Wear time per valid day	14.3 (1.2)	0.26	13.7 (1.0)	<0.01
Counts per minute	338.4 (112.1)	0.08	300.5 (121.5)	0.03
Minutes per day in different intensities				
Sedentary (cpm 0 – 99)	570.1 (82.6)	0.38	562.6 (68.9)	0.39
Light (cpm 100 – 1951)	244.3 (64.7)	0.05	223.4 (46.3)	0.04
Moderate (cpm 1952 – 5723)	42.9 (19.6)	0.15	33.0 (17.6)	<0.01
Vigorous (cpm ≥ 5724)	2.3 (2.9)	0.03	2.7 (5.1)	0.40
MVPA# (cpm ≥ 1952)	45.2 (21.0)	0.08	35.6 (20.0)	0.01
Meeting MVPA guidelines per day				
0 – 29 minutes	21 (26.6)		24 (44.4)	
30 – 59 minutes	41 (51.9)		23 (42.6)	
≥ 60 minutes	17 (21.5)		7 (13.0)*	

*: Statistically significantly different linear trend from sample included in manuscript (Table 1).

Appendix Table 2. Association between minutes per day spent in sedentary activity (CPM 0 – 99) at baseline and changes in body composition, adjusted for puberty#.

	Boys (n = 143)			Girls (n = 258)		
	Beta	95% CI	p value	Beta	95% CI	p value
Δ BMI						
Model 1	-0.02	-0.14, 0.09	0.70	-0.05	-0.15, 0.05	0.32
Model 2	-0.01	-0.17, 0.14	0.85	-0.11	-0.24, 0.03	0.12
Model 3	0.03	-0.17, 0.23	0.76	-0.11	-0.27, 0.05	0.19
Δ waist circumference						
Model 1	0.12	-0.27, 0.51	0.55	-0.01	-0.42, 0.39	0.95
Model 2	0.24	-0.28, 0.77	0.36	-0.38	-0.91, 0.15	0.16
Model 3	0.37	-0.32, 1.06	0.29	-0.52	-1.14, 0.10	0.10
Δ FMI						
Model 1	-0.01	-0.12, 0.09	0.84	-0.01	-0.11, 0.08	0.81
Model 2	-0.01	-0.15, 0.13	0.85	-0.06	-0.18, 0.07	0.35
Model 3	0.01	-0.17, 0.20	0.90	-0.05	-0.20, 0.10	0.49
Δ LMI						
Model 1	0.00	-0.05, 0.06	0.90	-0.06	-0.09, -0.02	< 0.01
Model 2	0.01	-0.07, 0.08	0.89	-0.07	-0.12, -0.02	< 0.01
Model 3	0.02	-0.08, 0.11	0.74	-0.08	-0.13, -0.02	< 0.01
Δ aLMI						
Model 1	-0.00	-0.03, 0.03	0.91	-0.02	-0.04, -0.00	0.02
Model 2	0.00	-0.04, 0.04	0.92	-0.03	-0.05, -0.00	0.02
Model 3	0.01	-0.04, 0.07	0.59	-0.03	-0.06, 0.00	0.06

#: The table displays the association between minutes spent in sedentary activity and difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2), LMI (lean mass in kg/m^2) and aLMI (appendicular lean mass in kg/m^2) between Fit Futures 1 (2010-2011) and Fit Futures 2 (2012-2013). The models give the beta coefficient for 30 minutes increase in sedentary activity. All models were adjusted for baseline values of the outcome. In model 2 also adjusted for time between measurements and baseline values of pubertal development (pds (boys) and age at menarche (girls)), screen time on weekdays, study specialisation, age in half-years, regularity of eating breakfast and device wear time. In Model 3 adjusted also for minutes spent in Moderate-to-vigorous physical activity (CPM ≥ 1952).

Appendix Table 3. Association between minutes per day spent in light activity (CPM 100 – 1951) at baseline and changes in body composition, adjusted for puberty#.

	Boys (n = 143)			Girls (n = 258)		
	Beta	95% CI	p value	Beta	95% CI	p value
Δ BMI						
Model 1	0.05	-0.10, 0.20	0.53	0.04	-0.09, 0.18	0.54
Model 2	-0.00	-0.19, 0.18	0.97	0.11	-0.04, 0.27	0.15
Model 3	-0.03	-0.23, 0.17	0.76	0.11	-0.05, 0.27	0.19
Δ waist circumference						
Model 1	-0.01	-0.53, 0.51	0.97	0.53	-0.00, 1.07	0.05
Model 2	-0.34	-0.98, 0.30	0.30	0.50	-0.11, 1.11	0.11
Model 3	-0.37	-1.06, 0.32	0.29	0.51	-0.11, 1.13	0.10
Δ FMI						
Model 1	0.05	-0.09, 0.18	0.51	0.02	-0.11, 0.14	0.78
Model 2	0.00	-0.17, 0.18	0.97	0.06	-0.09, 0.20	0.43
Model 3	-0.01	-0.20, 0.17	0.90	0.05	-0.10, 0.20	0.49
Δ LMI						
Model 1	-0.01	-0.08, 0.06	0.84	0.04	-0.01, 0.09	0.08
Model 2	-0.01	-0.10, 0.07	0.80	0.08	0.02, 0.13	< 0.01
Model 3	-0.02	-0.11, 0.07	0.74	0.08	0.02, 0.13	< 0.01
Δ aLMI						
Model 1	0.00	-0.04, 0.04	0.93	0.02	-0.01, 0.04	0.17
Model 2	-0.01	-0.06, 0.04	0.73	0.03	0.00, 0.06	0.04
Model 3	-0.01	-0.07, 0.04	0.59	0.03	-0.00, 0.06	0.06

#: The table displays the association between minutes spent in light activity and difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2), LMI (lean mass in kg/m^2) and aLMI (appendicular lean mass in kg/m^2) between Fit Futures 1 (2010-2011) and Fit Futures 2 (2012-2013). The models give the beta coefficient for 30 minutes increase in light activity. All models were adjusted for baseline values of the outcome. In model 2 also adjusted for time between measurements and baseline values of pubertal development (pds (boys) and age at menarche (girls)), screen time on weekdays, study specialisation, age in half-years, regularity of eating breakfast and device wear time. In Model 3 adjusted also for minutes spent in Moderate-to-vigorous physical activity (CPM ≥ 1952).

Appendix Table 4. Association between minutes per day spent in MVPA (CPM ≥ 1952) at baseline and changes in body composition, adjusted for puberty#.						
	Boys (n = 143)			Girls (n = 258)		
	Beta	95% CI	p value	Beta	95% CI	p value
Δ BMI						
Model 1	0.11	-0.08, 0.31	0.24	-0.00	-0.17, 0.16	0.97
Model 2	0.07	-0.15, 0.29	0.51	0.07	-0.11, 0.25	0.43
Δ waist circumference						
Model 1	0.28	-0.38, 0.95	0.40	-0.02	-0.68, 0.64	0.95
Model 2	-0.06	-0.82, 0.70	0.88	0.02	-0.69, 0.72	0.97
Δ FMI						
Model 1	0.02	-0.16, 0.20	0.80	-0.01	-0.17, 0.14	0.88
Model 2	0.05	-0.16, 0.25	0.66	0.06	-0.11, 0.22	0.52
Δ LMI						
Model 1	0.08	-0.02, 0.17	0.11	0.03	-0.03, 0.09	0.34
Model 2	0.01	-0.09, 0.11	0.84	0.03	-0.04, 0.09	0.42
Δ aLMI						
Model 1	0.05	-0.01, 0.10	0.09	0.02	-0.01, 0.05	0.13
Model 2	0.02	-0.04, 0.07	0.60	0.02	-0.01, 0.06	0.15

#: The table displays the association between minutes spent in moderate-to-vigorous physical activity (MVPA) and difference in BMI (kg/m^2), waist circumference, FMI (fat mass in kg/m^2), LMI (lean mass in kg/m^2) and aLMI (appendicular lean mass in kg/m^2) between Fit Futures 1 (2010-2011) and Fit Futures 2 (2012-2013). The models give the beta coefficient for 15 minutes increase in MVPA. Both models were adjusted for baseline values of the outcome. In model 2 also adjusted for time between measurements and baseline values of pubertal development (pds (boys) and age at menarche (girls)), screen time on weekdays, study specialisation, age in half-years, regularity of eating breakfast and device wear time.

Appendices

1. General questionnaire Fit Futures 1.
2. General questionnaire Fit Futures 2.
3. Letter of approval from The Regional Committee of Medical and Health Research Ethics (Rec North), project number 2014/1666.
4. License from publisher to include Paper 1 in the thesis.

FF - Generelt spørreskjema - Uke 1

Vi ønsker å vite mer om livsstil og helse.

Bruk den tiden du trenger til å svare så presist du kan.

Alle svarene dine blir behandlet med taushetsplikt.

Bruk "neste >>" og "<< tilbake" - knappene i skjema for å bla deg fremover og bakover.

Lykke til og tusen takk for hjelpen!

DEG OG DIN FAMILIE

1) Er du:

○ Jente ○ Gutt

2) Hvem bor du sammen med nå? (sett ett eller flere kryss)

☐ Mor

☐ Far

☐ 1-2 søsken

☐ 3 eller flere søsken

☐ Mors nye mann/samboer

☐ Fars nye kone/samboer

☐ Fosterforeldre

☐ Adoptivforeldre

☐ Besteforeldre

☐ Venner

☐ Alene/på hybel

☐ Institusjon

☐ Annet

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Hvem bor du sammen med nå? (sett ett eller flere kryss) *er lik*Venner

- eller
- Hvis Hvem bor du sammen med nå? (sett ett eller flere kryss) *er lik*Institusjon
- eller
- Hvis Hvem bor du sammen med nå? (sett ett eller flere kryss) *er lik*Alene/på hybel

-)

3) Hvor lenge er det siden du flyttet hjemmefra?

- Mindre enn 6 måneder
- 6 - 11 måneder
- 1 - 2 år
- Mer enn 2 år

4) Er moren din i arbeid? (sett ett eller flere kryss)

- Ja, heltid
- Ja, deltid
- Arbeidsledig
- Uførerygdet
- Hjemmeværende
- Går på skole, kurs, e.l.
- Pensjonist
- Mor er død
- Vet ikke
- Annet

5) Er faren din i arbeid? (sett ett eller flere kryss)

- Ja, heltid
- Ja, deltid
- Arbeidsledig
- Uførerygdet
- Hjemmeværende
- Går på skole, kurs, e.l.
- Pensjonist
- Far er død
- Vet ikke
- Annet

6) Hva er den høyeste fullførte utdanningen til dine foreldre? (sett kryss for alle utdanningene du vet om for mor og far)

	Grunnskole	Yrkesfaglig videregående, yrkesskole	Allmennfaglig videregående skole eller gymnas	Høyskole eller universitet, mindre enn 4 år	Høyskole eller universitet, 4 år eller mer	Vet ikke
Mors utdanning	○	○	○	○	○	○
Fars utdanning	○	○	○	○	○	○

7) Hva regner du deg selv som: (kryss av for ett eller flere alternativ)

☐ Norsk

☐ Samisk

☐ Kvensk/Finsk

☐ Annet, spesifiser her

8) I hvilken kommune bodde du da du var 5-6 år (førskolealder/1.klasse)?

Velg kommune

9) Er du født i Norge?

○ Ja

○ Nei, spesifiser hvilket land

10) Er din biologiske mor født i Norge?

○ Ja

○ Nei, spesifiser hvilket land

11) Er din biologiske far født i Norge?

○ Ja

○ Nei, spesifiser hvilket land

12) Har du noen gang oppholdt deg 4 uker eller mer sammenhengende i Australia, USA, Argentina eller Sør-Afrika?

○ Ja ○ Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du noen gang oppholdt deg 4 uker eller mer sammenhengende i Australia, USA, Argentina eller Sør-Afrika? *er lik* Ja
-)

Hvis det har vært flere opphold, oppgi varighet av siste opphold.

13) Hvor lenge varte oppholdet?

○ Mindre enn 2 måneder

○ 2-6 måneder

○ Mer enn 6 måneder

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du noen gang oppholdt deg 4 uker eller mer sammenhengende i Australia, USA, Argentina eller Sør-Afrika? *er lik* Ja
-)

Hvis det har vært flere opphold, oppgi når du hadde siste opphold.

14) Når var oppholdet? (Oppgi årstall når oppholdet sluttet - 4 siffer)

VENNER OG SKOLE

15) Har du vurdert å avbryte eller ta pause fra den videregående opplæringen du er i gang med?

○ Ja ○ Nei

16) Hvor sannsynlig er det at du fullfører den utdanningen du er i gang med?

○ Liten - kommer til å slutte

○ God - kommer sannsynligvis til å fullføre

○ Stor - Kommer helt sikkert til å fullføre

○ Vet ikke

17) Hvor mange tekstmeldinger (SMS/MMS) sendte du med mobiltelefon i går?

○ Ingen

○ 1-5 meldinger

○ 6-10 meldinger

○ 11-20 meldinger

○ 21-50 meldinger

○ Mer enn 50 meldinger

18) Nedenfor er det noen spørsmål om hvordan du synes du selv er. Kryss av for det som passer best for deg.

	Stemmer svært godt	Stemmer nokså godt	Stemmer nokså dårlig	Stemmer svært dårlig
Jeg synes det er ganske vanskelig å få venner	○	○	○	○
Jeg har mange venner	○	○	○	○
Andre ungdommer har vanskelig for å like meg	○	○	○	○
Jeg er populær blant jevnaldrende	○	○	○	○
Jeg føler at jevnaldrende godtar meg	○	○	○	○

19) Hvilke avgangskarakterer fikk du fra ungdomsskolen? (sett ett kryss for hvert fag)

	1	2	3	4	5	6	Husker ikke
Norsk skriftlig	○	○	○	○	○	○	○
Matematikk	○	○	○	○	○	○	○
Engelsk	○	○	○	○	○	○	○

HELSE

20) Hvordan vurderer du din egen helse sånn i alminnelighet?

○ Meget god

○ God

○ Verken god eller dårlig

○ Dårlig

○ Meget dårlig

21) Hvor ofte har du i løpet av de siste 4 ukene brukt følgende medisiner?

	Ikke brukt siste 4 uker	Sjeldnere enn hver uke	Hver uke, men ikke daglig	Daglig
Smertestillende på resept (f. eks. Paralgin forte, Pinex forte)	○	○	○	○
Smertestillende uten resept (f. eks. Paracet, Pinex, Ibux)	○	○	○	○
Sovemidler	○	○	○	○
Medisin mot depresjon	○	○	○	○
Medisiner mot ADHD	○	○	○	○
Beroligende medisiner	○	○	○	○

22) Har du diabetes?

