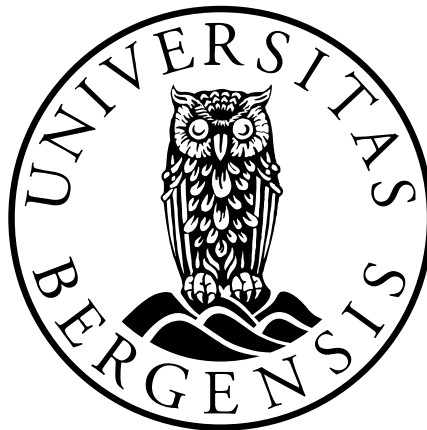# Overweight and obesity in Norwegian children

Trends, current prevalence, effect of socio-demographic factors and parental perception

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Dissertation for the degree philosophiae doctor (PhD)

at the University of Bergen

2010

"Det siger seg selv, at bedømmelse av et barns utviklingsforhold maa danne grundfundamentet ikke alene for en virkelig forstaaelsesfuld lægebehandling, men ogsaa for det store sociale begrep skolehygienen; sistnævnte bør efter forf.s mening regnes rummelig: skolebarnsalderens hygiene". Carl Schiøtz, Kristiania, 1918.

Acknowledgements

The work presented in this thesis is based upon data from the Bergen Growth Study (www.vekststudien.no). The idea of conducting a growth study in Bergen was not far-fetched as the two large scale growth studies done in Norway, both giving birth to national growth references, had their base in the same city. The initial planning was performed in collaboration with my principal supervisor, Professor Robert Bjerknes in the very first years after the millennium. I am indebted to Robert for not only introducing me to the exciting discipline of paediatric endocrinology, but also for being essential in realizing the Bergen Growth Study and this thesis, and giving me invaluable professional and personal support at all times.

As there was a need for up to date knowledge in Norway about how to perform a growth study, I went travelling. In London, Professor Ronaldo Rona pointed me to Brussels, and in the Laboratorium Anthropogenetica at the Free University of Brussels, I met Professor Roland Hauspie and biostatistician Mathieu Roelants. This became the start of a collaboration between the growth studies in Flanders and Bergen. My frequent visits to Brussels and Leuven during the last years and the close collaboration with Mathieu have not only been constructive for this work, but also great fun. Back in Bergen, associate Professor Geir Egil Eide, and Professor Emeritus Per Erik Waaler, became an important part of the team.

Many excellent co-workers have been for a shorter or a longer period involved in the Bergen Growth Study. I wish to thank Grethe Almenning, Linda Glomset, Janicke Hetland, Anita Hofstad, Marthe Holmgard, Eygló Jónsdóttir, Beate Nilsen, Margit Pedersen, Hilde Sælensminde, Sigrid Vinsjansen, Randi Vågset, Gerd-Anne Wincentsen and Kjersti Gunnleiksrud Ystgård, for not only performing the anthropometric measurements, but also for their enthusiasm and willingness to find good solutions to practical problems. Thanks to our children for repeatedly taking part in the test-retest sessions at Nesttun helsestasjon. Furthermore, thanks to Tale and Andrea Bjerknes, Merete B. Jacobsen and Ásbjörg Pétursdóttir for excellent work on registering questionnaire data.

Abstract

Background: The prevalence of paediatric overweight and obesity has shown a rapid increase in most parts of the world during the last decades. Estimates of prevalence of overweight and obesity in Norwegian children have been limited, and few studies have explored possible socio-demographic risk factors. The ability of parents to recognize weight deviations in their children is important for the management of emerging weight problems in children.

Objectives: To provide new data on weight-for-height and skinfolds in Norwegian children, and compare these to growth references collected in 1971-4. Also, to estimate the prevalence of overweight and obesity by comparisons with the World Health Organization (WHO) growth standard and the International Obesity Task Force (IOTF) criteria for overweight and obesity, and to identify socio-demographic risk factors. Finally, to compare parental perception of their children's weight status to objective criteria of overweight and underweight based on anthropometric measures (BMI, waist circumference and triceps skinfold thickness).

Materials and methods: A total of 8299 children aged 0-21 years from a stratified randomized selection of well-baby centres, kindergartens and schools in the city of Bergen, were included into the Bergen Growth Study during 2003-6. In 2006-7, a parental questionnaire including data on socio-demographic factors and parental perception were sent to 7472 participants and answers obtained for 4905 children.

Results: The first paper demonstrated an increase in the weight-for-height, triceps and subscapularis skinfolds between 1971-4 and 2003-6 in 4115 Norwegian children aged 4-15 years. The upward percentile shift was largest in the highest percentiles and more prominent for skinfolds than for weight-for-height. Overall, 18.0% of the boys and 20.1% of the girls were above the 90th weight-for-height percentile of the 1971-4 references. Corresponding values for the triceps skinfolds were 30.0% and 28.0%, and for subscapularis skinfolds 26.5% and 25.9%.

In the second paper, the growth of 2231 Norwegian and 4754 Belgian children aged 0-5 years was compared with the WHO growth standard. In general, the number of Norwegian and Belgian children below – 2 SD of the WHO standards was lower, and the number above + 2 SD higher than was to be expected if there were no differences between the populations. For BMI, the overall percentage below – 2 SD was 0.54% (expected 2.3%) and 4.29% above the + 2 SD (expected 2.3%). This was true for all Norwegian children, also those who were exclusively breastfed. The results were similar for the Belgian children.

The third paper reported the prevalence of overweight and obesity as defined by the IOTF in 6386 healthy Norwegian children aged 2-19 years. Overall 13.8% were assigned as overweight and 2.3% as obese. The prevalence was highest in the primary-school aged children (17.0%) as compared to pre-school children (12.7%) and adolescents (11.7%). Significantly more girls than boys were overweight in the pre-school age group (15.8% in girls vs. 9.6% in boys, p<0.001), whereas the opposite was true for adolescents (12.9% in boys vs. 10.2% in girls, p=0.026). Furthermore, this paper described the effect of socio-demographic risk factors on the prevalence of overweight and obesity as explored in a subsample of 3793 children. The risk of being overweight or obese increased in children with fewer siblings (p=0.003) and with lower parental educational level (p=0.001). No association was found with parental employment status, single-parent families or ethnic origin.

The fourth paper showed that 71.2% of overweight and obese children and 40.8% of underweight children, using the IOTF definition for overweight and a similar criterion for underweight, were recognised by their parents as being of normal weight. Above 90% of overweight pre-school children were assigned as normal weight. For a given value of BMI, primary-school age children, adolescents and girls had an increased risk of being assigned as overweight, whereas adolescents and girls had a lower risk of being assigned as underweight. Overweight parents more often assigned their children as underweight, but there was no effect of parental educational level or parental underweight.

Conclusions: There has been a significant increase in weight-for-height in Norwegian children during the last 30 years, and the increase in skinfolds indicate that increase in fat tissue is responsible for these changes. The current prevalence of overweight and obesity is comparable with data from other North- and Western-European countries, but lower than seen in Southern-Europe, the UK and the US. Socio-demographic factors have marked effects on the current prevalence of overweight and obesity. It is of great concern that in light of the increased prevalence of childhood overweight, parental ability to recognize weight deviations in their offspring is generally poor.

Contents

1. List of publications

I. Júlíusson PB, Roelants M, Eide GE, Hauspie R, Waaler PE, Bjerknes R. Overweight and obesity in Norwegian children: Secular trends in weight-for-height and skinfolds. Acta Paediatrica 2007;96:1333–7.