○ Ja ○ Nei

23) Har din biologiske mor diabetes?

○ Ja ○ Nei ○ Vet ikke

24) Har din biologiske far diabetes?

○ Ja ○ Nei ○ Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har din biologiske mor diabetes? *er lik* Ja
-)

25) Bruker mor insulin? (Penn eller pumpe)

Ja Nei Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har din biologiske mor diabetes? *er lik* Ja
-)

26) Hvor gammel var mor da hun fikk diabetes?

< 20 år 20 - 40 år > 40 år

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har din biologiske far diabetes? *er lik* Ja
-)

27) Bruker far insulin? (Penn eller pumpe)

Ja Nei Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har din biologiske far diabetes? *er lik* Ja
-)

28) Hvor gammel var far da han fikk diabetes?

< 20 år 20 - 40 år > 40 år

PSYKISKE VANSKER

29) Har du gått i behandling hos psykolog, psykiater eller PP-tjenesten det siste året?

Ja Nei

30) Under finner du en liste over ulike problemer. Har du opplevd noe av dette den siste uken (til og med i dag)?

	Ikke plaget	Litt plaget	Ganske mye	Veldig mye
Plutselig frykt uten grunn				
Føler deg redd eller engstelig				
Matthet eller svimmelhet				

Føler deg anspent eller oppjaget	◯	◯	◯	◯
Lett for å klandre deg selv	◯	◯	◯	◯
Søvnproblemer	◯	◯	◯	◯
Nedtrykt, tungsindig	◯	◯	◯	◯
Følelse av å være unyttig, lite verdt	◯	◯	◯	◯
Følelse av at alt er et slit	◯	◯	◯	◯
Følelse av håpløshet med hensyn til framtida	◯	◯	◯	◯

31) De følgende spørsmålene handler om hva du følte og gjorde de siste to ukene.

	Riktig	Noen ganger riktig	Ikke riktig
Jeg var lei meg eller ulykkelig	◯	◯	◯
Jeg følte meg så trøtt at jeg bare ble sittende uten å gjøre noen ting	◯	◯	◯
Jeg var veldig rastløs	◯	◯	◯
Jeg var ikke glad for noe	◯	◯	◯
Jeg følte meg lite verdt	◯	◯	◯
Jeg gråt mye	◯	◯	◯
Jeg hatet meg selv	◯	◯	◯
Jeg tenkte at jeg aldri kunne bli så god som andre ungdommer	◯	◯	◯
Jeg følte meg ensom	◯	◯	◯
Jeg tenkte at ingen egentlig var glad i meg	◯	◯	◯
Jeg følte meg som et dårlig menneske	◯	◯	◯
Jeg gjorde alt galt	◯	◯	◯
Jeg syntes det var vanskelig å tenke klart eller å konsentrere meg	◯	◯	◯

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Er du: *er lik* Jente
-)

PUBERTET

Her har vi noen spørsmål om kroppslige forandringer som skjer gjennom ungdomstiden:

32) Har du fått menstruasjon?

◯ Ja ◯ Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du fått menstruasjon? *er lik* Ja
-)

Hvor gammel var du da du fikk menstruasjon første gang?
33) År

Velg alternativ

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du fått menstruasjon? *er lik* Ja
-)

34) Måneder

Velg alternativ

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du fått menstruasjon? *er lik* Nei
-)

35) Har du fått eller begynt å få kjønnshår?

Ja Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du fått menstruasjon? *er lik* Nei
-)

36) Har du fått eller begynt å få bryster?

Ja Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Er du: *er lik* Gutt
-)

37) Har du fått eller begynt å få kjønnshår?

○ Ja ○ Nei

Denne informasjonen vises kun i forhåndsvisningen

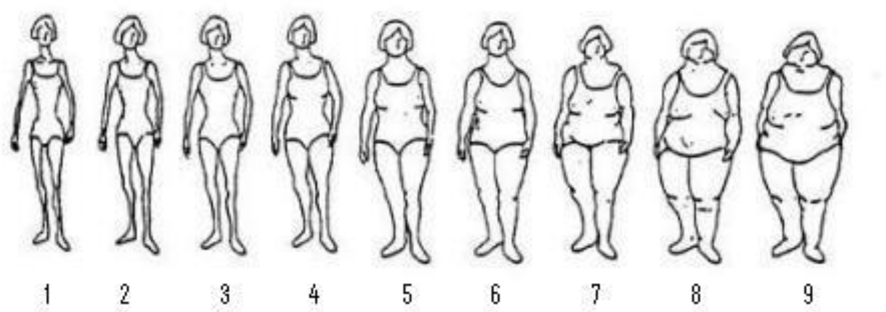
Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du fått eller begynt å få kjønnshår? *er lik* Ja
-)

38) Hvor gammel var du da du begynte å få kjønnshår?

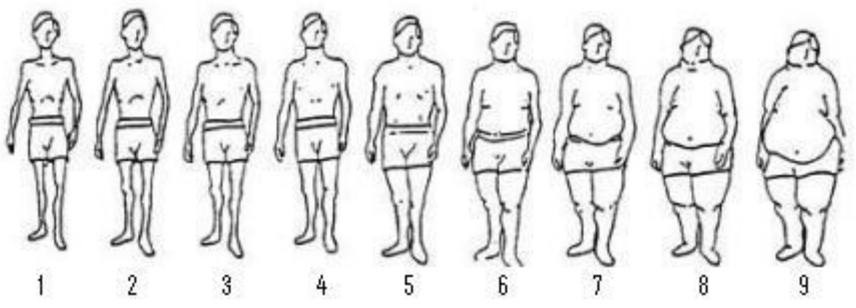
Velg alternativ

KROPP OG VEKT



39) Hvilken av disse kroppsfasongene likner mest på kroppen til moren din?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9



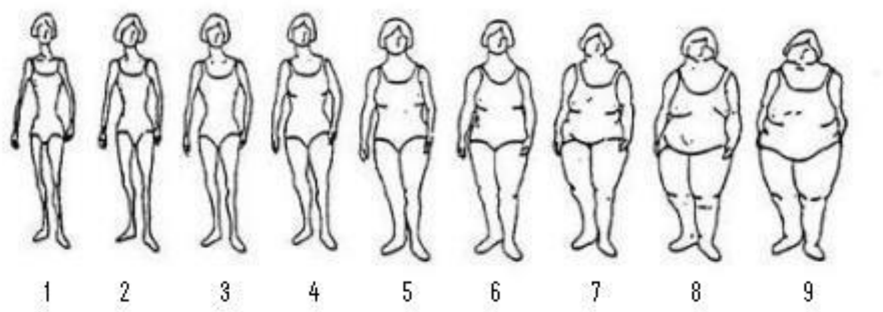
40) Hvilken av disse kroppsfasongene likner mest på kroppen til faren din?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Er du: *er lik* Jente
-)



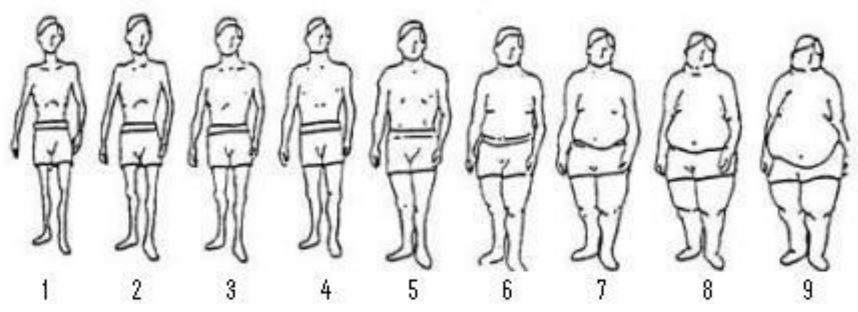
41) Hvilken av disse kroppsfasongene likner mest på din kropp slik du er i dag?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Er du: *er lik* Gutt
-)



42) Hvilken av disse kroppsfasongene likner mest på din kropp slik du er i dag?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

RØYK, SNUS OG ALKOHOL

43) Røyker du?

○ Nei, aldri ○ Av og til ○ Daglig

44) Bruker du snus eller skrå?

○ Nei, aldri ○ Av og til ○ Daglig

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Røyker du? *er lik* Av og til
-)

45) Hvor mange sigaretter røyker du vanligvis i løpet av en uke?

○ 1 eller færre

○ 2-3

○ 4-6

○ 7-10

○ Mer enn 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Røyker du? *er lik* Daglig
-)

46) Hvor mange sigaretter røyker du vanligvis per dag?

○ 1

○ 2-3

○ 4-6

○ 7-10

○ Mer enn 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Bruker du snus eller skrå? *er lik* Av og til
-)

47) Hvor mange priser snus/skrå bruker du vanligvis i løpet av en uke?

- 1 eller færre
- 2-3
- 4-6
- 7-10
- Mer enn 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Bruker du snus eller skrå? *er lik* Daglig
-)

48) Hvor mange priser snus/skrå bruker du per dag?

- 1
- 2-3
- 4-6
- 7-10
- Mer enn 10

49) Hvor ofte drikker du alkohol?

- Aldri
- 1 gang per måned eller sjeldnere
- 2-4 ganger per måned
- 2-3 ganger per uke
- 4 eller flere ganger per uke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Hvor ofte drikker du alkohol? *er lik* 1 gang per måned eller sjeldnere
  - eller
  - Hvis Hvor ofte drikker du alkohol? *er lik* 4 eller flere ganger per uke

- eller
  - Hvis Hvor ofte drikker du alkohol? *er lik* 2-3 ganger per uke
  - eller
  - Hvis Hvor ofte drikker du alkohol? *er lik* 2-4 ganger per måned
-)

50) Hvor mange enheter alkohol (en øl, ett glass vin eller en drink) tar du vanligvis når du drikker?

○ 1-2

○ 3-4

○ 5-6

○ 7-9

○ 10 eller flere

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Hvor ofte drikker du alkohol? *er lik* 1 gang per måned eller sjeldnere
  - eller
  - Hvis Hvor ofte drikker du alkohol? *er lik* 4 eller flere ganger per uke
  - eller
  - Hvis Hvor ofte drikker du alkohol? *er lik* 2-3 ganger per uke
  - eller
  - Hvis Hvor ofte drikker du alkohol? *er lik* 2-4 ganger per måned
-)

51) Hvor ofte drikker du 6 eller flere enheter alkohol ved en anledning?

○ Aldri

○ Sjeldnere enn 1 gang per måned

○ 1 gang per måned

○ 1 gang per uke

○ Daglig eller nesten daglig

FYSISK AKTIVITET

52) Hvilken beskrivelse passer best når det gjelder din fysiske aktivitet på fritiden det siste året?

○ Sitter ved PC/TV, leser eller annen stillesittende aktivitet.

○ Går, sykler eller beveger deg på annen måte minst 4 timer i uken (her skal du også regne med tur til/fra skolen, shopping, søndagsturer med mer).

○ Driver med idrett/trening, tyngre utearbeid, snømåking eller liknende minst 4 timer i uka.

○ Trener hardt eller driver konkurranseidrett regelmessig og flere ganger i uka.

53) Hvordan kommer du deg vanligvis til og fra skolen i sommerhalvåret?

○ Med bil, motorsykkel/moped

Med buss

Med sykkel

Går

54) Hvor lang tid bruker du vanligvis til og fra skolen (en vei) i sommerhalvåret?

Mindre enn 5 minutter

6 til 15 minutter

16 til 30 minutter

1/2 til 1 time

Mer enn 1 time

55) Hvordan kommer du deg vanligvis til og fra skolen i vinterhalvåret?

Med bil, motorsykkel/moped

Med buss

Med sykkel

Går

56) Hvor lang tid bruker du vanligvis til og fra skolen (en vei) i vinterhalvåret?

Mindre enn 5 minutter

6 til 15 minutter

16 til 30 minutter

1/2 til 1 time

Mer enn 1 time

57) Driver du med idrett eller fysisk aktivitet (f.eks. skateboard, fotball, dans, løping) utenom skoletid?

Ja Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Driver du med idrett eller fysisk aktivitet (f.eks. skateboard, fotball, dans, løping) utenom skoletid? *er lik* Ja
-)

58) Hvor mange dager i uken driver du med idrett/fysisk aktivitet utenom skoletid?

Aldri

Sjeldnere enn 1 dag i uka

1 dag i uka

2-3 dager i uka

4-6 dager i uka

Omtrent hver dag

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Driver du med idrett eller fysisk aktivitet (f.eks. skateboard, fotball, dans, løping) utenom skoletid? *er lik* Ja
-)

59) Omtrent hvor mange timer per uke bruker du til sammen på idrett/fysisk aktivitet utenom skoletid?

Ingen

Omtrent 1/2 time

Omtrent 1 - 1 1/2 time

Omtrent 2 - 3 timer

Omtrent 4 - 6 timer

7 timer eller mer

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Driver du med idrett eller fysisk aktivitet (f.eks. skateboard, fotball, dans, løping) utenom skoletid? *er lik* Ja
-)

60) Hvor slitsom er vanligvis idretten/aktiviteten du driver med utenom skoletid?

Ikke anstrengende

Litt anstrengende

Ganske anstrengende

Meget anstrengende

Svært anstrengende

Utenom skoletid: Hvor mange timer per dag ser du på PC, TV, DVD og liknende?

61) Hverdager, antall timer per dag:

Ingen

Omtrent 1/2 time

Omtrent 1 - 1 1/2 time

- Omtrent 2 - 3 timer
- Omtrent 4 - 6 timer
- Omtrent 7 - 9 timer
- 10 timer eller mer

62) Fridager (helg, helligdager, ferie), antall timer per dag:

- Ingen
- Omtrent 1/2 time
- Omtrent 1 - 1 1/2 time
- Omtrent 2 - 3 timer
- Omtrent 4 - 6 timer
- Omtrent 7 - 9 timer
- 10 timer eller mer

Svar på en skala fra 1 til 5, der 1 tilsvarer svært sjelden eller aldri og 5 tilsvarer svært ofte.

63) I hvilken grad har andre oppmuntret deg til å være fysisk aktiv

	1	2	3	4	5
Foreldre/foresatte	○	○	○	○	○
Søsken	○	○	○	○	○
Venner	○	○	○	○	○
Trenere	○	○	○	○	○
Gymlærere	○	○	○	○	○
Nabolaget	○	○	○	○	○

Svar på en skala fra 1 til 5, der 1 tilsvarer helt enig og 5 tilsvarer helt uenig.

64) Hvordan passer disse utsagnene for deg?