II. Júlíusson PB, Roelants M, Hoppenbrouwers K, Hauspie R, Bjerknes R. Growth of Belgian and Norwegian children compared to the WHO growth standards: Prevalence below –2 and above +2 standard deviations and the effect of breastfeeding. Arch Dis Child 2009, Nov 30 [Epub ahead of print].

III. Júlíusson PB, Eide GE, Roelants M, Waaler PE, Hauspie R, Bjerknes R. Overweight and obesity in Norwegian children: Prevalence and socio-demographic risk factors. Acta Paediatrica 2010;99:900-5.

IV. Júlíusson PB, Roelants M, Markestad T, Bjerknes R. Parental perception of their children's weight status. Acta Paediatrica 2010. Accepted for publication.

2. Abbreviations

BGS = Bergen Growth Study

BMI = body mass index (kg/m^2)

CDC = Centre for Disease Control

DXA = Dual X-ray Absorptiometry

FFMI = Fat free mass index

FGS = Flandern Growth Study

FMI = Fat mass index

IOTF = International Obesity Task Force

MGRS = Multicentre Growth Reference Study (WHO)

NHANES = National health and nutrition examination survey

NIPH = Norwegian institute of public health

OB = obesity

OR = odds ratio

OWOB = overweight including obesity

WC = waist circumference

WHO = World Health Organization

WHR = waist-to-height ratio

TEM = Technical error of measurement

T2D = Type 2 diabetes mellitus

%BF = Percentage body fat

3. Introduction

3.1 Childhood overweight and obesity - historical background

The growth of a child is the outcome of a complex interaction between nutrition, genetics, general health and environment. One hundred years ago, malnutrition was common in European children. In the city of Bergen, the paediatrician Carl Looft reported that 3/4 of the children he investigated in his practise were rachitic (1). These were times of high paediatric morbidity and mortality with stunting in growth. In European countries, a secular trend in longitudinal growth has been documented with gradual increase in final height of 0.3-3 cm per decade (2). This improvement in growth appeared together with improvements in nutritional status and disease panorama. Anthropometric measurements have been invaluable as markers of individual nutritional status and health, but also for monitoring the general growth status of the population. Whereas growth of an individual child reflects the state of its health and nutrition, "the average values of children's heights and weights reflect accurately the state of a nation's public health and the average nutritional status of its citizens", as stated by Eveleth and Tanner (3).

With the gradual transition from poverty to affluent societies, the problem of undernutrition has been replaced with that of overnutrition. Current national and international efforts in monitoring growth of children have gradually also included focus on overweight and obesity (4). The "paediatric obesity epidemic" began in the early 1970s with a progressive increase in children's weight, a trend that has been ongoing (5), although most recent publications suggest that this trend is levelling off (6-8). The current prevalence rates have been reported up to 30% in the US and Europe (9, 10), with consequent rise in health care costs (11). The increase in childhood overweight is also representing a problem in developing countries, some of them showing a direct transition from the underweight problem to the overweight problem (12).

In Norway, annual routinely performed measurements of weight and height of school children were initiated by Carl Schiøtz in the 1920s. Brundtland et al. published trends in height and weight in Oslo schoolchildren from 1920 to 1975 based on these data. Gradual positive secular trends in height-for-age and weight-for-age were seen (13). Furthermore, Brundtland published means and percentiles for height, weight and weight-for-height in 7-19 years old school children from Oslo measured in 1970 (14).

Additionally, two growth studies, giving data to the first and the second Norwegian growth charts, have been performed in the city of Bergen. The first study by Sundal, performed in 1952-6, gave data to the first Norwegian growth charts and included measurements of length/height and weight from 17 795 children between 0 and 15 years (15). The second study, performed by Waaler in 1971-4, included various anthropometric data from 3-17 year-old children (n=3068) from Bergen (16). The second Norwegian growth charts included these data, and data from 0-4 year-old children (n=23669) from Oslo and Hedmark (the SYSBARN study) recorded in 1982-4 (17). Both Waaler's study and the SYSBARN study were mixed-longitudinal, and the total number of measurements for height and weight were 8414 and 70908, respectively. Figure 1 compares the mean height-for-age and weight-for-age in three cohorts, school children in Oslo measured in1920, Alfred Sundal's data, and Per Erik Waaler's data.

Figure 1. Secular trends in height-for-age and weight-for-age. Data from Oslo 1920 (13), Bergen 1952-6 (15) and Bergen 1971-4 (16).
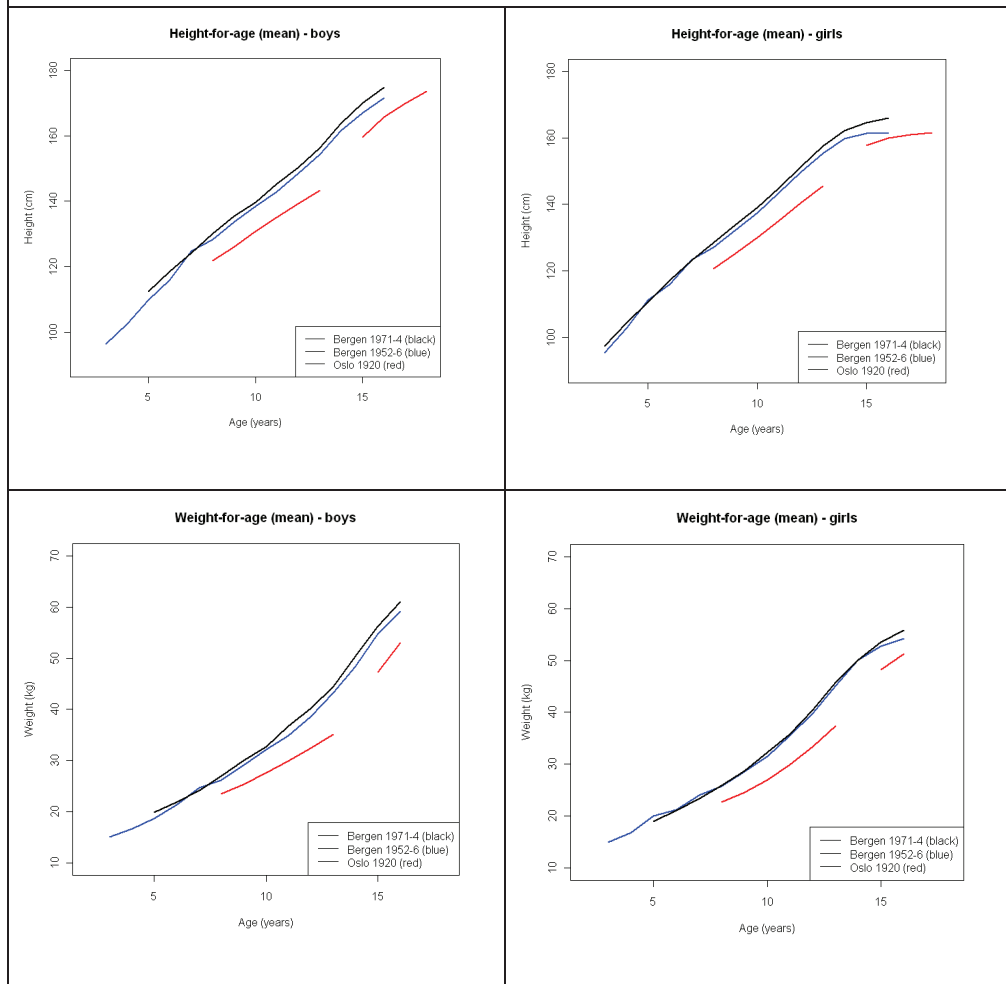
None of the aforementioned studies published BMI references, but Sundal and Waaler published table data and charts for weight-for-height. Sundal's weight-for-height curves were based on the assumption that the weight data were normally distributed. Therefore, comparisons to Waaler's data were limited to the mean as direct comparison of percentiles was not possible. The weight-for-height mean curve for boys was "practically similar" in Sundal's and Waaler's data (16). For the girls, mean