	1	2	3	4	5
Det er morsommere å drive med trening eller fysisk aktivitet enn å gjøre andre ting...	○	○	○	○	○
Jeg skulle ønske jeg kunne drive mer med trening eller fysisk aktivitet enn det jeg har anledning til å gjøre...	○	○	○	○	○
Jeg føler at jeg er bedre enn de fleste på min alder i idrett/fysisk aktivitet...	○	○	○	○	○
Jeg føler at jeg lett kan holde følge med de andre på min alder når vi driver med idrett/fysisk aktivitet...	○	○	○	○	○

Svar på en skala fra 1 til 5, der 1 tilsvarer helt enig og 5 tilsvarer helt uenig.

65) Hvordan passer disse utsagnene for deg?

	1	2	3	4	5
Jeg liker ikke å trene mens noen står å ser på...	○	○	○	○	○
Tilgang til egen garderobe hadde gjort det lettere å trene...	○	○	○	○	○
Jeg blir ubehagelig andpusten, svett eller får vondt i kroppen ved trening...	○	○	○	○	○

Gymtimene er organisert slik at jeg ikke henger med...					
Jeg har ingen å trene sammen med...					
Jeg mangler utstyr for å drive med den aktiviteten jeg har lyst til...					
Jeg har for mange andre oppgaver som gjør at jeg ikke får tid til å trene (f.eks lekser, hjemmeoppgaver)...					
Det mangler egnede haller eller gode uteområder for å drive fysisk aktivitet der jeg bor...					

MATVANER OG KOSTHOLD

66) Hvor ofte pleier du å spise følgende i løpet av en uke?

	Hver dag	4-6 dager i uka	1-3 dager i uka	Sjelden eller aldri
Frokost				
Middag				

67) Hvor ofte spiser du matpakke hjemmefra på skolen?

- Hver dag
- 3-4 ganger per uke
- 1-2 ganger per uke
- Sjelden eller aldri

68) Hvor ofte spiser du vanligvis disse matvarene?

	Sjelden/ aldri	1-3 ganger per måned	1-3 ganger per uke	4-6 ganger per uke	Hver dag
Ost (alle typer)					
Fet fisk (f.eks. laks, ørret, makrell, sild)					
Mager fisk (f.eks. torsk, sei, hyse)					
Pizza, hamburger eller pølser					
Hermetisert mat (fra metallbokser)					
Godteri (f.eks. sjokolade, drops)					
Snacks og søtsaker (f.eks. potetgull, kake, kjeks, bolle)					
Sukkerfri tyggegummi					

69) Hvor ofte spiser du vanligvis

	Sjelden/ aldri	1-3 ganger per mnd	1-3 ganger per uke	4-6 ganger per uke	1-2 ganger per dag	3-4 ganger per dag	5 eller flere ganger per dag
Frukt							
Grønnsaker							

70) Hvor mange ganger i året spiser du vanligvis disse matvarene?

	0	1-3	4-5	6-9	10 eller flere
Mølje med fiskelever	◯	◯	◯	◯	◯
Måsegg	◯	◯	◯	◯	◯
Reinsdyrkjøtt	◯	◯	◯	◯	◯
Selvplukket sopp	◯	◯	◯	◯	◯

71) Hvor mye drikker du vanligvis av følgende?

	Sjelden/ aldri	1-6 glass per uke	1 glass per dag	2-3 glass per dag	4 glass eller mer per dag
Helmelk, kefir, yoghurt	◯	◯	◯	◯	◯
Lettmelk, cultura, lettyoghurt	◯	◯	◯	◯	◯
Skummet melk (sur/søt)	◯	◯	◯	◯	◯
Ekstra lett melk	◯	◯	◯	◯	◯
Juice	◯	◯	◯	◯	◯
Saft med sukker	◯	◯	◯	◯	◯
Lettsaft, kunstig søtet	◯	◯	◯	◯	◯
Brus med sukker (1/2 liters flaske = 2 glass)	◯	◯	◯	◯	◯
Lettbrus, kunstig søtet (1/2 liters flaske = 2 glass)	◯	◯	◯	◯	◯
Vann	◯	◯	◯	◯	◯

72) Bruker du følgende kosttilskudd?

	Ja, daglig	Iblant	Nei
Tran, trankapsler, fiskeoljekapsler	◯	◯	◯
Vitamin- og/eller mineraltilskudd	◯	◯	◯

SØVN OG SØVNVANER

73) Når pleier du å legge deg for å sove på ukedagene?

Velg alternativ [▾]

74) Når pleier du å legge deg for å sove i helgen?

Velg alternativ [▾]

75) Hvor lenge pleier du å ligge våken før du får sove på ukedagene?

Velg alternativ [▾]

76) Hvor lenge pleier du å ligge våken før du får sove i helgen?

Velg alternativ [▾]

77) Når pleier du å våkne på ukedagene (endelig oppvåkning)?

Velg alternativ

78) Når pleier du å våkne i helgen (endelig oppvåkning)?

Velg alternativ

79) Hvor mange timer sover du vanligvis pr. natt?

Velg alternativ

80) Hvor mange timer søvn trenger du pr. natt for å føle deg uthvilt?

Velg alternativ

81) Synes du at du får tilstrekkelig med søvn?

- Ja, absolutt tilstrekkelig
- Ja, stort sett tilstrekkelig
- Nei, noe utilstrekkelig
- Nei, klart utilstrekkelig
- Nei, langt fra tilstrekkelig

HUD

Her har vi noen spørsmål om vanlige hudplager/hudsykdommer.

82) Har du hatt kløende utslett i løpet av de siste 12 månedene?

Ja Nei Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du hatt kløende utslett i løpet av de siste 12 månedene? *er lik* Ja
-)

83) Har dette utslettet sittet på noen av de følgende stedene: rundt hals, ører eller øyne, i albuebøyene (på innsiden), under baken, bak knærne eller foran på anklene?

Ja Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du hatt kløende utslett i løpet av de siste 12 månedene? *er lik* Ja
-)

84) Hvor gammel var du første gang du fikk denne typen utslett?

Velg alternativ

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du hatt kløende utslett i løpet av de siste 12 månedene? *er lik* Ja
-)

Hvor mye plaget er du av dette utslettet i dag?
Svar på en skala fra 0-10, der 0 tilsvarer ingen plager og 10 tilsvarer verst tenkelige plager.

0 1 2 3 4 5 6 7 8 9 10

86) Har du hatt håndeksem flere ganger?

Ja Nei Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du hatt håndeksem flere ganger? *er lik* Ja
-)

Hvor mye plaget er du av håndeksem i dag?
Svar på en skala fra 0-10, der 0 tilsvarer ingen plager og 10 tilsvarer verst tenkelige plager.

0 1 2 3 4 5 6 7 8 9 10

88) Har du noen gang vært plaget av kviser?

Ja Nei Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du noen gang vært plaget av kviser? *er lik* Ja
-)

Hvor mye plaget er du av kviser i dag?
Svar på en skala fra 0-10, der 0 tilsvarer ingen plager og 10 tilsvarer verst tenkelige plager.

0 1 2 3 4 5 6 7 8 9 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du noen gang vært plaget av kviser? *er lik* Ja
-)

90) Har du noen gang oppsøkt lege på grunn av kviser?

Ja Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du noen gang oppsøkt lege på grunn av kviser? *er lik* Ja
-)

91) Har du fått noen av disse behandlingene av lege?

	Ja	Nei	Vet ikke
Lokalbehandling (f.eks. kremer eller oppløsninger)			
Antibiotika tabletter (f.eks. Tetracyclin)			
Roaccutan tabletter			

92) Har du eller har du noen gang hatt psoriasis?

Ja Nei Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du eller har du noen gang hatt psoriasis? *er lik* Ja
-)

Hvor mye plaget er du av psoriasis i dag?
Svar på en skala fra 0-10, der 0 tilsvarer ingen plager og 10 tilsvarer verst tenkelige plager.

0 1 2 3 4 5 6 7 8 9 10

Verkebyller er svært store kviser som er ømme/smertefulle og som ofte gir arr.

94) Har du noen gang hatt verkebyller under armene/armhulene?

Ja

Nei

Vet ikke

95) Har du noen gang oppsøkt lege pga verkebyllene?

Ja Nei

96) Har du noen gang hatt verkebyller i lyskene/nært skrittet?

Ja

Nei

Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

97) Har du noen gang oppsøkt lege på grunn av verkebyllene?

Ja Nei

98) Har en lege noen gang sagt at du har...

	Ja	Nei	Vet ikke
høysnue eller neseallergi?			
astma?			
barneeksem eller atopisk eksem?			

SMERTER

99) Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer?

Ja Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

100) Hvor lenge har du hatt disse smertene? (Dersom du har flere typer smerte, svar for den som har vart lengst)

3 - 6 måneder

6 - 12 måneder

1-2 år

3-6 år

Mer enn 6 år

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

101) Hvor ofte har du vanligvis disse smertene?

- ○ Hele tiden, uten opphør
- ○ Hver dag, men ikke hele tiden
- ○ Hver uke, men ikke hver dag
- ○ Sjeldnere enn hver uke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

Hvor er det vondt?
(kryss av på alle aktuelle steder)

	Venstre side	Høyre side
Skulder	☐	☐
Arm/albue	☐	☐
Hånd	☐	☐
Hofte	☐	☐
Lår/kne/legg	☐	☐
Ankel/fot	☐	☐

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

-

	Midten
Hode/ansikt	☐
Kjeve/kjeveledd	☐
Nakke	☐
Øvre del av ryggen	☐
Korsryggen	☐
Bryst	☐
Mage	☐
Underliv/kjønnsorganer	☐

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

104) Hva mener du er årsaken til smertene? (flere svar mulig)

☐ PC-bruk, dataspill og lignende

☐ Idrettsskade

☐ Ulykke/skade

☐ Kirurgisk inngrep/operasjon

☐ Migrene/hodepine

☐ Medfødt sykdom

☐ Tannproblemer

☐ Whiplash

☐ Prolaps (skiveutglidning i ryggen)

☐ Annet ryggproblem

☐ Nerveskade

☐ Mage- eller tarmsykdom

☐ Annet, spesifiser her ________

☐ Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

Hvis du har langvarige smerter flere steder i kroppen, gjelder de 4 neste spørsmålene smerten som plager deg mest.

Hvor sterke vil du si at smertene vanligvis er?
Svar på en skala fra 0-10, der 0 tilsvarer ingen smerte og 10 tilsvarer verst tenkelig smerte.

Dersom du har flere typer smerte, svar den som plager deg mest.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

Hvor sterke er smertene når de er på sitt sterkeste?
Svar på en skala fra 0-10, der 0 tilsvarer ingen smerte og 10 tilsvarer verst tenkelig smerte.

Dersom du har flere typer smerte, svar den som plager deg mest.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

I hvor stor grad påvirker smertene søvnen din?
Svar på en skala fra 0-10, der 0 tilsvarer ingen smerte og 10 tilsvarer verst tenkelig smerte.

Dersom du har flere typer smerte, svar den som plager deg mest.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (

- ○ Hvis Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer? *er lik* Ja
-)

I hvor stor grad hindrer smertene deg i å utføre vanlige aktiviteter hjemme og på skolen?
Svar på en skala fra 0-10, der 0 tilsvarer ingen smerte og 10 tilsvarer verst tenkelig smerte.

Dersom du har flere typer smerte, svar den som plager deg mest.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

MAGE- OG TARMPROBLEMER

109) I løpet av de siste 2 månedene: Hvor ofte har du hatt smerte eller ubehag i magen?

○ Aldri

○ 1-3 ganger i måneden

○ En gang i uka

○ Flere ganger i uka

○ Hver dag

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis I løpet av de siste 2 månedene: Hvor ofte har du hatt smerte eller ubehag i magen? *er lik* 1-3 ganger i måneden
  - eller
  - Hvis I løpet av de siste 2 månedene: Hvor ofte har du hatt smerte eller ubehag i magen? *er lik* Hver dag
  - eller
  - Hvis I løpet av de siste 2 månedene: Hvor ofte har du hatt smerte eller ubehag i magen? *er lik* Flere ganger i uka
  - eller
  - Hvis I løpet av de siste 2 månedene: Hvor ofte har du hatt smerte eller ubehag i magen? *er lik* En gang i uka
-)

110) Hvor lenge har du vært plaget av smerte eller ubehag i magen?

○ Mindre enn 1 måned

○ 2 måneder

○ 3 måneder

○ 4-11 måneder

○ Ett år eller mer

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 2 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*Ett år eller mer
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*4-11 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 3 måneder
-)

111) I hvilken del av magen er det du har hatt smerte eller ubehag? (kryss av for alt som passer)

☐ Over navlen

☐ Rundt navlen

☐ Nedenfor navlen

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 2 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*Ett år eller mer
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*4-11 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 3 måneder
-)

112) Når du har smerter eller ubehag i magen, hvor lenge varer det vanligvis?

○ Mindre enn 1 time

○ 1-2 timer

○ 3-4 timer

○ Mesteparten av dagen

○ Hele døgnet

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 2 måneder
  - eller

- Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*Ett år eller mer
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*4-11 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 3 måneder
-)

Når du har smerte eller ubehag i magen, hvor sterke smerter har du vanligvis?
Svar på en skala fra 0-10, der 0 tilsvarer ingen smerte og 10 tilsvarer verst tenkelig smerte.

Dersom du har flere typer smerte, svar den som plager deg mest.

0 1 2 3 4 5 6 7 8 9 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 2 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*Ett år eller mer
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*4-11 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 3 måneder
-)

114) Når du har smerter eller ubehag i magen, hvor ofte blir det bedre etter at du har hatt avføring?

- Sjelden eller aldri
- En del ganger
- For det meste/hver gang

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 2 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*Ett år eller mer
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik*4-11 måneder
  - eller
  - Hvis Hvor lenge har du vært plaget av smerte eller ubehag i magen? *er lik* 3 måneder
-)

115) Når du har smerter eller ubehag i magen, hvor ofte skjer det i forbindelse med at du..

	Sjelden eller aldri	En del ganger	For det meste
har fastere eller mer klumpete avføring enn vanlig?			
har løsere eller mer vannaktig avføring enn vanlig?			
hadde avføring oftere enn vanlig?			
hadde avføring sjeldnere enn vanlig?			

HODEPINE

116) Har du vært plaget av hodepine det siste året?

Ja Nei

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du vært plaget av hodepine det siste året? *er lik* Ja
-)

117) Hva slags hodepine er du plaget av? (Du kan sette flere kryss)

Migrene Annen hodepine Vet ikke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du vært plaget av hodepine det siste året? *er lik* Ja
-)

118) Omtrent hvor mange dager per måned har du hodepine?

Mindre enn 1 dag

1-6 dager

7-14 dager

Mer enn 14 dager

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du vært plaget av hodepine det siste året? *er lik* Ja

-)

119) Er hodepinen vanligvis:

	Ja	Nei
Bankende/dunkende smerte	◯	◯
Pressende smerte	◯	◯
Ensidig smerte (høyre eller venstre)	◯	◯

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Har du vært plaget av hodepine det siste året? *er lik* Ja
-)

120) Hvor lenge varer hodepinen vanligvis?

◯ Mindre enn 4 timer

◯ 4 timer - 1 døgn

◯ 1-3 døgn

◯ Mer enn 3 døgn

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Har du vært plaget av hodepine det siste året? *er lik* Ja
-)

121) Før eller under hodepinen, kan du da ha forbigående:

	Ja	Nei
Synsforstyrrelse? (takkede linjer, flimring, tåkesyn, lysglimt)	◯	◯
Nummenhet i halve ansiktet eller i hånden?	◯	◯
Forverring ved moderat fysisk aktivitet?	◯	◯
Kvalme og/eller oppkast?	◯	◯

122) Hvor ofte pusser du vanligvis tennene dine? (sett ett kryss)

◯ Sjeldnere enn 1 gang per uke

◯ 1 gang per uke

◯ 2-3 ganger per uke

◯ 4-6 ganger per uke

◯ 1 gang daglig

2 eller flere ganger daglig

Hvor smertefullt, jevnt over, synes du det er å gå til tannlegen?
Svar på en skala fra 0-10, der 0 tilsvarer ingen smerte og 10 tilsvarer verst tenkelig smerte.

0 1 2 3 4 5 6 7 8 9 10

Nedenfor er det fire spørsmål om hvordan du opplever det er å gå til tannlege. Les hvert spørsmål og velg det svaralternativet som du synes passer best for deg.

124) Dersom du skulle gå til tannlegen i morgen, hva ville du føle?

Jeg ville se frem til det som en ganske hyggelig opplevelse

Det ville være det samme for meg, ikke bety noe

Det ville gjøre meg litt urolig

Jeg ville bli redd for at det skulle bli ubehagelig og vondt

Jeg ville bli svært redd med tanke på hva tannlegen kanskje skulle gjøre

125) Når du venter på tannlegens venteværelse, hvordan føler du deg da?

Avslappet

Litt urolig

Anspent, nervøs

Redd, engstelig

Så redd at jeg av og til begynner å svette eller nesten føler meg syk

126) Når du sitter i tannlegestolen og venter på at tannlegen skal begynne behandlingen, hvordan føler du deg da?

Avslappet

Litt urolig

Anspent, nervøs

Redd, engstelig

Så redd at jeg av og til begynner å svette eller nesten føler meg syk

Tenk at du sitter i tannlegestolen og skal få tennene renset og pusset. Mens du sitter og venter på at tannlege skal finne frem instrumentene som brukes til å skrape og pusse med,

127) hvordan føler du deg da?

Avslappet

Litt urolig

Anspent, nervøs

Redd, engstelig

Så redd at jeg av og til begynner å svette eller nesten føler meg syk

128) Har du øresus?

Aldri Sjelden Ofte

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du øresus? *er lik* Ofte
-)

129) Hvor ofte har du øresus?

- ○ Hele tiden, uten opphør
- ○ Hver dag, men ikke hele tiden
- ○ Hver uke, men ikke hver dag
- ○ Sjeldnere enn hver uke

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du øresus? *er lik* Ofte
-)

130) Hvor lenge varer vanligvis periodene med øresus?

○ Mindre enn 10 minutter ○ 10 minutter - 1 time ○ Mer enn 1 time

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du øresus? *er lik* Ofte
-)

131) Når får du vanligvis øresus?

☐ Etter sterke lyder ☐ Når det er stille ☐ Vet aldri når

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
  - Hvis Har du øresus? *er lik* Ofte
-)

Noen bryr seg ikke om lyden, for andre oppleves det svært plagsomt å ha øresus. Angi hvor plaget du er av øresusen.
Svar på en skala fra 0 til 10, der 0 tilsvarer ingen plager og 10 tilsvarer verst tenkelige plager.

○ 0 ○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9 ○ 10

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Har du øresus? *er lik* Ofte
-)

133) På hvilket øre har du vanligvis øresus?

- Bare høyre
- Bare venstre
- Begge, men mest høyre
- Begge, men mest venstre
- Like mye på begge

Denne informasjonen vises kun i forhåndsvisningen

Følgende kriterier må være oppfylt for at spørsmålet skal vises for respondenten:

- (
    - Hvis Har du øresus? *er lik* Ofte
-)

134) Omtrent hvor gammel var du når du begynte å ha øresus ofte?

Velg alternativ

FF2 Generelt spørreskjema - UKE 1

Vi ønsker å vite mer om livsstil og helse.

Bruk den tiden du trenger til å svare så presist du kan.

Alle svarene dine blir behandlet med taushetsplikt.

Bruk "neste >>" og "<< tilbake" - knappene i skjema for å bla deg fremover og bakover.

Lykke til og tusen takk for hjelpen!

DEG OG DIN FAMILIE

1) Er du:

○ Jente ○ Gutt

2) Hvem bor du sammen med nå? (sett ett eller flere kryss)

- Mor
- Far
- 1-2 søsken
- 3 eller flere søsken
- Mors nye mann/samboer
- Fars nye kone/samboer
- Fosterforeldre
- Adoptivforeldre
- Besteforeldre
- Venner
- Alene/på hybel
- Institusjon
- Samboer/gift
- Annet

3) Hvor lenge er det siden du flyttet hjemmefra?

- Mindre enn 6 måneder
- 6 - 11 måneder
- 1 - 2 år
- Mer enn 2 år

4) Er moren din i arbeid? (sett ett eller flere kryss)

- Ja, heltid
- Ja, deltid
- Arbeidsledig
- Uførerygdet
- Hjemmeværende
- Går på skole, kurs, e.l.
- Pensjonist
- Mor er død
- Vet ikke
- Annet

5) Er faren din i arbeid? (sett ett eller flere kryss)

- Ja, heltid
- Ja, deltid
- Arbeidsledig
- Uførerygdet
- Hjemmeværende
- Går på skole, kurs, e.l.
- Pensjonist
- Far er død
- Vet ikke
- Annet

6) Har du noen gang oppholdt deg 4 uker eller mer sammenhengende i Australia, USA, Argentina eller Sør-Afrika?

- Ja
- Nei

Hvis det har vært flere opphold, oppgi varighet av siste opphold.

7) Hvor lenge varte det siste oppholdet?

- Mindre enn 2 måneder
- 2-6 måneder
- Mer enn 6 måneder

Hvis det har vært flere opphold, oppgi når du hadde siste opphold.

8) Når var det siste oppholdet?

Velg... Velg... ▼

9) Er du i dag?

- Elev i videregående skole
- Lærling/elev i bedrift
- Ikke i videregående opplæring

VENNER OG SKOLE

10) Har du vurdert å avbryte eller ta pause fra den videregående opplæringen du er i gang med?

- Ja
- Nei

11) Hvor sannsynlig er det at du fullfører den utdanningen du er i gang med?

- Liten - kommer til å slutte
- God - kommer sannsynligvis til å fullføre
- Stor - Kommer helt sikkert til å fullføre
- Vet ikke

12) Hvor mange tekstmeldinger (SMS/MMS) sendte du med mobiltelefon i går?

- Ingen
- 1-5 meldinger
- 6-10 meldinger
- 11-20 meldinger
- 21-50 meldinger
- Mer enn 50 meldinger

13) Nedenfor er det noen spørsmål om hvordan du synes du selv er. Kryss av for det som passer best for deg.

	Stemmer svært dårlig	Stemmer nokså dårlig	Stemmer nokså godt	Stemmer svært godt
Jeg synes det er ganske vanskelig å få venner				
Jeg har mange venner				
Andre ungdommer har vanskelig for å like meg				
Jeg er populær blant jevnaldrende				
Jeg føler at jevnaldrende godtar meg				

HELSE

14) Hvordan vurderer du din egen helse sånn i alminnelighet?

- Meget god
- God
- Verken god eller dårlig
- Dårlig
- Meget dårlig

15) Hvor ofte har du i løpet av de siste 4 ukene brukt følgende medisiner?

	Ikke brukt siste 4 uker	Sjeldnere enn hver uke	Hver uke, men ikke daglig	Daglig
Smertestillende på resept (f. eks. Paralgin forte, Pinex forte)	○	○	○	○
Smertestillende uten resept (f. eks. Paracet, Pinex, Ibux)	○	○	○	○
Sovemidler	○	○	○	○
Medisin mot depresjon	○	○	○	○
Medisiner mot ADHD	○	○	○	○
Beroligende medisiner	○	○	○	○

16) Har en lege noen gang sagt at du har...

	Ja	Nei	Vet ikke
høysnue eller neseallergi?	○	○	○
astma?	○	○	○
barneeksem eller atopisk eksem?	○	○	○
psoriasis?	○	○	○

PSYKISKE VANSKER

17) Har du gått i behandling hos psykolog, psykiater eller PP-tjenesten det siste året?

○ Ja ○ Nei

18) Under finner du en liste over ulike problemer. Har du opplevd noe av dette den siste uken (til og med i dag)?

	Ikke plaget	Litt plaget	Ganske mye	Veldig mye
Plutselig frykt uten grunn	○	○	○	○
Føler deg redd eller engstelig	○	○	○	○
Matthet eller svimmelhet	○	○	○	○
Føler deg anspent eller oppjaget	○	○	○	○
Lett for å klandre deg selv	○	○	○	○
Søvnproblemer	○	○	○	○
Nedtrykt, tungsindig	○	○	○	○
Følelse av å være unyttig, lite verdt	○	○	○	○
Følelse av at alt er et slit	○	○	○	○
Følelse av håpløshet med hensyn til framtida	○	○	○	○

19) De følgende spørsmålene handler om hva du følte og gjorde de siste to ukene.

	Ikke riktig	Noen ganger riktig	Riktig
Jeg var lei meg eller ulykkelig	○	○	○
Jeg følte meg så trøtt at jeg bare ble sittende uten å gjøre noen ting	○	○	○
Jeg var veldig rastløs	○	○	○
Jeg var ikke glad for noe	○	○	○
Jeg følte meg lite verdt	○	○	○
Jeg gråt mye	○	○	○
Jeg hatet meg selv	○	○	○
Jeg tenkte at jeg aldri kunne bli så god som andre ungdommer	○	○	○
Jeg følte meg ensom	○	○	○
Jeg tenkte at ingen egentlig var glad i meg	○	○	○
Jeg følte meg som et dårlig menneske	○	○	○
Jeg gjorde alt galt	○	○	○
Jeg syntes det var vanskelig å tenke klart eller å konsentrere meg	○	○	○

De følgende spørmålene handler om hvordan du ser på deg selv.

20) Jeg ser på meg selv som en som...

	Svært uenig 1	2	3	4	5	Svært enig 6
Er pratsom	○	○	○	○	○	○
Har en tendens til å finne feil med andre	○	○	○	○	○	○
Gjør en grundig jobb	○	○	○	○	○	○
Er deprimert, nedstemt	○	○	○	○	○	○
Er orginal, kommer med nye ideer	○	○	○	○	○	○
Er reservert	○	○	○	○	○	○
Er hjelpsom og uegoistisk ovenfor andre	○	○	○	○	○	○
Kan være uforsiktig	○	○	○	○	○	○
Er avslappet, takler stress godt	○	○	○	○	○	○
Er nysgjerrig på mange ting	○	○	○	○	○	○
Er full av energi	○	○	○	○	○	○
Er en kranglefant	○	○	○	○	○	○
Er pålitelig i arbeidet mitt	○	○	○	○	○	○
Kan være anspent	○	○	○	○	○	○
Er skarpsindig, tenker dypt	○	○	○	○	○	○
Skaper mye entusiasme	○	○	○	○	○	○
Er tilgivende av natur	○	○	○	○	○	○
Har en tendens til å være ustrukturert	○	○	○	○	○	○
Bekymrer meg mye	○	○	○	○	○	○
Har livlig fantasi	○	○	○	○	○	○
Har en tendens til å være stillferdig	○	○	○	○	○	○
Er tillitsfull	○	○	○	○	○	○

De følgende spørmålene handler om hvordan du ser på deg selv.

21) Jeg ser på meg selv som en som...

	Svært uenig 1	2	3	4	5	Svært enig 6
Har en tendens til å være lat	○	○	○	○	○	○
Er følelsesmessig stabil	○	○	○	○	○	○
Er oppfinnsom	○	○	○	○	○	○
Er selvhevdende	○	○	○	○	○	○
Kan være kald og fjern	○	○	○	○	○	○
Står på til oppgaven er gjennomført	○	○	○	○	○	○
Kan være humørsyk	○	○	○	○	○	○
Setter pris på skjønnhet og kunst	○	○	○	○	○	○
Kan være sjenert og hemmet	○	○	○	○	○	○
Er hensynsfull og vennlig ovenfor de fleste	○	○	○	○	○	○
Gjør ting effektivt	○	○	○	○	○	○
Beholder roen i spente situasjoner	○	○	○	○	○	○
Foretrekker rutinearbeid	○	○	○	○	○	○
Er utadvendt og sosial	○	○	○	○	○	○
Kan noen ganger være uhøflig	○	○	○	○	○	○
Legger planer og gjennomfører dem	○	○	○	○	○	○
Blir lett nervøs	○	○	○	○	○	○
Liker å tenke, leke med ideer	○	○	○	○	○	○
Har få kunstneriske interesser	○	○	○	○	○	○
Liker å samarbeide	○	○	○	○	○	○
Blir lett distrahert	○	○	○	○	○	○
Har kunnskaper om kunst, musikk, litteratur	○	○	○	○	○	○

PUBERTET

Her har vi noen spørsmål om kroppslige forandringer som skjer gjennom ungdomstiden:

22) Har du fått menstruasjon?

○ Ja ○ Nei

Hvor gammel var du da du fikk menstruasjon første gang?

23) År

Velg... [Velg... ▼]

24) Måneder

Velg... [Velg... ▼]

➯

25) Hvis du ser bort fra svangerskap, har du noen gang vært blødningsfri i minst 6 måneder?

- ◯ Ja
- ◯ Nei

➯

26) Hvor mange ganger har du vært blødningsfri i mer enn 6 måneder?

Velg... [Velg... ▼]

27) Hvordan er blødningene dine nå?

- ◯ Jeg har regelmessige blødninger
- ◯ Jeg har uregelmessige blødninger
- ◯ Jeg har ikke hatt blødninger det siste året

➯

PUBERTET

28) Når man er tenåring, er det perioder da man vokser raskt. Har du merket at kroppen din har vokst fort (blitt høyere)?