weight-for-height was 0-0.8 kg heavier (overall mean 0.5 kg) in Sundal's material. This suggests that the children in Bergen were not more overweight in 1971-4 when compared with data from the same city in 1950-6. Girls in Oslo measured in 1970 were found to be heavier than girls in Bergen measured in 1971-4 (difference in the 50th percentile in weight-for-height 0.2-2.4 (mean 1.0 kg)), with the same tendency found in boys (16). More recent Norwegian prevalence data based on measured height and weight throughout childhood and adolescence were lacking prior to the current study.

3.2 The physiology of fat accumulation

Childhood and adolescence seems to be sensitive periods for abnormal weight gain. Physiologically, accumulation of fat tissue in early childhood can be interpreted as a preparation to periods with extensive growth. During the first 6 months of age, there is a rapid accumulation of fat tissue in the body (18). Between about 6 months to 5 years the relative amount of fat tissue declines gradually. Thereafter, an increase occurs, a period termed "adiposity rebound" (AR) (18). Early adiposity rebound has been associated with an increased risk of later overweight. However, this has been shown to be a statistical but not physiological phenomenon, e.g. children with early AR are children with high BMI. This means that early AR only reflects increased growth in children that are already heavier or showing upward percentile crossing, a phenomenon that applies to all ages, not only the rebound period (19, 20). Normally growing boys with late onset of puberty have a tendency to become overweight, but this fat accumulation can disappear during the pubertal growth spurt (18). Girls with early puberty seem to have increased risk of becoming overweight (21).

3.3 Measuring and defining paediatric overweight and obesity

3.3.1 Introduction

In the literature, overweight is commonly defined as having more body fat than is optimal for the health of an individual. The term has been used as a descriptive term for a "presumed overfat children in whom we are concerned"(18). Obesity is usually defined as excess body fat that may have adverse effect on health. The difference is one of degree with obese children more severely affected. Defining overweight, obesity or excess body fat in children is more difficult than in adults as normal body fat not only differ between the sexes, but also varies with age and the maturity of the child.

Definitions of paediatric overweight and obesity have both an epidemiological and a clinical relevance. In an epidemiological setting, a definition is needed to assess prevalence and follow trends over time. In the clinical setting, a definition should be related to health risk outcomes. Optimally, clinical thresholds could be defined for when to alert the parents or when to initiate evaluation or intervention.

There are several methods available for assessing overweight and obesity in children. These include measurements of body fat and estimations of body composition demanding use of advanced equipment, more simple anthropometric measurements of fat accumulation of specific sites (skinfolds, waist circumference), and indexes based on the relationship between height and weight.

3.3.2 Estimation of body composition

Although direct measures of fat tissue would be the optimal alternative when assessing overweight children, the methods for doing so are not suitable for large scale use because of the cost, limited availability and lack of reference data. MR/CT-scans, Dual-energy X-ray absorptiometry (DXA), underwater weighing, total-body water, total-body potassium, total-body electrical conductivity and air displacement

plethysmography either measure fat tissue directly or give information about the proportion of fat tissue (18, 22). Body fatness is expressed as percent body fat (fat mass/body weight) or fat mass index (fat mass/height^2, FMI) and fat-free mass index (fat-free mass/height^2, FFMI)(23). The latter two can again be related to BMI as FMI+FFMI=BMI. Underwater weighing has been used as the reference method for body composition measurements in the past. Studies on animals and humans have shown that DXA accurately measures the body composition. Because of its low radiation dose and convenience when compared to underwater weighing, it might represent the currently preferred reference method for body composition estimation (24, 25).

Excess body fat has been defined as >25% in boys and 30% in girls (26). The same definition has been used for all ages, but this might not be appropriate. In 2006, McCarthy et al. published body fat reference curves for children based on bio-impedance measurements (27). However, one should use these curves with caution when interpreting percentage body fat (%BF) data that are not gathered with the same equipment and methodology as used by McCarthy. In this study, the International Obesity Task Force (IOTF) definitions of overweight and obesity corresponded best with the 85th and 95th percentile on the %BF curves.

3.3.3 Measurements of skinfolds and waist circumference

3.3.3.1 Skinfolds

Skinfold thickness is a direct measure of subcutaneous fat tissue. The most usual skinfolds to measure are the triceps, biceps, subscapularis and suprailiac. Attempts have been made to assess body composition with skinfolds measurements, and several equations have been constructed for that purpose. Reilly et al. validated five skinfolds-equations for estimating body composition with underwater weighing, and concluded that "skinfolds might best be regarded as indices (rather than measures) of body fatness in individuals" (28). Freedman et al. showed that although triceps and subscapularis skinfolds improved the prediction of DXA estimated body fatness when

used in addition with BMI, this only marginally applied to obese children (above 95th CDC centile) (29).

Measuring skinfolds is dependent on the skills of the observer and training sessions are therefore necessary. It is especially demanding to measure skinfolds in obese children where in many cases it is difficult to pick up folds of skin with the underlying subcutaneous fat tissue. Generally, measurements are prone to large inter-observational variability, more so in overweight and obese children, and measurements of skinfolds are therefore not suited for routine clinical practice (30).

Despite these limitations, skinfolds measurements might represent a valuable addition to weight and height measurements when monitoring overweight trends in a population. Studies have suggested that the paediatric obesity epidemic might be underestimated by only following trends in BMI. These studies have shown more pronounced secular trends in skinfolds than in BMI (31, 32).

3.3.3.2 Waist circumference and waist-to-height ratio

Waist circumference (WC) predicts the amount of abdominal fat and in adults, abdominal obesity is associated with increased metabolic risk (33). Studies in children have shown that WC is correlated to levels of lipids and insulin in children (34). Also, WC showed a stronger association with cardiovascular risk than with BMI (35). In adults, WC > 80 cm in women and > 85 cm in men have been used as a marker of increased risk of obesity related complications (36). However, no such criteria exist for children. Several sex- and age-related WC references have been published (37-39).

In the literature, there are several definitions of where to measure WC, leading to different results (40). The definition advocated by WHO seems to be gaining acceptance, where WC was measured horizontally, halfway between the lower border of the ribs and the upper border of the iliac crest on the mid-axillary line, at the end of a normal expiration (41).

Waist-to-height ratio (WHR) might also be a marker of metabolic risk in children (42). It has been suggested to use a single WHR cut-off value of 0.5 for all ages and both

sexes (43). Other studies have however shown variation of WHR with sex and age, suggesting that use of a sex- and age-dependent references would be more appropriate (38).

In adults, waist-to-hip ratio is frequently measured, but in children, WC is a better estimator of trunk fat than the waist-to-hip ratio (44). Although the measurement error for WC is larger than for height and weight (for calculation of BMI), the measurement is reproducible and correlates with total body and trunk adiposity when compared to DXA (40). There are no published data on WC or WHR in the Norwegian paediatric population.