- ◯ Nei, den har ikke begynt å vokse
- ◯ Ja, den har såvidt begynt å vokse
- ◯ Ja, den har helt tydelig begynt å vokse
- ◯ Ja, det virker som om jeg er ferdig med å vokse raskt

➯

29) Og hva med hår på kroppen (under armene og i skrittet)? Vil du si at håret på kroppen din har:

- Ikke begynt å vokse enda
- Såvidt begynt å vokse
- Helt tydelig begynt å vokse
- Det virker som om håret på kroppen er utvokst

30) Hvor gammel var du da du begynte å få hår i skrittet (kjønnshår)?

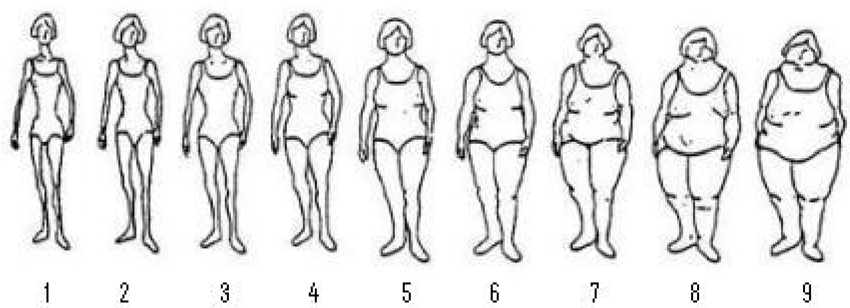
Velg... Velg... ▼

31) Har du begynt å komme i stemmeskifte?

- Nei, har ikke begynt ennå
- Ja, har såvidt begynt
- Ja, har helt tydelig begynt
- Det virker som om stemmeskifte er ferdig

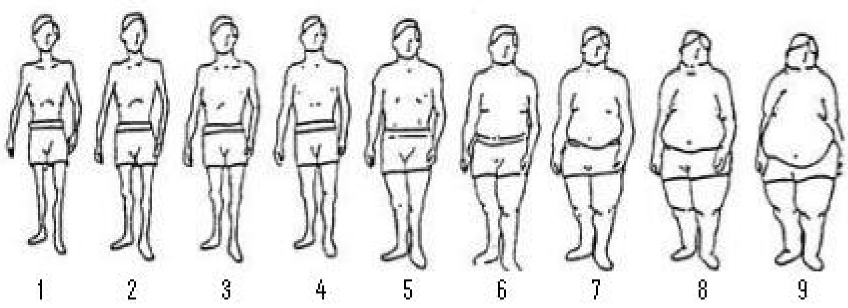
32) Har du begynt å få bart eller skjegg?

- Nei, har ikke begynt ennå
- Ja, har såvidt begynt
- Ja, har helt tydelig begynt
- ja, har fått en god del skjeggvekst



33) Hvilken av disse kroppsfasongene likner mest på din kropp slik du er idag?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9



34) Hvilken av disse kroppsfasongene likner mest på din kropp slik du er idag?

○ 1 ○ 2 ○ 3 ○ 4 ○ 5 ○ 6 ○ 7 ○ 8 ○ 9

35) Gjør du for tiden noe forsøk på å endre kroppsvekten din?

○ Nei

○ Ja, jeg forsøker å legge på meg

○ Ja, jeg forsøker å slanke meg

36) Hvilken vekt vil du være fornøyd med (din trivselsvekt i hele kilo)?

LIVSSTIL

37) Røyker du?

○ Nei, aldri ○ Før, men ikke nå ○ Av og til ○ Daglig

38) Hvor gammel var du da du først begynte å røyke?

Velg... Velg... ▼

39) Hvor mange sigaretter røyker/røkte du vanligvis i løpet av en uke?

- 1 eller færre
- 2-3
- 4-6
- 7-10
- Mer enn 10

40) Hvor mange sigaretter røyker/røkte du vanligvis i løpet av en dag?

- 1 eller færre
- 2-3
- 4-6
- 7-10
- Mer enn 10

41) Bruker du snus eller skrå?

Nei, aldri | Før, men ikke nå | Av og til | Daglig

42) Hvor gammel var du da du først begynte å bruke snus eller skrå?

Velg... Velg... ▼

43) Hvor mange priser snus/skrå bruker du vanligvis i løpet av en uke?

- 1 eller færre
- 2-3
- 4-6
- 7-10
- Mer enn 10

44) Hvor mange priser snus/skrå bruker du per dag?

- 1
- 2-3
- 4-6
- 7-10
- Mer enn 10

45) Hvor ofte drikker du alkohol?

- Aldri
- 1 gang per måned eller sjeldnere
- 2-4 ganger per måned
- 2-3 ganger per uke
- 4 eller flere ganger per uke

46) Hvor mange enheter alkohol (en øl, ett glass vin eller en drink) tar du vanligvis når du drikker?

- 1-2
- 3-4
- 5-6
- 7-9
- 10 eller flere

47) Hvor ofte drikker du 6 eller flere enheter alkohol ved en anledning?

- Aldri
- Sjeldnere enn 1 gang per måned
- 1 gang per måned
- 1 gang per uke
- Daglig eller nesten daglig

FYSISK AKTIVITET

48) Hvilken beskrivelse passer best når det gjelder din fysiske aktivitet på fritiden det siste året?

- Sitter ved PC/TV, leser eller annen stillesittende aktivitet.
- Går, sykler eller beveger deg på annen måte minst 4 timer i uken (her skal du også regne med tur til/fra skolen, shopping, søndagsturer med mer).
- Driver med idrett/trening, tyngre utearbeid, snømåking eller liknende minst 4 timer i uka.
- Trener hardt eller driver konkurranseidrett regelmessig og flere ganger i uka.

49) Hvordan kommer du deg vanligvis til og fra skolen eller arbeid i sommerhalvåret?

- Med bil, motorsykkel/moped
- Med buss
- Med sykkel
- Går
- Ikke i skole eller arbeid

50) Hvor lang tid bruker du vanligvis til og fra skolen eller arbeid (en vei) i sommerhalvåret?

- Mindre enn 5 minutter
- 6 til 15 minutter
- 16 til 30 minutter
- 1/2 til 1 time
- Mer enn 1 time

51) Hvordan kommer du deg vanligvis til og fra skolen eller arbeid i vinterhalvåret?

- Med bil, motorsykkel/moped
- Med buss
- Med sykkel
- Går (til fots eller på ski)

52) Hvor lang tid bruker du vanligvis til og fra skolen eller arbeid (en vei) i vinterhalvåret?

- Mindre enn 5 minutter
- 6 til 15 minutter
- 16 til 30 minutter
- 1/2 til 1 time
- Mer enn 1 time

53) Driver du med idrett eller fysisk aktivitet (f.eks. fotball, dans, løping, sykling, skateboard) utenom skoletid?

- Ja
- Nei

54) Hvor mange dager i uken driver du med idrett/fysisk aktivitet utenom skoletid?

- Sjeldnere enn 1 dag i uka
- 1 dag i uka
- 2-3 dager i uka
- 4-6 dager i uka
- Omtrent hver dag

55) Omtrent hvor mange timer per uke bruker du til sammen på idrett/fysisk aktivitet utenom skoletid?

- Omtrent 1/2 time
- Omtrent 1 - 1 1/2 time
- Omtrent 2 - 3 timer
- Omtrent 4 - 6 timer
- 7 timer eller mer

56) Hvor slitsom er vanligvis idretten/aktiviteten du driver med utenom skoletid?

- Ikke anstrengende
- Litt anstrengende
- Ganske anstrengende
- Meget anstrengende
- Svært anstrengende

Utenom skoletid: Hvor mange timer per dag ser du på PC, TV, DVD og liknende?

57) Hverdager, antall timer per dag:

- Ingen
- Omtrent 1/2 time
- Omtrent 1 - 1 1/2 time
- Omtrent 2 - 3 timer
- Omtrent 4 - 6 timer
- Omtrent 7 - 9 timer
- 10 timer eller mer

58) Fridager (helg, helligdager, ferie), antall timer per dag:

- Ingen
- Omtrent 1/2 time
- Omtrent 1 - 1 1/2 time
- Omtrent 2 - 3 timer
- Omtrent 4 - 6 timer
- Omtrent 7 - 9 timer
- 10 timer eller mer

59) I hvilken grad har andre oppmuntret deg til å være fysisk aktiv

	Svært sjelden/aldri 1	2	3	4	Svært ofte 5
Foreldre/foresatte	○	○	○	○	○
Søsken	○	○	○	○	○
Venner	○	○	○	○	○
Trenere	○	○	○	○	○
Gymlærere	○	○	○	○	○
Nabolaget	○	○	○	○	○

60) Hvordan passer disse utsagnene for deg?

	Helt uenig 1	2	3	4	Helt enig 5
Det er morsommere å drive med trening eller fysisk aktivitet enn å gjøre andre ting...	○	○	○	○	○
Jeg skulle ønske jeg kunne drive mer med trening eller fysisk aktivitet enn det jeg har anledning til å gjøre...	○	○	○	○	○
Jeg føler at jeg er bedre enn de fleste på min alder i idrett/fysisk aktivitet...	○	○	○	○	○
Jeg føler at jeg lett kan holde følge med de andre på min alder når vi driver med idrett/fysisk aktivitet...	○	○	○	○	○

61) Hvordan passer disse utsagnene for deg?

	Helt uenig 1	2	3	4	Helt enig 5
Jeg liker ikke å trene mens noen står å ser på...	○	○	○	○	○
Tilgang til egen garderobe hadde gjort det lettere å trene...	○	○	○	○	○
Jeg blir ubehagelig andpusten, svett eller får vondt i kroppen ved trening...	○	○	○	○	○
Gymtimene er organisert slik at jeg ikke henger med...	○	○	○	○	○
Jeg har ingen å trene sammen med...	○	○	○	○	○
Jeg mangler utstyr for å drive med den aktiviteten jeg har lyst til...	○	○	○	○	○
Jeg har for mange andre oppgaver som gjør at jeg ikke får tid til å trene (f.eks lekser, hjemmeoppgaver)...	○	○	○	○	○
Det mangler egnede haller eller gode uteområder for å drive fysisk aktivitet der jeg bor...	○	○	○	○	○

MATVANER OG KOSTHOLD

62) Hvor ofte pleier du å spise følgende i løpet av en uke?

	Hver dag	4-6 dager i uka	1-3 dager i uka	Sjelden eller aldri
Frokost	○	○	○	○
Middag	○	○	○	○

63) Hvor ofte spiser du matpakke hjemmefra på skole eller arbeid?

- ○ Hver dag
- ○ 3-4 ganger per uke
- ○ 1-2 ganger per uke
- ○ Sjelden eller aldri

64) Hvor ofte spiser du vanligvis disse matvarene?

	Sjelden/ aldri	1-3 ganger per måned	1-3 ganger per uke	4-6 ganger per uke	Hver dag
Ost (alle typer)	○	○	○	○	○
Fet fisk (f.eks. laks, ørret, makrell, sild)	○	○	○	○	○
Mager fisk (f.eks. torsk, sei, hyse)	○	○	○	○	○
Pizza, hamburger eller pølser	○	○	○	○	○
Hermetisert mat (fra metallbokser)	○	○	○	○	○
Godteri (f.eks. sjokolade, drops)	○	○	○	○	○
Snacks og søtsaker (f.eks. potetgull, kake, kjeks, bolle)	○	○	○	○	○
Sukkerfri tyggegummi	○	○	○	○	○

65) Hvor ofte spiser du vanligvis

	Sjelden/ aldri	1-3 ganger per mnd	1-3 ganger per uke	4-6 ganger per uke	1-2 ganger per dag	3-4 ganger per dag	5 eller flere ganger per dag
Frukt	○	○	○	○	○	○	○
Grønnsaker	○	○	○	○	○	○	○

66) Hvor mye drikker du vanligvis av følgende?

	Sjelden/ aldri	1-6 glass per uke	1 glass per dag	2-3 glass per dag	4 glass eller mer per dag
Helmelk, kefir, yoghurt	○	○	○	○	○
Lettmelk, cultura, lettyoghurt	○	○	○	○	○
Skummet melk (sur/søt)	○	○	○	○	○
Ekstra lett melk	○	○	○	○	○
Juice	○	○	○	○	○
Saft med sukker	○	○	○	○	○
Lettsaft, kunstig søtet	○	○	○	○	○
Brus med sukker (1/2 liters flaske = 2 glass)	○	○	○	○	○
Lettbrus, kunstig søtet (1/2 liters flaske = 2 glass)	○	○	○	○	○
Vann	○	○	○	○	○

67) Bruker du følgende kosttilskudd?

	Ja, daglig	Av og til	Nei
Tran, trankapsler, fiskeoljekapsler	○	○	○
Vitamin- og/eller mineraltilskudd	○	○	○

SØVN OG SØVNVANER

68) Når pleier du å legge deg for å sove på ukedagene?

Velg... [Velg... ▼]

69) Når pleier du å legge deg for å sove i helgen?

Velg... [Velg... ▼]

70) Hvor lenge pleier du å ligge våken før du får sove på ukedagene?

Velg... [Velg... ▼]

71) Hvor lenge pleier du å ligge våken før du får sove i helgen?

Velg... [Velg... ▼]

72) Når pleier du å våkne på ukedagene (endelig oppvåkning)?

Velg... [Velg... ▼]

73) Når pleier du å våkne i helgen (endelig oppvåkning)?

Velg... [Velg... ▼]

74) Hvor mange timer sover du vanligvis pr. natt?

Velg... [Velg... ▼]

75) Hvor mange timer søvn trenger du pr. natt for å føle deg uthvilt?

Velg... [Velg... ▼]

76) Synes du at du får tilstrekkelig med søvn?

- Ja, absolutt tilstrekkelig
- Ja, stort sett tilstrekkelig
- Nei, noe utilstrekkelig
- Nei, klart utilstrekkelig
- Nei, langt fra tilstrekkelig

77) I løpet av den siste måneden, hvor mange dager pr. uke har du

	0 dager	1 dag	2 dager	3 dager	4 dager	5 dager	6 dager	7 dager
brukt mer enn 30 minutter for å sovne etter at lysene ble slukket?	○	○	○	○	○	○	○	○
vært våken mer enn 30 minutter innimellom søvnen?	○	○	○	○	○	○	○	○
våknet mer enn 30 mintter tidligere enn du ønsket å gjøre uten å få sove igjen?	○	○	○	○	○	○	○	○
følt deg for lite uthvilt etter å ha sovet?	○	○	○	○	○	○	○	○
vært så søvnig/trett at det har gått ut over skole/jobb eller privatlivet?	○	○	○	○	○	○	○	○
vært misfornøyd med søvnen din?	○	○	○	○	○	○	○	○
hatt vansker med å sovne før kl 02:00?	○	○	○	○	○	○	○	○
hatt vansker med å våkne om morgenen?	○	○	○	○	○	○	○	○
har du forsovet deg til skolen, arbeid eller avtaler?	○	○	○	○	○	○	○	○

Følsomhet for støy

78) Hvor enig eller uenig er du i utsagnene? Sett kryss for det svaralternativet som passer best for hvert utsagn

	Helt uenig	Ganske uenig	Litt uenig	Litt enig	Ganske enig	Helt enig
Jeg vekkes lett av støy	○	○	○	○	○	○
Jeg venner meg til de fleste lyder uten store problemer	○	○	○	○	○	○
Det er vanskelig for meg å slappe av på et sted med mye støy	○	○	○	○	○	○
Jeg er flink til å konsentrere meg uansett hva som skjer rundt meg	○	○	○	○	○	○
Jeg blir sint på folk som lager støy som hindrer meg i å sovne eller å få gjort jobben min	○	○	○	○	○	○
Jeg er følsom for støy	○	○	○	○	○	○

SOLING

79) Hva skjer med huden din hvis du soler deg om sommeren?

- Alltid rød, aldri brun
- Nesten alltid rød, av og til brun
- Nesten alltid brun, av og til rød
- Alltid brun, aldri rød

80) Har du vært i Syden-/solingsferie de siste 2 måneder?

- Ja
- Nei

81) Har du tatt solarium i løpet av de siste 4 ukene?

- Nei
- Ja, en gang
- Ja, flere ganger

SMERTER

82) Har du langvarige eller stadig tilbakevendende smerter som har vart i 3 måneder eller mer?

- Ja
- Nei

83) Hvor ofte har du vanligvis disse smertene?

- Hele tiden, uten opphør
- Hver dag, men ikke hele tiden
- Hver uke, men ikke hver dag
- Sjeldnere enn hver uke

84) Hvor lenge har du hatt disse smertene? (Dersom du har flere typer smerte, svar for den som har vart lengst)

- 3 - 6 måneder
- 6 - 12 måneder
- 1-2 år
- 3-6 år
- Mer enn 6 år

Hvor er det vondt?

(Kryss av på alle aktuelle steder)

	Venstre side	Høyre side
Skulder	☐	☐
Arm/albue	☐	☐
Hånd	☐	☐
Hofte	☐	☐
Lår/kne/legg	☐	☐
Ankel/fot	☐	☐

Hode/ansikt	☐
Kjeve/kjeveledd	☐
Nakke	☐
Øvre del av ryggen	☐
Korsryggen	☐
Bryst	☐
Mage	☐
Underliv/kjønnsorganer	☐

87) Hva mener du er årsaken til smertene? (flere svar mulig)

- ☐ PC-bruk, dataspill og lignende
- ☐ Idrettsskade
- ☐ Ulykke/skade
- ☐ Kirurgisk inngrep/operasjon
- ☐ Migrene/hodepine
- ☐ Medfødt sykdom
- ☐ Tannproblemer
- ☐ Whiplash
- ☐ Prolaps (skiveutglidning i ryggen)
- ☐ Annet ryggproblem
- ☐ Nerveskade
- ☐ Mage- eller tarmsykdom
- ☐ Annet, spesifiser her ______
- ☐ Vet ikke

Hvis du har langvarige smerter flere steder i kroppen, gjelder de 4 neste spørsmålene smerten som plager deg mest.

Dersom du har flere typer smerte, svar den som plager deg mest.

88) Hvor sterke vil du si at smertene vanligvis er?

- ○ 0 Ingen smerte
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 Verst tenkelige smerte

89) Hvor sterke er smertene når de er på sitt sterkeste?

- 0 Ingen smerte
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Verst tenkelige smerte

90) I hvor stor grad påvirker smertene søvnen din?

- 0 Ingen påvirkning
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Umulig å få sove på grunn av smertene

91) I hvor stor grad hindrer smertene deg i å utføre vanlige aktiviteter hjemme og på skolen?

- 0 Påvirker ikke vanlige aktiviteter
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Kan ikke gjøre noe på grunn av smertene

92) Får du smerter i muskler og ledd når du har feber?

- Ja
- Nei

93) Hvor sterke er febersmertene vanligvis?

- 0 Ingen smerte
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Verst tenkelige smerte

MAGE- OG TARMPROBLEMER

94) I løpet av de siste 2 månedene: Hvor ofte har du hatt smerte eller ubehag i magen?

- Aldri
- 1-3 ganger i måneden
- En gang i uka
- Flere ganger i uka
- Hver dag

95) Hvor lenge har du vært plaget av smerte eller ubehag i magen?

- Mindre enn 1 måned
- 2 måneder
- 3 måneder
- 4-11 måneder
- Ett år eller mer

96) I hvilken del av magen er det du har hatt smerte eller ubehag? (kryss av for alt som passer)

- Over navlen
- Rundt navlen
- Nedenfor navlen

97) Når du har smerter eller ubehag i magen, hvor lenge varer det vanligvis?

- Mindre enn 1 time
- 1-2 timer
- 3-4 timer
- Mesteparten av dagen
- Hele døgnet

98) Når du har smerte eller ubehag i magen, hvor sterke smerter har du vanligvis?

- 0 Ingen smerte
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Verst tenkelige smerte

99) Når du har smerter eller ubehag i magen, hvor ofte blir det bedre etter at du har hatt avføring?

- Sjelden eller aldri
- En del ganger
- For det meste/hver gang

100) Når du har smerter eller ubehag i magen, hvor ofte skjer det i forbindelse med at du..

	Sjelden eller aldri	En del ganger	For det meste
har fastere eller mer klumpete avføring enn vanlig?			
har løsere eller mer vannaktig avføring enn vanlig?			
hadde avføring oftere enn vanlig?			
hadde avføring sjeldnere enn vanlig?			

HODEPINE

101) Har du vært plaget av hodepine det siste året?

- Ja
- Nei

102) Hva slags hodepine er du plaget av? (Du kan sette flere kryss)

- Migrene
- Annen hodepine
- Vet ikke

103) Omtrent hvor mange dager per måned har du hodepine?

- Mindre enn 1 dag
- 1-6 dager
- 7-14 dager
- Mer enn 14 dager

104) Er hodepinen vanligvis:

	Ja	Nei
Bankende/dunkende smerte		
Pressende smerte		
Ensidig smerte (høyre eller venstre)		

105) Hvor lenge varer hodepinen vanligvis?

- Mindre enn 4 timer
- 4 timer - 1 døgn
- 1-3 døgn
- Mer enn 3 døgn

106) Før eller under hodepinen, kan du da ha forbigående:

	Ja	Nei
Synsforstyrrelse? (takkede linjer, flimring, tåkesyn, lysglimt)		
Nummenhet i halve ansiktet eller i hånden?		
Forverring ved moderat fysisk aktivitet?		
Kvalme og/eller oppkast?		

Nedenfor er det fire spørsmål om hvordan du opplever det er å gå til tannlege. Les hvert spørsmål og velg det svaralternativet som du synes passer best for deg.

107) Dersom du skulle gå til tannlegen i morgen, hva ville du føle?

- Jeg ville se frem til det som en ganske hyggelig opplevelse
- Det ville være det samme for meg, ikke bety noe
- Det ville gjøre meg litt urolig
- Jeg ville bli redd for at det skulle bli ubehagelig og vondt
- Jeg ville bli svært redd med tanke på hva tannlegen kanskje skulle gjøre

108) Når du venter på tannlegens venteværelse, hvordan føler du deg da?

- Avslappet
- Litt urolig
- Anspent, nervøs
- Redd, engstelig
- Så redd at jeg av og til begynner å svette eller nesten føler meg syk

109) Når du sitter i tannlegestolen og venter på at tannlegen skal begynne behandlingen, hvordan føler du deg da?

- Avslappet
- Litt urolig
- Anspent, nervøs
- Redd, engstelig
- Så redd at jeg av og til begynner å svette eller nesten føler meg syk

110) Tenk at du sitter i tannlegestolen og skal få tennene renset og pusset. Mens du sitter og venter på at tannlege skal finne frem instrumentene som brukes til å skrape og pusse med, hvordan føler du deg da?

- Avslappet
- Litt urolig
- Anspent, nervøs
- Redd, engstelig
- Så redd at jeg av og til begynner å svette eller nesten føler meg syk

HØRSEL

111) Har du et hørseltap som du vet om?

- Nei
- Ja
- Kanskje

112) Er hørseltapet bekreftet av lege eller annet helsepersonell?

- Nei
- Ja

113) Bruker du høreapparat?

- Nei
- Ja

114) Har du øresus?

- Aldri
- Sjelden
- Ofte

115) Hvor ofte har du øresus?

- Hele tiden, uten opphør
- Hver dag, men ikke hele tiden
- Hver uke, men ikke hver dag
- Sjeldnere enn hver uke

116) Hvor lenge varer vanligvis periodene med øresus?

- Mindre enn 10 minutter
- 10 minutter - 1 time
- Mer enn 1 time

117) Når får du vanligvis øresus?

- Etter sterke lyder
- Når det er stille
- Vet aldri når

118) Noen bryr seg ikke om lyden, for andre oppleves det svært plagsomt å ha øresus. Angi hvor plaget du er av øresusen.

- 0 Ingen plager
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Verst tenkelige plager

119) På hvilket øre har du vanligvis øresus?

- Bare høyre
- Bare venstre
- Begge, men mest høyre
- Begge, men mest venstre
- Like mye på begge

120) Omtrent hvor gammel var du når du begynte å ha øresus?

Velg... Velg... ▼

121) Omtrent hvor gammel var du når du begynte å ha øresus ofte?

Velg... Velg... ▼

SYKEHUS OG INFEKSJONER

122) Har du vært innlagt som pasient på sykehus i løpet av de siste 12 månedene?

- Ja
- Nei

123) Arbeider noen du bor sammen med i helsevesenet (sykehus, sykehjem, hjemmetjenesten, legekontor, helsestasjon)?

- Ja
- Nei

124) Har du tidligere fått fjernet mandlene?

- Ja
- Nei
- Vet ikke

125) Jeg fikk fjernet mandlene fordi jeg hadde

- halsbetennelse som kom og gikk
- halsbetennelse og vondt i halsen og/eller dårlig ånde hele tiden
- store mandler og trang hals (dette kan gi svelgproblemer, snorking, pustestopp)
- både halsbetennelse og store mandler
- vet ikke

126) Jeg har nå

- ingen plager fra halsen
- plaget med halsbetennelse som kommer og går
- konstante plager med halsbetennelse og vondt i halsen og/eller dårlig ånde
- store mandler og trang hals (dette kan gi svelgproblemer, snorking, pustestopp)
- plaget med både halsbetennelse og store mandler

TANNHELSE

127) Hvor ofte pusser du vanligvis tennene dine?

- Sjeldnere enn 1 gang per uke
- 1 gang per uke
- 2-3 ganger per uke
- 4-6 ganger per uke
- 1 gang daglig
- 2 eller flere ganger daglig

128) Hvor ofte bruker du noen av følgende hjelpemidler?

	Daglig	Noen ganger i uka	Noen ganger i måneden	Sjelden/aldri
Fluor tannkrem				
Tanntråd				
Tannstikker				
Fluortabletter				
Fluor skyllevæske				

129) Hvor ofte kontrollerte foreldrene dine eller dine foresatte at du hadde pusset tennene dine da du var yngre?

- Ofte
- Omtrent daglig
- Av og til
- Sjelden/aldri

130) Hvordan vurderer du din egen tannhelse?

- Meget god
- God
- Verken god eller dårlig
- Dårlig
- Meget dårlig

131) Hvorfor er fluor tilsatt i tannkrem?

- Behagelig smak
- Gir god ånde
- Hindrer hull i tennene
- Gir hvite tenner

132) Har du følt at tannlegen/tannpleieren ikke tar seg tid til å forklare eller svare på spørsmål?

- Ja, ofte
- Ja, av og til
- Nei

133) Er du fornøyd med tannstillingen din i fronten?

- Veldig fornøyd
- Fornøyd
- Ganske fornøyd
- Verken fornøyd eller misfornøyd
- Ganske misfornøyd
- Misfornøyd
- Veldig misfornøyd

134) Prøver du å unngå å smile på grunn av dine tenners utseende?

- Aldri
- Veldig sjelden
- Sjelden
- Vanskelig å si
- Av og til
- Ganske ofte
- Ofte

135) Ønsker du tannregulering for å få rettet opp tennene dine?

- Ja, absolutt
- Ja
- Ja, kanskje
- Verken ja eller nei
- Tror ikke det
- Nei
- Absolutt ikke

136) Har du hatt fast tannregulering/streng?

- Ja
- Nei

137) Har du hatt avtagbar plate?

- Ja
- Nei

138) Har du hatt tannregulering siden forrige gang du deltok i Fit Futures undersøkelsen?

- Nei
- Ja
- Har ikke deltatt tidligere

139) Hadde du allergiske reaksjoner i forbindelse med tannreguleringen?

- Ja
- Nei

140) Hvor smertefullt, jevnt over, synes du det er å gå til tannlegen?

- 0 Ingen smerte
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Verst tenkelige smerte

141) Har du latt være å møte opp til en tannlegetime pga frykt for tannbehandling?

- Ja
- Nei

<u>Ta stilling til følgende påstander:</u>

142) Tannpuss er svært viktig for meg når jeg skal

	Helt uenig	Uenig	Enig	Helt enig
ut med venner på ungdomsklubb, diskotek osv.				
møte en kjæreste				
på skolen				
møte min beste venn/venninne				
delta i sport eller drive med hobbyer				
til tannlegen				

143) Tannpuss er svært viktig for at jeg skal

	Helt uenig	Uenig	Enig	Helt enig
føle meg frisk	○	○	○	○
unngå hull i tennene	○	○	○	○
unngå at tennene får en stygg farge	○	○	○	○
få frisk pust	○	○	○	○
beholde sunt tannkjøtt	○	○	○	○
få bedre utseende	○	○	○	○

144) jeg synes det ville være pinlig dersom det ble hull i

	Helt uenig	Uenig	Enig	Helt enig
mine egne tenner	○	○	○	○
min mors tenner	○	○	○	○
min fars tenner	○	○	○	○
min venn/venninnes tenner	○	○	○	○

145) Tannpuss er svært viktig for at jeg skal få

	Helt uenig	Uenig	Enig	Helt enig
mine foreldres anerkjennelse	○	○	○	○
mine venners anerkjennelse	○	○	○	○

Ta stilling til følgende utsagn

146) Hvor sikker er du på at du vil pusse tennene 2 ganger om dagen i 2 minutter med fluortannkrem i følgende situasjoner

	Svært sikker	Ganske sikker	Noe usikker	Ganske usikker
Når du er trøtt om kvelden	○	○	○	○
Når du har mye å gjøre (mye lekser, eksamener)	○	○	○	○
Når du har skoleferie	○	○	○	○
Når du er trøtt på morgenen	○	○	○	○
Når du føler deg syk (hodepine)	○	○	○	○

147) Hvor sikker er du på at du er villig til avstå fra sukkerholdige drikker som brus, juice og saft til andre tider enn ved lunsj eller middag?