In a study from the UK, changes in waist circumference showed a larger increase than BMI when comparing cross-sectional data from 1977, 1987 and 1997 (39). These findings, similar to skinfolds, suggest taking additional measurements of simple anthropometric traits like waist circumference, as well as skinfolds, might be appropriate when studying trends in obesity.

3.3.4 Weight-for-height indexes

When assessing overweight and obesity in children, measuring weight alone is not suitable as it needs adjustment for height, age and sex. These variables are usually easily assessable and not sensitive to observational bias. There are several alternatives for age and sex specific weight-for-height indexes: weight-for-height (WFH, kg/m), body mass index (BMI or Quetelet index, kg/m^2) and ponderal index (kg/m^3).

More generally, weight adjusted for height can be expressed as,

Adjusted weight = weight/height^p, p = value between 1 and 3 (Benn index).

In an ideal population with all individuals having the same shape and body density, the value of p should be close to 3 (weight adjusted for volume). In a population where height and weight are uncorrelated, the value of p would be close to 0 (45).

WFH was the only weight-for-height index incorporated into many national references during the previous decades. It is still in use today, especially in the younger age

groups and for the assessment of undernutrition (4). It is nevertheless to a large extent replaced by BMI in the evaluation of weight deviations in children above 2 years of age. The BMI is preferred over the ponderal index as it is less correlated with height and therefore gives a better adjustment for height (46). The ponderal index will not be discussed further in this work.

Previous Norwegian growth charts included WFH references but not BMI. WFH has therefore traditionally been used to assess weight deviations in children in Norway. The criteria for overweight and obesity were set to 20% and 30% above the median weight-for-height (47). Both WFH and BMI are indices of length/height and do not specifically measure fat tissue. In both instances, one would expect that the correlation with fat tissue increases when approaching the upper end of the distribution. Flegal et al. compared WFH in children 2-5 years of age (77 cm up to 122 cm) with BMI-for-age charts and concluded that these parameters did not give identical results and were thus not interchangeable (48). WFH percentiles tended to be lower than the BMI-percentiles, e.g. more conservative, or making it less likely for a person to be assigned as "overweight" or "obese", and more likely to be assigned as "underweight". However, this was dependent on age; the 10th WFH percentile corresponding with the 3rd to 21st BMI percentile, the 85th percentile with 74th to 92nd BMI percentile (48).

WFH is easier to plot and understand than BMI, and is an attractive option in circumstances where the age of the child is not known. However, WFH has certain limitations, some of which can be solved by the use of BMI for age. It has been shown that WFH is not independent of age (49) and the assessment of weight/height in relation to age cannot be done with a single WFH chart, but this is not a problem in the case of BMI. Furthermore, there is no consensus about cut-offs for under- or overweight when using WFH, where these are well established for the BMI. Therefore, there is now an international agreement to use BMI as the preferred weight-for-height index (50).

However, the BMI has some limitations, summarized below:

a) As shown by Franklin et al., elimination of the effect of height in the weight-for-height equation, demands adjustment of the Benn index (*p*) on a yearly basis. The index was shown optimally to be above 2 in children below 18 years of age (45). Because of this, tall children, particularly at the age of 6 to 12 years, tend to have somewhat higher BMI than shorter children (45). When compared to skinfold measurements, a Benn index=2 was found reasonable in children up to 12 years of age, but between 12 and 17 years, a higher value was preferable (45).

b) The BMI does not give any information about distribution of fat tissue (central versus peripheral fat distribution) (51, 52).

c) The BMI is a measure of weight-for-height rather than adiposity (51). As a consequence, the BMI does not differentiate between bone, muscle and fat tissue. In children of normal weight, the BMI estimates body fat poorly, but in overweight and obese children, a high BMI does reflect excess body fat (53).

d) There are variations between ethnic groups in the limits for "at risk of complications" (4).

Despite these limitations, the BMI has been generally accepted as the best available option for the objective assessment of overweight in childhood (54). It is however important to bear in mind that in a clinical context, the BMI only represents an information complementary to through clinical investigation.

The BMI shows a rapid increase during the first year of life, and thereafter it decreases until about 5 years of age. It then starts to increase again (the adiposity rebound) and continues to increase throughout childhood and into adulthood, but decreases again after about 65 years of age (55).

3.3.4.1 Definitions of overweight and obesity based on BMI

For meaningful comparisons of the prevalences of overweight and obesity to be made between studies, a uniform definition should be the goal. As reviewed by Chinn and in

another paper by Sweeting, the use of different references or cut-off values when reporting prevalence rates of overweight and obesity makes the literature confusing (56, 57). In the US, the 85th and 95th BMI-percentiles on the CDC growth charts have been used to define "at risk for overweight" and "overweight", respectively (4), although the terminology has now changed to "overweight" and "obesity" (51). The CDC reference charts consist of pooled data from different periods (1963-1994 up to 6 years of age, 1963-1980 for children older than 6 years), and consequently they do not reflect growth at a certain time (58). Other countries have used their national reference and defined "overweight" and "obesity" by using the 85th and 95th percentiles, 90th and 97th percentiles, or 91th and 98th percentiles in the relevant national reference charts (56).

The IOTF promoted the construction of a single international definition of paediatric overweight and obesity, which were published in the year 2000 (59). These definitions were based on data from Brazil, the UK, Hong Kong, the Netherlands, Singapore, and the US collected in 1968-1993. Consistency with the adult cut-offs for overweight and obesity was ensured by using the percentiles corresponding to a BMI of 25 kg/m^2 and 30 kg/m^2 at the age of 18 years as the age and sex specific thresholds from 2 to 18 years of age. This was done for each country separately, and the IOTF reference values were obtained by averaging the individual lines from all six countries (59). While these cut-off limits are of value for epidemiological use, when comparing prevalence rates over time or between countries, there is an ongoing debate about whether they are equally suitable for use in a clinical practice (54).

In 2006, the WHO published a universal growth standard intended to show optimal growth of all children aged 0-5 years, irrespective from which region of the world or population they originate. To achieve this goal, WHO set up a multicentre growth reference study (MGRS) in six countries (Brazil, Ghana, India, Norway, Oman and the US), and only included children of high social class (except in Norway and US where social class was not an inclusion criterion), of non-smoking mothers, and being breastfed according to the WHO recommendations (60). Based on the comparison of length between the different measurement sites, the WHO concluded that children

grow similarly under optimal conditions, and universal use of these charts was therefore recommended (61). To this date, site differences for weight, BMI or head circumferences have not been reported. Although the WHO growth standards represents a valuable tool for international comparisons on growth (length, weight, BMI or head circumference), it is a matter of debate whether they can replace national references for monitoring growth of the individual child (62, 63).

3.3.4.2 The choice of national versus international definition

Although there is no debate about the use of the IOTF cut-offs as an independent international platform for comparisons, its use in clinical practice for identifying overweight and obesity in individual children is debated (64). Comparing the IOTF-criteria with the UK BMI reference charts, Reilly found that the IOTF-definition underestimated obesity when compared with bioelectrical impedance measurements (65). He concluded that the IOTF-criteria were highly specific, but very insensitive. Furthermore, he claimed that the national UK reference using the 91th and 95th percentiles as cut-offs, were more appropriate (64). Other authors have also advocated the use of national references using similar arguments (66, 67). There are several other limitations with the IOTF-approach as pointed out by Chinn (56). Firstly, one can not calculate z-scores based on the IOTF data when using BMI as a continuous variable. Secondly, the IOTF cut-off lines only exist for children above 2 years of age, and finally, the IOTF criteria might under- or overestimate the prevalence rates of overweight and obesity when compared to national BMI references.