- ○ Svært sikker
- ○ Ganske sikker
- ○ Noe usikker
- ○ Svært usikker

148) Jeg har til hensikt å pusse tennene 2 ganger om dagen i minst 2 minutter med fluortannkrem hver dag

- ○ Helt enig
- ○ Enig
- ○ Uenig
- ○ Helt uenig

149) Hvor fornøyd er du med din tannhelse?

- ○ Svært misfornøyd
- ○ Misfornøyd
- ○ Verken eller
- ○ Fornøyd
- ○ Svært fornøyd

150) Har du vært, eller er du, plaget med sur smak i munnen eller sure oppstøt?

- Nei
- Ja

151) Hvor ofte har du vært, eller er du, plaget med sur smak i munnen eller sure oppstøt?

- Daglig
- Noen ganger i uken
- Månedlig
- Sjelden eller aldri

152) Hvor lenge har det vart?

- Uker
- Måneder
- Flere år

153) Har du vært, eller er du, plaget med oppkast?

- Nei
- Ja

154) Hvor ofte har du vært, eller er du, plaget med oppkast?

- Daglig
- Noen ganger i uken
- Månedlig
- Sjelden eller aldri

155) Hvor lenge har det vart?

- Uker
- Måneder
- Flere år

ASTMA OG PUSTEBESVÆR

156) Har du - de siste 12 månedene - hatt pipende eller hvesende pust?

- Nei
- Ja

157) Hvor mange ganger har du hatt disse plagene de siste 12 månedene ?

- 1-3 ganger
- 4-12 ganger
- Mer enn 12 ganger

158) Har du - de siste 12 månedene - unnlatt å gjøre ting du vil gjøre pga pipende eller hvesende pust?

- Nei
- Ja

159) Hvor mye har pipende eller hvesende pust hindret deg fra å gjøre ting du har villet gjøre de siste 12 månedene?

- Lite
- Moderat
- Ganske mye
- Mye

160) Har du - de siste 12 månedene - hatt vanskelig for å sove, eller våknet pga pipende eller hvesende pust?

- Nei
- Mindre enn en gang i uken
- 1 eller flere ganger i uken

161) Har du - de siste 12 månedene - vært borte fra skolen pga pipende eller hvesende pust?

- Nei
- Ja

162) Hvor mange dager har du vært borte fra skolen pga pipende eller hvesende pust de siste 12 månedene?

- Mindre enn 5 dager
- 5-10 dager
- Mer enn 10 dager

163) Har du - de siste 12 månedene - hatt så store plager med pipende eller hvesende pust, at du har hatt behov for å ta nye åndedrag midt i en setning?

- Nei
- Ja

164) Har du - de siste 12 månedene - hatt pustebesvær (hatt tungt for å puste, kjent deg tett i brystet, hatt pipende eller hvesende pust)?

- Nei
- Ja

165) Dersom du har hatt pustebesvær eller pipende eller hvesende pust de siste 12 månedene, hvor tungt opplevde du at det var å puste? (Marker med et kryss på linjen)

- 0 Ikke tungt i det hele tatt
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Verst tenkbar

166) Har du - de siste 12 månedene - hatt pipende eller hvesende pust, tungt for å puste, eller besværlig hoste, i forbindelse med noe av det nedenstående?

- Nei, har ikke hatt besvær ved noe av dette
- Kald luft eller tåke
- Katt
- Hund
- Hest
- Bjørkepollen
- Gresspollen
- Burotpollen
- Psykisk belastning eller stress
- Tobakksrøyk
- Luftforurensninger
- Sterke dufter
- Mat eller matos
- Kald drikke
- Annet

167) Har du - de siste 12 månedene - hatt pipende eller hvesende pust, tungt for å puste, eller besværlig hoste i forbindelse med anstrengelse?

- Nei
- Ja

168) Har du - de siste 12 månedene - brukt noen medisiner for astma eller pustebesvær?

- Nei
- Ja

169) Hvilke medisiner for astma eller pustebesvær har du brukt de siste 12 månedene?

	Ved behov, eller for en kortere periode, noen uker av gangen	Over en lengre periode, minst 2 mnd
Bricanyl, Ventoline, Airomir, Buventol, Salbutamol Arrow	○	○
Pulmicort, Flutide, Becotide, Giona Easyhaler, Beklomet, AeroBec autohaler, Budesonid Arrow, Alvesco	○	○
Symbicort, Seretide	○	○
Oxis, Serevent, Onbrez Breezehaler	○	○
Atrovent, Ipraxa, Ipratropiumbromid	○	○
Singulair tabelett	○	○

170) Dersom du bruker luftrørsutvidende medisin (Bricanyl, Ventoline, Airomir, buventol...), hvor ofte bruker du dem i løpet av en vanlig uke?

- Mindre enn 2 ganger pr uke
- 2 ganger eller mer pr uke

171) Har du - de siste 12 månedene - tatt kortisontabletter oppløst i vann (f.eks Betapred) mot astma eller pustebesvær?

- Nei
- Ja

172) Har du tatt kortisontabletter oppløst i vann 3 dager i strekk eller mer de siste 12 månedene?

- Nei
- Ja

173) Har du brukt medisiner for astma eller pustebesvær som er skrevet ut til andre?

- Nei
- Ja, delvis
- Ja, helt

174) Har noen andre brukt dine medisiner for astma eller pustebesvær?

- Nei
- Ja, delvis
- Ja, helt

175) Hvor mange inhalatorer av samme merke bruker du å ha samtidig? (men kanskje på ulike steder)

- 1 inhalator
- 2 inhalatorer
- 3 inhalatorer
- Mer enn 3 inhalatorer

176) Hvor ofte hender det at du bruker din inhalator til den er tom?

- Aldri
- Sjelden
- Ofte
- Alltid

177) Har du fått undervisning om din astmasykdom av sykepleier eller lege? (f.eks hva astma er slags sykdom, hvordan medisinene fungerer og hva du skal gjøre ved forverring)

Nei Ja

178) Har du - de siste 12 månedene - hatt tørrhoste om natten uten samtidig å være forkjølet?

Nei Ja

179) Har du vært plaget av hoste mesteparten av tiden, i minst 3 måneder pr år?

Nei

Ja

180) Hvor mange år har du vært plaget med hoste mesteparten av tiden, i minst 3 måneder pr år?

Velg... Velg... ▼

181) Har du vært plaget av slim fra brystet mesteparten av tiden, i minst 3 måneder pr år?

Nei

Ja

182) Hvor mange år har du vært plaget med slim fra brystet mesteparten av tiden, i minst 3 måneder pr år?

Velg... Velg... ▼

183) Om du har pustebesvær eller astma, har det...

	Ikke i det hele tatt	Litt	En del	Ganske mye	Mye
hindret deg i skolearbeidet	○	○	○	○	○
hindret deg i fritidsaktiviteter	○	○	○	○	○
uroet deg de siste 4 ukene	○	○	○	○	○

HUDPLAGER OG EKSEM

184) Har du noen gang vært plaget av kviser?

- ○ Ja
- ○ Nei
- ○ Vet ikke

185) Hvor mye plaget er du av kviser idag?

- ○ 0 Ingen plager
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 Verst tenkelige plager

186) Har du noen gang oppsøkt lege på grunn av kviser?

○ Ja ○ Nei

187) Har du fått noen av disse behandlingene av lege?

	Ja	Nei	Vet ikke
Lokalbehandling (f.eks. kremer eller oppløsninger)	○	○	○
Antibiotika tabletter (f.eks. Tetracyclin)	○	○	○
Roaccutan tabletter	○	○	○

188) Har du eller har du noen gang hatt psoriasis?

○ Ja ○ Nei ○ Vet ikke

189) Hvor gammel var du første gang du fikk psoriasis?

Velg... [Velg... ▼]

190) Hvor mye plaget er du av psoriasis idag?

- ○ 0 Ingen plager
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 Verst tenkelige plager

Verkebyller er svært store kviser som er ømme/smertefulle og som ofte gir arr.

191) Har du noen gang hatt verkebyller under armene/armhulene?

- Ja
- Nei
- Vet ikke

192) Har du noen gang oppsøkt lege på grunn av verkebyllene?

Ja Nei

193) Har du noen gang hatt verkebyller i lyskene/nært skrittet?

- Ja
- Nei
- Vet ikke

194) Har du noen gang oppsøkt lege på grunn av verkebyllene?

- Ja
- Nei

195) Har du - de siste 12 månedene - hatt plager med tørr hud?

Nei Ja

196) Har du - de siste 12 månedene - smurt deg med mykgjørende krem/lotion på grunn av tørr hud?

- Nei
- Ja, mindre enn 1 måned
- Ja, 1-6 måneder
- Ja, mer enn 6 måneder

197) Har du - de siste 12 månedene - hatt kløende utslett?

- ○ Nei
- ○ Ja

198) Hvor lenge pleier det kløende utslettet å vare?

- ○ Mindre enn 1 uke
- ○ 1-2 uker
- ○ Mer enn 2 uker

199) Hvor har du de kløende utslettene? (Flere alternativer kan krysses av)

- ☐ I hodebunnen
- ☐ I ansiktet
- ☐ I ørene
- ☐ På halsen eller i nakken
- ☐ På håndledd eller fotledd
- ☐ På hendene
- ☐ På eller under rumpeballene
- ☐ På lårenes innsider
- ☐ På brystkasse, mage, rygg eller skuldre
- ☐ I armhulene
- ☐ På armenes eller benas utsider
- ☐ I albuebøyer eller knehaser
- ☐ I lysken eller underlivet
- ☐ På føttene
- ☐ Andre steder

200) Hvor gammel var du første gang du fikk denne typen utslett?

Velg... [Velg... ▼]

201) I hvilken periode i løpet av året har du hatt kløende utslett de siste 12 månedene?

- Januar
- Februar
- Mars
- April
- Mai
- Juni
- Juli
- August
- September
- Oktober
- November
- Desember

202) Har det kløende utslettet forsvunnet helt ved noe tidspunkt de siste 12 månedene?

- Nei
- Ja

203) Har du - de siste 12 månedene - hatt vanskelig for å få sove, eller våknet pga kløende utslett?

- Nei
- Mindre enn 1 gang pr uke
- 1 eller flere ganger pr uke

204) Har du - den siste uken - hatt kløende utslett?

- Nei
- Ja

205) I løpet av den siste uken, hvor mye har huden din klødd eller føltes smertefull?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

206) I løpet av den siste uken, hvor plaget, trist eller lei deg, har du vært pga huden?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

207) I løpet av den siste uken, har huden din påvirket hvordan det har vært å være sammen med dine venner?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

208) I løpet av den siste uken, har du byttet eller hatt på deg andre eller spesielle klær/sko på grunn av din hud?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

209) I løpet av den siste uken, har dine hudplager påvirket deg når det gjelder å gå ut eller holde på med dine hobbyer?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

210) I løpet av den siste uken, har du unngått svømming eller annen trening pga dine hudplager?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

211) I løpet av den siste uken, har huden din påvirket ditt skolearbeid?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

212) Dersom du har hatt ferie: I løpet av den siste uken, har dine hudplager hindret deg i å nyte ferien?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

213) I løpet av den siste uken, hvor mye plager har du hatt pga din hud fordi andre personer har gitt deg tilnavn, ertet deg, mobbet deg, stilt spørsmål eller unngått deg?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

214) I løpet av den siste uken, hvor mye har din søvn blitt påvirket av dine hudplager?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

215) I løpet av den siste uken, hvor mye problem har du hatt med behandlingen av huden din?

- Veldig mye
- Ganske mye
- Litt
- Ikke i det hele tatt

216) Har du - de siste 12 månedene - hatt eksem?

Nei Ja

217) Hvor lenge har du tilsammen hatt eksem de siste 12 månedene?

- Mindre enn 1 måned
- 1-3 måneder
- 4-6 måneder
- Mer enn 6 måneder

218) Har du smurt deg med kortison pga eksem de siste 12 månedene?

- Nei
- Ja, mindre enn 1 måned
- Ja, 1-6 måneder
- Ja, mer enn 6 måneder

219) Har du noen gang hatt håndeksem? (Kløende forandring i huden, blemmer eller kløende utslett)

Nei Ja

220) Hvor gammel var du da håndeksemet begynte?

Velg... Velg... ▼

221) Har du - de siste 12 månedene - ved noen anledning hatt håndeksem?

Nei Ja

222) Hvor mye plaget er du av håndeksem i dag?

- 0 Ingen plager
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Verst tenkelige plager

223) Hvor mange ganger kommer hendene dine i kontakt med vann i løpet av en dag? (ikke tell med den tiden du beskytter hendene med hansker)

- Ingen ganger pr dag
- 1-10 ganger pr dag
- 11-20 ganger pr dag
- 21-30 ganger pr dag
- Mer enn 30 ganger pr dag

224) Har du - noen gang - fått kløende utslett eller eksem (rødhet, blemmer eller flassing) av sminke eller hygieneprodukter?

- Nei
- Ja

225) Av hva har du fått plager?

- Sminke eller parfyme
- Deodorant
- Shampo eller balsam
- Såpe eller dusjkrem
- Annet

226) Har du - noen gang - farget håret? (farget, tonet, bleket eller stripet håret ditt, hjemme eller hos frisør)

Nei Ja

227) Har du noen gang fått plager ved hårfarging?

Nei Ja

228) På hvilken måte har du reagert når du har farget håret?

- Reaksjon i ansiktet, hodebunn, på ørene eller halsen (rødhet, flassing, kløe)
- Kraftig reaskjon i ansiktet, hodebunn, på ørene eller halsen (hevelse, væskende utslett)
- Reaksjon på hendene (rødhet, flassing, kløe)
- Annet

229) Har du - noen gang - fått kløende utslett eller eksem (rødhet, blemmer eller flassing) av latex eller gummi (ballonger, gummihansker, kondomer...)?

Nei Ja

230) Av hvilke latex-/gummiprodukter har du fått plager?

- ☐ Ballonger ved ballongblåsing
- ☐ Gummihansker
- ☐ Kondomer
- ☐ Annet

231) Har du - noen gang - tatt hull i ørene eller laget hull for smykker noen andre steder på kroppen?

○ Nei ○ Ja

232) Har du noen tatovering?

○ Nei ○ Ja

233) Har du noen gang fått kløende utslett eller eksem (rødhet, blemmer eller flassing) av din tatovering?