It seems nevertheless clear, that prevalence estimates should be based on the IOTF-definition for meaningful comparisons between studies. Furthermore, countries without their own BMI reference might use the international approach. The IOTF 25 line is close to the CDC 85, considered to be a meaningful cut-off for the increase in fat mass. The IOTF 30 is more conservative than the CDC 95th percentile, but might prove useful for the definition of excess fat mass, where it is appropriate to implement strategies to stop weight gain or reduce weight.

The IOTF cut-offs are "fixed" lines. In an environment with a secular increase in the prevalence overweight and obesity, the most recent reference might be inappropriate as it reflects a population with a lot of children with an already unhealthy weight status. One can avoid this problem by using a BMI reference based on data from before the start of the "obesity epidemic", as has been done in the UK, where the UK90 reference will not be replaced (68), and in the US, were the BMI charts for children older than 6 years of age include data measured before 1980 (69). Others have added the IOTF cut-off lines on their national BMI reference charts (the Netherlands, Sweden, Norway (Figure 2)). A third possibility is to construct lines in the same manner as IOTF did, but based on the national dataset (Belgium).

Figure 2. BMI charts for 2-19 year old Norwegian boys and girls published by the Bergen Growth Study in 2009 (70). The IOTF limits for overweight and obesity are plotted onto the percentile charts (upper gray area). Similar criteria for underweight (based on the same dataset (71)) define the lower gray area.
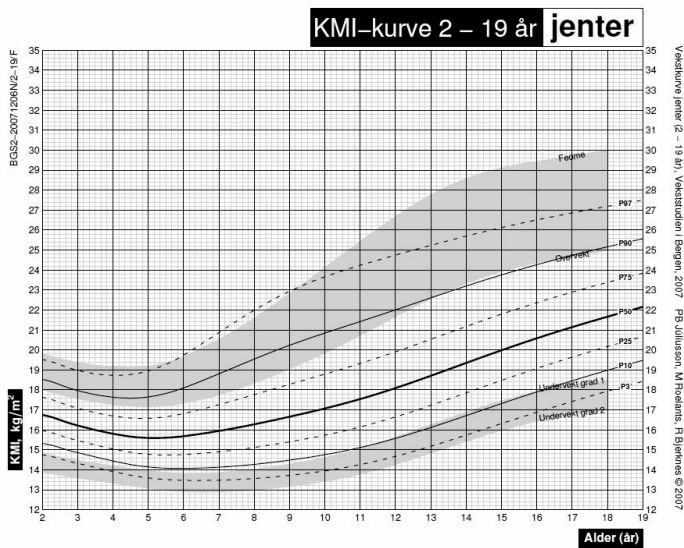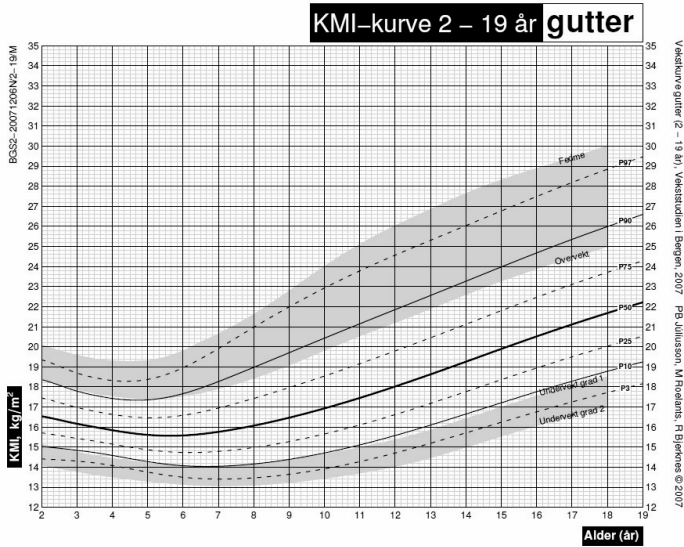
Gutter = Boys; Jenter = Girls; KMI = BMI; Alder (år) = Age (years)

3.3.4.3 The ability of BMI to detect increased body fat

It has been shown that in normal weight children BMI correlates poorly with fat tissue, and that variations in the BMI in this group are mostly explained by the fat-free mass (72). Nevertheless, a high BMI is associated with excess fat tissue which again is related to adverse health outcomes (72, 73). When comparing CDC BMI-z-scores with DXA-estimated body fatness, a non-linear relationship was shown with the FMI and a linear relationship with the FFMI. Fat mass increased only for z-scores >1 (corresponding roughly with the CDC >85th percentile, or IOTF 25). In individuals below 50th percentile, BMI was more strongly associated with the FFMI (72).

Several studies focused on the ability of the BMI to identify children with excess body fat. Studies by Freedman et al., comparing body fat with BMI z-scores, showed that most of the children between CDC percentiles 85 and 95 did not have excess body fatness (defined as fat mass >30%) (74). Furthermore, a high BMI (>95th CDC percentile) was found to be a satisfactory index of excess body fatness (51). Children above the obesity limit (CDC 95 percentile or the more strict IOTF 30) have therefore a high probability of excessive fat; with a high specificity and a low false positive rate. The sensitivity is not equally high, leading to some false negatives (75). This is nevertheless clinically acceptable as the children assigned as obese do have excess body fat, avoiding the problem of stigmatizing non-obese children as being obese (73).

3.3.4.4 Ethnical differences in BMI

There are ethnical differences in the relation between BMI and body fatness. For a given BMI-for-age, Caucasian children have a higher percentage of body fat than black children, but less than Asian children (76, 77). Furthermore, Caucasian children are less likely to develop type 2 diabetes (T2D) or hypertension than Asian children with the same BMI (78). Therefore, lower BMI cut-off limits for overweight and obesity might be more appropriate for use in Asian populations.

3.4 The paediatric obesity epidemic

As summarized by Wang and Lobstein, there has been, with only few exceptions, an increase in paediatric overweight and obesity around the world, in both developed and developing countries (9). The exceptions reported are regions of the former Soviet Union and the sub-Saharan Africa. Because of the different definitions of paediatric overweight and obesity and different methodological characteristics (age, self reported height and weight, timing) of the studies reported, comparisons of prevalence numbers are not straight forward.

In Europe and USA, there has been a two- to fourfold increase in the prevalence of overweight for the last decades (79). In the UK, there has been a steady increase in prevalence since the 1980s, with the prevalence of overweight (IOTF) in 5-10 year old girls moving from 9.9% in 1984, to 23.3% in 2002-3 (5.7% to 16.4% in boys) (80). In the US, the prevalence of overweight defined with the IOTF cut-offs was 29% in 1999-2000, but had risen to above 35% in 2003-4 (81). Furthermore, the prevalence of obesity (>95% CDC percentile) in adolescents increased from 4.6% to 15.5% between 1966-70 and 1999-2000 (82). Between to 12-21% of children in Northern and Western European countries, and above 30% of children in Southern Europe were found overweight (IOTF cut-offs) (9, 10, 79, 83, 84) at the time when the Bergen Growth Study was initiated (2003).

In the adult population, overweight is now more common than underweight among young women in developing countries (85). Recent analyses from the US have suggested falling life expectancy during the 21st century because of overweight-related diseases (86). In Norway, the prevalence of obesity in adults has increased gradually from early 1990s, and recently 40-year-old Norwegian men were found among the most overweight in Europe (87).

Nevertheless, there may be a light at the end of the tunnel. Recent studies from Europe and the US suggest that this development might be levelling off in children (6, 7, 88).

Norwegian prevalence BMI data based on measured height and weight through childhood and adolescence were lacking prior to the current study. Data on self-reported height and weight in a national representative cohort of 8 and 12 years old children, however, showed an increase in the prevalence of overweight and obesity between 1993 and 2000. In year 2000, the prevalence of overweight and obesity was 11.5% and 1.8% in a group of 825 children 12 years of age (IOTF cut-offs), an increase of 4% and 0.9% from 1993, respectively (89). Another study analyzed self-reported height and weight data from 7343 children age 15 and 16 years in Oslo. Prevalences of overweight among boys and girls were 12% and 7% respectively (IOTF cut-offs) (90). Data from the school health care in Oslo with measured weight and height in 8 and 12 year old children published in 2004, reported the overall prevalence of overweight for both age groups to be 21% (IOTF cut-offs). There was no significant difference between boys and girls (91). Data on 6774 children aged 14-18 years measured in 1995-7 (part of the Ung-HUNT study in Nord-Trøndelag, Norway), were compared with measurements collected in 1966-9 in the same area. The authors did not publish IOTF-prevalence data but showed increase in mean BMI in boys of all age groups, but only in 18 year old girls. Furthermore, this study showed some increase in the underweight group (92).

Most studies have published trends in BMI. There is evidence, however, that this might underestimate the scale of the changes as studies comparing changes in waist circumference or skinfolds tend to show larger upward shift than BMI (31, 39). On the other hand, views have also been presented that the increase in BMI might not only be due to increase in fat mass, but also in fat-free mass (93).

3.4.1 Causes of the paediatric overweight epidemic

The increase in overweight and obesity in children constitutes complex interactions between the human biological circumstances and the environment. As our genetic material changes slowly, such changes cannot explain a development occurring over a few decades. Therefore, the most plausible explanations lie in environmental changes

or environmental-genetic interactions (93). Eating behaviour and activity patterns have changed dramatically in children and adults during the last decades.

3.4.1.1 Energy balance: Nutrition

Reduction in daily activity and increased sedentary behaviour with unfavourable diet habits resulting in positive increments in energy balance, have been postulated as the main explanations for the paediatric obesity epidemic (94). Dietary surveys based on self-reported or parental reported food intake, have not shown any secular increase in energy intake during the last two decades, and some have even shown a decrease (95). However, under-reporting of energy intake is a well known bias that is more evident in overweight persons (96). There has been a threefold increase in consumption of energy-dense fast food during the last two decades (97), changes in portion size and eating pattern have also been marked (95). There has also been a significant increase in sugar-sweetened beverages, with the consumption increasing in four-year-old children in the UK from 13 g/week in 1950 up to 446 g/week in 1992–3 (98). Norwegian teenagers consume about 100 g of sugar daily, twice the amount recommended by WHO; sugar intake is also high for children down to age of four (99). Food with a high glycaemic index food might be connected with increased obesity because of rapid and high insulin response, which again leads to a fall in glucose and thereby a lesser feeling of satiety (100).

3.4.1.2 Energy balance: Sedentary behaviour and physical activity

The daily activity is the part of the total daily energy expenditure that can affect the energy balance equation. During the last decades the way of living has changed towards lifestyles that include more comfort and less activity. Studies have found sedentary behaviour such as television viewing and playing video games to be associated with obesity (22, 101). In a longitudinal US study, following 9-10 year old girls over 10 years, reduction in physical activity was related to an increase in BMI and obesity (102). Unstructured activity (playing in the street or biking), have been suggested to be of greater preventive significance than organized sports (103).

3.4.1.3 Socio-demographic and family factors

In westernized countries, lower prevalences of childhood overweight have been found in high social strata (104). In a recent review, parental education level was found to be inversely associated with adiposity in 15 out of 20 studies. Parental education was showing stronger association to adiposity than parental income (105). In non-affluent countries, the opposite has been found, with overweight more prevalent among high social strata (22). There seems to be a certain ethnic difference in the propensity for developing obesity, although this difference might not be great when controlled for socio-economic factors (22). In developed countries, only minor differences in the prevalence have been found between boys and girls (10). Other socio-demographic factors associated with increased risk for paediatric overweight are single parent families, small family size and rural setting (105). The Norwegian studies addressing socio-demographic risk factors and adiposity have been restricted to self-reported weight and height and have mainly been limited to adolescents (90, 106). A study comparing the effect of poverty on the obesity prevalence in Canada, Norway and the US, showed that children defined as being not poor were less obese in all countries, although non-poor children in Norway were less obese than non-poor children in US and Canada (107).

3.4.1.4 Programming: Pre- and perinatal factors

Maternal obesity increases the risk of macrosomic (> 4500g) offspring (108). There have been some reports of increase in birth weight in Western societies. A Danish study showed an increase in mean birth weight during 1990-1999, and an increase in the proportion of children large for gestational age (109). This has not been shown in studies from the US (110). In Norway, an increase in mean birth weight was observed in the 1990s, but after the year 2000 this has normalized again to values from the 1970s and 1980s, about 3500g. In the same time period, a temporary increase in macrosomic infants was noticed, normalizing again to previous values after the year 2000 (111).

Studies have shown that both low and high birth weight are associated with later overweight. Children with low birth weight that show rapid catch up growth are especially at risk (112-115). In addition, these individuals seem to be more prone to coronary heart disease and T2D (116). Baird et al. reported high birth weight infants to be at greater risk for later overweight (117). Newborns with rapid growth during the first 12 months tend, at the age of 5 years, to be the heaviest children and those with the largest waist circumference (118).

It has been shown that breastfed children grow differently when compared with bottle fed children, with faster growth during the first six months and slower growth thereafter (119). Many studies have found breastfeeding to be preventive for later development of overweight and obesity (120). The problem of selection-bias is nevertheless an issue, and recent studies correcting for potentially biasing factors (socio-economic status, maternal smoking in pregnancy, maternal BMI) have not been able to show a preventive role of breastfeeding (121, 122).

Although these programming studies are of great interest, they cannot explain the rapid overall increase in the prevalence of overweight and obesity in children. The proportion of children with low birth weight is small. The amount of children with high birth weight has not changed substantially. Children becoming overweight or obese will inevitable show rapid weight gain, and this might happen early in individuals that are genetically susceptible. Moreover, breastfeeding is much more common today compared with the 1960s or 1970s (123).

3.4.1.5 Genetic factors

Parental obesity is strongly associated with overweight of the children. About 70-80% of obese children have one obese parent, 20-40% have both parents obese (124). This is probably partly because of genetic factors, and partly because of shared lifestyles, but separation of these factors has been difficult (125). Data from twin and adoption studies have nevertheless suggested that genetic factors are more influential than environmental factors (126). Whole genome studies have shown that weight and BMI are polygenic traits, including at least tens of genes (127). Monogenetic overweight

syndromes (mutations in the genes for leptin, leptin-receptor, pro-opiomelanocortin (POMC), melanocortin-4 receptor, prohormone convertase-1 (PC1)) have contributed with important biologic understanding, but patients with such syndromes are rare. Different genetic backgrounds seem to place individuals at different risks of becoming overweight, while also facing a more "obesogenic" environment (22, 128).