○ Nei ○ Ja

234) Har du - noen gang - fått kløende utslett eller eksem (rødhet, blemmer eller flassing) av metallgjenstander?

○ Nei ○ Ja

235) Av hva har du fått kløende utslett eller eksem?

- ☐ Armbånd, halsbånd, fingerring eller annet
- ☐ Smykke (unntatt smykker for hull)
- ☐ Smykker for hull
- ☐ Knapp, nål, spenne, glidelås eller liknende i sko eller støvler
- ☐ Klokke eller klokkereim
- ☐ Briller eller solbriller
- ☐ Hårspenner eller liknende
- ☐ Mobiltelefon
- ☐ Øretelefon
- ☐ Annet

236) Dersom du har hudbesvær eller eksem, har det...

	Ikke i det hele tatt	Litt	En del	Ganske mye	Mye
Hindret deg i skolearbeidet	○	○	○	○	○
Hindret deg i fritidsaktiviteter	○	○	○	○	○
Bekymret (Uroet) deg de siste fire ukene	○	○	○	○	○

NESE- ELLER ØYEPLAGER

237) Har du - de siste 12 månedene - hatt nysing, kløende nese, rennende nese eller tett nese uten at du samtidig har vært forkjølet?

○ Nei ○ Ja

238) Har du hatt nysing, kløende nese, rennende nese eller tett nese i mer en 4 dager uten at du samtidig har vært forkjølet i de siste 12 månedene?

○ Nei ○ Ja

239) Skjedde dette over 4 uker i strekk de siste 12 månedene?

- Nei
- Ja

240) Hvor lenge har du hatt disse plagene uten samtidig å være forkjølet de siste 12 månedene?

- Mindre enn 1 måned
- 1-3 måneder
- 3-6 måneder
- Mer enn 6 måneder

241) Har disse neseplagene - de siste 12 månedene - forekommet samtidig med kløende, rennende øyne?

- Nei
- Ja

242) I løpet av hvilken periode har du hatt plager med nysing, kløende nese, rennende nese eller tett nese de siste 12 månedene?

- Januar
- Februar
- Mars
- April
- Mai
- Juni
- Juli
- August
- September
- Oktober
- November
- Desember

243) Har du hatt nese- eller øyeplager, uten å være forkjølet, ved kontakt med noe av det nedenstående de siste 12 månedene?

- ☐ Nei, har ikke hatt besvær med noen av disse
- ☐ Katt
- ☐ Hund
- ☐ Hest
- ☐ Kanin, marsvin eller andre gnagere
- ☐ Bjørkepollen
- ☐ Gresspollen
- ☐ Burotpollen
- ☐ Tobakksrøyk
- ☐ Luftforurensninger
- ☐ Sterke dufter
- ☐ Annet

244) Har du unnlatt å gjøre ting du har villet gjøre pga neseplager de siste 12 månedene?

○ Nei ○ Ja

245) Hvor mye har neseplagene påvirket at du har unnlatt å gjøre ting du har villet gjøre de siste 12 månedene?

- ○ Litt
- ○ Moderat
- ○ Ganske mye
- ○ Mye

246) Har du hatt vanskelig for å sove pga neseplager de siste 12 månedene?

○ Nei ○ Ja

247) Har du - de siste 12 månedene - tatt noen medisiner for allergisnue/høysnue?

○ Nei ○ Ja

248) Hvilke medisiner for allergisnue/høysnue har du brukt de siste 12 månedene?

- ☐ Øyedråper
- ☐ Nesespray
- ☐ Allergitabletter
- ☐ Andre

249) Dersom du har hatt neseplager, allergisnue/høysnue, hvor plagsomt opplevde du at det var de siste 12 månedene?

- ○ 0 Ingen plager
- ○ 1
- ○ 2
- ○ 3
- ○ 4
- ○ 5
- ○ 6
- ○ 7
- ○ 8
- ○ 9
- ○ 10 Verst tenkelige plager

250) Har du - de siste 12 månedene - vært tett i nesen?

- ○ Nei
- ○ Mindre enn 10 dager
- ○ 10 dager - 12 uker
- ○ 12 uker eller mer

251) Har du - de siste 12 månedene - hatt gulgrønt slim eller snørr bak i halsen?

- Nei
- Mindre enn 10 dager
- 10 dager - 12 uker
- 12 uker eller mer

252) Har du - de siste 12 månedene - hatt nedsatt luktesans?

- Nei
- Mindre enn 10 dager
- 10 dager - 12 uker
- 12 uker eller mer

253) Har du - de siste 12 månedene - opplevd smerter eller trykk ved eller omkring pannen, nesen eller øynene?

- Nei
- Mindre enn 10 dager
- 10 dager - 12 uker
- 12 uker eller mer

254) Dersom du har hatt nesetetthet, snue, nedsatt luktesans eller smerter i ansiktet, hvor plagsomt synes du det var de siste 12 månedene?

- 0 Ikke plagsomt i det hele tatt
- 1
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 Verst tenkelig

255) Dersom du har hatt nese- eller øyeplager, har det...

	Ikke i det hele tatt	Litt	En del	Ganske mye	Mye
Hindret deg i skolearbeid	○	○	○	○	○
Hindret deg i fritidsaktiviteter	○	○	○	○	○
Bekymret deg de siste 4 uker	○	○	○	○	○

Reaksjoner på mat

256) Har du - de siste 12 månedene - reagert på noe i maten?

○ Nei ○ Ja

257) Har du reagert på noen av de nedenstående matvarene de siste 12 månedene?

- ☐ Melk - protein
- ☐ Melk - laktose
- ☐ Egg
- ☐ Fisk
- ☐ Skalldyr
- ☐ Hvete, andre kornslag
- ☐ Soya
- ☐ Sesam
- ☐ Eple, pære
- ☐ Fersken, nektarin, plommer, kirsebær
- ☐ Kiwi
- ☐ Banan
- ☐ Rå gulrot
- ☐ Peanøtter
- ☐ Hasselnøtter
- ☐ Mandel
- ☐ Valnøtt, pekannøtt
- ☐ Cashewnøtt, pistasjnøtt
- ☐ Paranøtt
- ☐ Annet

258) Dersom du reagerer på fisk, hvilke(n) reaksjon(er) får du?

- ☐ Kløende utslett
- ☐ Hevelse i og rundt munnen
- ☐ Hevelse i ansiktet
- ☐ Slim i halsen
- ☐ Oppkast
- ☐ Diare
- ☐ Tungpust
- ☐ Svimmelhet
- ☐ Besvimelse/allergisjokk

259) Dersom du reagerer på fisk, reagerer du ved å...

- ☐ Spise fisk
- ☐ Ta på fisk
- ☐ Puste inn damp fra fisk som kokes eller stekes

260) Dersom du ikke reagerer på fisk nå, har du:

- ○ Reagert på fisk tidligere
- ○ Aldri reagert på fisk

261) Dersom du tidligere har reagert på fisk, hvilke(n) reaksjon(er) fikk du da?

- ☐ Kløende utslett
- ☐ Hevelse i og rundt munnen
- ☐ Hevelse i ansiktet
- ☐ Slim i halsen
- ☐ Oppkast
- ☐ Diare
- ☐ Tungpust
- ☐ Svimmelhet
- ☐ Besvimelse/allergisjokk

262) Har du en adrenalinsprøyte (Epipen, Anapen, Jext) som du kan ta, dersom du reagerer på noe i maten?

○ Nei ○ Ja

263) Har du - noen gang - brukt sprøyten?

○ Nei ○ Ja

264) Har du - de siste 12 månedene - brukt sprøyten?

○ Nei ○ Ja

265) Dersom du får plager av matvarer, har det...

	Ikke i det hele tatt	Litt	En del	Ganske mye	Mye
Hindret deg i skolearbeid	○	○	○	○	○
Hindret deg i fritidsaktiviteter	○	○	○	○	○
Bekymret deg de siste 4 ukene	○	○	○	○	○

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK nord			06.11.2014	2014/1666/REK nord
			Deres dato:	Deres referanse:
			23.09.2014	

Vår referanse må oppgis ved alle henvendelser

Sameline Grimsgaard
Institutt for Samfunnsmedisin

2014/1666 Vekt, vektutvikling og fysisk aktivitet i Fit Futures kohorten

Forskningsansvarlig: Nordlandssykehuset
Prosjektleder: Sameline Grimsgaard

Vi viser til søknad om forhåndsgodkjenning av ovennevnte forskningsprosjekt. Søknaden ble behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk (REK nord) i møtet 23.10.2014. Vurderingen er gjort med hjemmel i helseforskningsloven (hfl.) § 10, jf. forskningsetikkloven § 4.

Prosjektleders prosjektomtale
Overvekt/fedme og fysisk inaktivitet øker både blant barn og voksne og bidrar til økt sykelighet, dødelighet og behov for helsetjenester. Forekomsten av overvekt/fedme er høyere blant barn i Nord Norge enn i andre deler av landet. Vi har sparsomt med data og kunnskap om ungdom. Dette prosjektet vil gi ny kunnskap om determinanter for overvekt /fedme og sammenheng med fysisk aktivitet i en ungdomsundersøkelse. Fit Futures-studien av ungdommer i videregående skole ble gjennomført i Tromsø/Balsfjord i 2010-11 og med oppfølgingsundersøkelse i 2012-13. I alt 688 ungdommer deltok i begge undersøkelser. Fysisk aktivitet ble målt med spørreskjema og aktivitetsmåler (Aktigraf) Vi planlegger både tverrsnitts- og longitudinelle analyser.

Vurdering

Tidligere avgitt samtykke
Formålet med prosjektet er å undersøke: 1) Forekomst og determinanter for overvekt/fedme i en ungdomskohort i Nord Norge, med fokus på selvrapportert fysisk aktivitet. 2) Endring, og determinanter for endring i overvekt/fedme mellom første og tredje år i videregående skole.

I samtykke avgitt i forbindelse med Fit futures er det opplyst at hovedområdene det forskes på er: Smerte, eksem og kviser, beintetthet, astma og allergi, diabetes, infeksjoner, øresus, fysisk aktivitet og overvekt, D-vitamin, frafall fra skole, jernmangel, genmodifisert mat, miljøgifter, personlighet og helseatferd og tannhelse, syreskader og medfødte skader på tennene.

Det tidligere avgitte samtykke anses som dekkende for studien.

Vedtak
Med hjemmel i helseforskningsloven § 2 og § 9, samt forskningsetikkloven § 4 godkjennes prosjektet.

Sluttmelding og søknad om prosjektendring
Prosjektleder skal sende sluttmelding til REK nord på eget skjema senest 01.07.2018, jf. hfl. §

12. Prosjektleder skal sende søknad om prosjektendring til REK nord dersom det skal gjøres vesentlige endringer i forhold til de opplysninger som er gitt i søknaden, jf. hfl. § 11.

Klageadgang
Du kan klage på komiteens vedtak, jf. forvaltningsloven § 28 flg. Klagen sendes til REK nord. Klagefristen er tre uker fra du mottar dette brevet. Dersom vedtaket opprettholdes av REK nord, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag for endelig vurdering.

Med vennlig hilsen

May Britt Rossvoll
sekretariatsleder

Kopi til:jan.terje.henriksen@nordlandssykshuset.no

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK nord	Maren Johannessen Melsbø	776 46 140	25.09.2018	2014/1666/REK nord
			Deres dato:	Deres referanse:
			20.09.2018	

Vår referanse må oppgis ved alle henvendelser

Sameline Grimsgaard
Institutt for Samfunnsmedisin

2014/1666 Vekt, vektutvikling og fysisk aktivitet i Fit Futures kohorten

Forskningsansvarlig: Nordlandssykehuset, Nordlandssykehuset HF
Prosjektleder: Sameline Grimsgaard

Vi viser til to søknader om prosjektendring, begge datert 20.9.2018. Søknadene er behandlet av Regional komité for medisinsk og helsefaglig forskningsetikk (REK nord) ved sekretariatsleder, etter fullmakt gitt av komiteen med hjemmel i forskningsetikkforskriften § 7, første ledd, andre punktum. Søknadene er vurdert med hjemmel i helseforskningsloven § 11.

Vurdering
Prosjektleder opplyser i endringssøknadene at endringene gjelder forlengelse av prosjektperioden til 1.8.2020 grunnet omsorgspermisjon hos prosjektleder og dermed utvidelse av stipendiatperioden, samt tillegg av en ny prosjektmedarbeider som biveileder.

REK har ingen innvendinger til de omsøkte endringene.

Etter fullmakt er det fattet slikt

Vedtak
Med hjemmel i helseforskningsloven § 11 godkjennes prosjektendringen.

Klageadgang
Du kan klage på komiteens vedtak, jf. helseforskningsloven § 10 og forvaltningsloven § 28 flg. Klagen sendes til REK nord. Klagefristen er tre uker fra du mottar dette brevet. Dersom vedtaket opprettholdes av REK nord, sendes klagen videre til Den nasjonale forskningsetiske komité for medisin og helsefag for endelig vurdering.

Med vennlig hilsen

May Britt Rossvoll
Sekretariatsleder

Maren Johannessen Melsbø
rådgiver

Kopi til: *jan.terje.henriksen@nordlandssykshuset.no; postmottak@nlsh.no*

REK
REGIONALE KOMITEER FOR MEDISINSK OG HELSEFAGLIG FORSKNINGSETIKK

Region:	Saksbehandler:	Telefon:	Vår dato:	Vår referanse:
REK nord	Maren Melsbø	77620748	09.09.2020	9704
			Deres referanse:	

Sameline Grimsgaard

9704 Vekt, vektutvikling og fysisk aktivitet i Fit Futures kohorten

Forskningsansvarlig: Nordlandssykehuset HF

Søker: Sameline Grimsgaard

REKs vurdering

Vi viser til søknad om prosjektendring for ovennevnte forskningsprosjekt mottatt 18.08.2020. Søknaden er behandlet av sekretariatet i REK Nord på delegert fullmakt fra komiteen, med hjemmel i forskningsetikkforskriften § 7, første ledd, tredje punktum. Søknaden er vurdert med hjemmel i helseforskningsloven § 11.

Det fremgår av endringsmeldingen at man søker å forlenge prosjektperioden frem til 31.03.2021.

Dette er begrunnet med at «Stipendiatperioden er forlenget grunnet to omsorgspermisjoner og prosjektet søkes derfor forlenget t.o.m. 31.03.2021. Protokollen er uendret. Avhandlingen leveres i september 2020.»

REK har ingen innvendinger til dette:

På fullmakt er det fattet slikt:

Vedtak

Godkjent

Med hjemmel i helseforskningsloven § 11 godkjennes prosjektendringen.

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MVH

May Britt Rossvoll
Sekretariatsleder
Veronica Sørensen
Seniorrådgiver

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