3.4.1.6 Other postulated factors

Other factors that have been postulated to play a role in driving the paediatric obesity epidemic are an increase in psycho-neuro-endorcrinological stress (129), and reduced intake of dietary calcium (130).

3.4.2 Consequences

Childhood obesity has both short and long term consequences. Obesity represents a health problem already in childhood and is related to increased morbidity and mortality in adulthood. The spectre of co-morbidities can more or less influence all organ systems. Several excellent reviews exist on this topic (22, 75, 79).

Ludwig described the paediatric obesity epidemic to have four phases (131). The first phase represents the gradual increase in weight among children (which began in the early 1970s), in phase two serious weight-related problems emerge with development of weight related co-morbidities. In phase three, life-threatening complications rise to the degree that leads to a reduction in life expectancy of the population. The fourth phase constitutes the effect upon the next generation, e.g. the consequences of being born to an overweight or obese mother, a biological phenomenon that might be mediated through epigenetic mechanisms.

3.4.2.1 Consequences of obesity in childhood

Psychological consequences of obesity are prominent. One study showed low self-esteem in 34% of overweight girls compared with 8% of their non-obese peers (132). Associations with body image dissatisfaction, poorer self-assessed health status,

potential social isolation and decreased life satisfaction, have also been documented (133).

Studies have shown associations between major cardiovascular risk factors and childhood obesity. A US study showed a threefold increased risk of high blood pressure in obese children (>95th CDC percentile) (134). The Bogalusa Heart Study showed that obese children (>95th CDC percentile) had significantly increased risk of having high insulin levels (OR = 12.6, 95%CI 10 – 16) and high levels of triglycerides (OR = 7.1, 95%CI 5.8 – 8.6) (135). The prevalence of cardiovascular risk factors has been shown to increase steeply in children with BMI above the CDC 99 percentile (51, 136). Sinha et al. investigated 167 obese (>95th CDC percentile) children and adolescents referred to an obesity clinic. Glucose tolerance test showed that 25% had decreased glucose tolerance and 4% had T2D, and all those children were either African or Hispanic Americans (137). Other studies have also suggested ethnical differences in insulin sensitivity (135). T2D have been shown to constitute up to 45% of newly diagnosed cases of diabetes in children and adolescents in some areas in the US (138), a disorder that previously was more or less unknown in children. Several papers have shown relationship of adiposity with low grade inflammation potentially contributing to metabolic disturbances (139). Hyppönen et al. suggested that childhood obesity is a risk factor for type 1 diabetes (140). The hyperinsulinemia associated with obesity plays a central role in the pathogenesis of the metabolic disturbances (141).

Prospective studies have supported the hypothesis that overweight predispose to asthma in childhood (142). Other potential health problems associated with obesity and presenting in childhood are obesity related renal failure (143), orthopaedic problems (slipped capital epiphysis and Blount's disease), neurological problems (idiopathic intracranial hypertension), sleep-associated respiratory disturbances and gallstones (reviewed by Field (144)).

3.4.2.2 Long term consequences of childhood obesity

A large number of studies have demonstrated the persistence of childhood overweight and obesity into adulthood (75). Overweight adolescents are more likely to become overweight adults than younger children. In one study, 69% of obese 6-9 years old children (above CDC 95th percentile) became obese adults, when 83% of obese 10-14 year old children became obese adults (125). High degree of overweight in the child and co-existents of parental overweight increases the risk of persistence into adulthood.

Adult obesity increases the risk of death, mainly because of cardiovascular disease (145). Although cardiovascular risk factors and evidences of atherosclerotic processes are identified already in childhood, clinical cardiovascular heart disease is usually not present until third or fourth decade of life. In a large Danish study, the risk of coronary heart disease in adults was linked to a gradual increase in childhood BMI, without any natural threshold. This increased risk was greater in boys and was detected with only minor increase in childhood BMI (146). A Norwegian study showed increased mortality in adults that had high BMI in adolescence (147). The gradual increase of the risk underlines the fact that BMI-based cut-off limits for overweight and obesity should not be used as a diagnostic tool in the clinical setting, but rather as a screening tool or supplement to clinical investigation. Some authors has nevertheless questioned whether childhood obesity is an independent risk factor for adult cardiovascular disease (148).

There is a strong relationship in adults between body weight and the risk for developing T2D, and one assumes that obesity in preadolescence, adolescence and adulthood increases the insulin resistance and risk for developing T2D (149). Studies have shown that risk of developing T2D in adulthood is decreased with higher birth weight, but increased with rising weight at age 11 (116). The association between overweight and cancer risk is well described in adults, but there are limited information about the eventual relationship between childhood overweight and later

cancer development. Laitinen et al. showed that obesity at age of 14 increased the risk of developing polycystic ovary syndrome in adulthood (150).

Obesity in adolescence and young adulthood have been shown to have negative socio-economic impact in young adulthood, when corrected for other factors (151). There is evidence that this might be a bigger problem for women than for men.

3.5 Parental perception of overweight and obesity

As the population gains weight and overweight becomes more frequent, our perception of what is "normal" weight might change. The "overweight" child in the school class 30 years ago might be in the upper normal range nowadays, and currently, the child generally thought of as "overweight" might have considerable higher weight. Several studies have shown tendencies in parents to assign overweight children as having normal weight (152-155). As parents to a large extent shape the environment the children grow up in, a successful approach for overweight prevention and treatment would involve the parents. One study found increased misjudgement among less educated mothers (154) and another study showed overweight younger children and overweight girls more often assigned as having normal weight by their parents (153). Most of these studies included only narrow age range and focused solely on overweight and did not include the perception of underweight. Norwegian studies on this topic were lacking prior to the current study.

4. Objectives

1. To provide data on current weight-for-height and skinfold thicknesses, triceps and subscapularis, in 4-15 years old Norwegian children and compare those to data from 1971-4.

2. To explore the current prevalence of overweight and obesity in Norwegian children:

    i. By comparison to the WHO growth standards for children aged 0-5 years.

    ii. By comparison to the IOTF cut-off values for overweight and obesity in children aged 2-19 years.

3. To study possible socio-demographic risk factors for overweight and obesity in Norwegian children aged 2-19 years.

4. To compare the parental perception of Norwegian children's weight status to IOTF cut-off limits for overweight and underweight, and study the possible effect of child age and sex, parental educational level and parental overweight.

5. Material and methods

5.1 Child populations

A total of 8299 children aged 0-21 years were measured and included in the Bergen Growth Study database in the period November 2003 and December 2006 (the cross-sectional part of the study, table 1). Of these, 936 children had one or both of the parents originating outside the Nordic countries. Furthermore, 85 children had a chronic disorder known to affect growth. Children were recruited in a stratified, random selection of well-baby care clinics (n = 8), kindergartens (n = 34) and schools (n = 24, including 19 elementary/primary and/or middle schools and five secondary/high-schools) was conducted in the city of Bergen. All children were invited to participate, but were only measured when a signed informed consent was available. The participation rate was about 98% in the well-baby care centres, 57% in the kindergartens, 69% in primary schools (grades 1-7), 53% in middle schools (grades 8-10) and 45% in secondary schools (grades 11-13). Factors that contributed to non-participation were part-time kindergarten attendance, kindergarten activities, exams days in schools, or non-attendance due to travelling or illness, as well as children or parents declining participation.

Data on birth weight, birth length, and head circumference of 12 576 children were retrieved from the Medical Birth Registry of Norway. Inclusion criteria were a life born child without abnormalities, between 37th and 42nd weeks of gestation in the time period 1999-2003, and with the mother's registered address in Bergen. Children registered as descendants of immigrants were excluded.

Table 1. The total numbers of children in the Bergen Growth Study sample			
Age	Boys	Girls	Total
0	729	687	1416
1	174	183	357
2	175	139	314
3	157	178	335
4	160	142	302
5	204	198	402
6	193	200	393
7	221	198	419
8	187	211	398
9	196	196	392
10	197	209	406
11	180	185	365
12	159	160	319
13	247	222	469
14	244	210	454
15	242	254	496
16	208	181	389
17	230	184	414
18	134	85	219
19	18	11	29
20	8	2	10
21	1	0	1
Total	4264	4035	8299

Furthermore, data from the Flandern Growth Study were available for comparison (156) (Paper II).

5.2 Measurements

A total of thirteen nurses and one paediatrician (PBJ) performed all measurements by using a standardized technique (157). The data were entered directly into a computer database. All children were measured between 8:30 am and 1 pm wearing light underwear only. In the kindergartens and the schools the nurses were working in teams of two, one doing the measurements, the other entering the data directly into the computer database.

Length was measured with the child in supine position until two years of age, standing height was measured thereafter. Length was measured without diaper with a Harpenden Infant Measuring Table®, Crosswell, UK. Height was measured with a Harpenden Portable Stadiometer®, Crosswell, UK, with minimum clothing (usually just underclothes). Measurements of weights where either done with a digital Seca® infant scale with the nearest 10g registered, or with a digital Seca® personal scale with the nearest 0.1kg registered. Head circumference was measured with a steel tape (Lufkin®, Surray, Canada). The largest circumference was measured with the tape situated just above the glabella. Triceps and subscapularis skinfolds were measured on the left side with a Holtain Tanner/Whitehouse Skinfold Caliper®, Cosswell, UK. The triceps skinfold was picked up by the thumb and forefinger over the posterior part of the triceps, and measured in the middle between the superior and lateral border of acromion and the proximal and superior border of caput radii, with the arm hanging straight. The subscapular skinfold was picked up inferomedially just below the inferior angle of scapula. In both instances the calliper was placed about 1 cm below the edge of the fingers and measurements taken 2-3 seconds after full pressure was exerted. The WC was measured horizontally, halfway between the lower border of the ribs and the upper border of the iliac crest on the mid-axillary line, at the end of a normal expiration. All measurements were done only once and recorded to the nearest millimetre.

5.3 Questionnaire

A parental questionnaire on socio-demographic factors, general health and life styles was sent to 7472 participants of the Bergen Growth Study in August 2006 (Appendix I). In January 2007 the questionnaire was again posted to 3807 participants that had not responded. Because the questionnaire was sent before the end of the recruitment period, 518 children, all older than 15 years, who participated in the study, did not receive a questionnaire. Questionnaires were returned for 4905 children (67%).

5.4 Quality control

5.4.1 Equipment

At the beginning of each study day, the Infant Measuring Table and Stadiometers were controlled and calibrated. Skin fold calipers were calibrated before each measurement. The digital weighing scales in the well-baby centres were calibrated twice a year, and the digital person weighing scales used in schools and kindergartens were usually calibrated every time they were moved to a new location.

5.4.2 Observer reliability assessment

All measurements were performed by a limited number of trained observers (n=14). This is in contrast to growth studies or growth surveys that collect routinely performed measurements done during usual health checks. During the period of anthropometric data collection in the Bergen Growth Study, observer reliability was assessed with a test-retest study every 6 months. This usually included the measurements of 10 children by all observers working at the time on the study. All measurements were performed twice with an interval of at least 20 minutes. Based on these data, a measure of precision, the technical error of measurements,

$$TEM=\sqrt{(\sum d^2 /2N)},$$

was calculated for all observers in all measurements sessions. The TEM describes the standard error of a single determination, and it indicates that 95% of all measurements from an observer are expected to fall between ± 2 times her/his TEM (158). The TEM for height was 0.28, 0.21 for head circumference, 0.80 for triceps skinfold, 0.64 for subscapularis skinfold and 0.80 for waist circumference. These figures were comparable with published values in the litterature (159). Furthermore, the level of accuracy was found to be good when compared with the expert, with F-test below 2.97 in all instances.

5.4.3 Selection bias study

To examine the possibility of selection bias, we have compared the prevalence of overweight and obesity based on parental reported height and weight of their child. This was obtained by an additional questionnaire in 368 participants of the Bergen Growth Study (36% of 1011 questionnaires mailed to parents of participating children), and in 149 children who were invited but did not participate in the study (38% of the 393 questionnaires mailed to parents of non-participating children), aged 7–17 years (Appendix II). Based on these data, the prevalence of overweight or obesity was not significantly different in children who participated in the study and those who did not (p = 0.109).

5.5 Ethical considerations

The Bergen Growth Study was approved by the Regional Committee for Medical Research Ethics and the Norwegian Data Inspectorate (project number 9740). A signed informed consent was obtained from one or both parents of each participating child. For children 12 years of age and above, the informed consent was also signed by the child itself (Appendix III).

6. Results

6.1 Comparisons of weight-for-height and triceps and subscapularis skinfold measurements between 1971-4 and 2003-6, in children aged 4-15 years from the city of Bergen (Paper I)

Measurements of weight-for-height and triceps and subscapularis skinfolds in 4115 children aged 4-15 years in the city of Bergen collected in the years 2003-6 (all children measured and recruited into the Bergen Growth Study in this age range) were compared with data collected in Bergen in the years 1971-4. An overall trend towards higher values was observed for measured parameters, and towards a higher degree of positive skewness. The increase in weight-for-height and skinfolds was most pronounced in the pre-adolescent age groups.

When comparing weight-for-height percentiles between 1971-4 and 2003-6, we observed the greatest increase in the upper percentiles. In total, the number of children above the 97.5[th] percentile from 1971-4 was about trippled, with 8% of the boys and 7.2% of the girls in the present study being above this limit (range 1.7%, 16.4% for boys, 4.3%, 13.9% for girls). For the 90th percentile the number was about doubled, 18% for the boys and 20.1% for the girls (range 5.9%, 27.2% for boys, 10.0%, 36.7% for girls). On the other hand, the lower percentiles were not much affected; with the overall percentage of boys in the present study below the 2.5 and 10 percentiles from 1971-4 were 3.4% and 9.9%, respectively. The corresponding figures for girls were 1.7% and 6.9%.

When comparing skinfolds measurements we saw a greater increase and observed an elevation of all percentiles during this time period. For the triceps skinfold, 30.2% of the boys and 28% of the girls were over 90th percentile from 1971-4 (range 13.8%, 39.5% for boys, 9.9%, 43.9% for girls). The overall percentage below the 10th percentile from 1971-4 was 2.8% in boys and 3.8% in girls. For subscapularis

skinfold, 26.5% of the boys and 25.9% of the girls were above the 90th percentile from 1971-4 (range 14.5 to 35.6% for boys, 8.1 to 37.9% for girls). The overall percentage below 10th percentile from 1971-4 was 2.3% for boys and 2% for girls.

In both sexes there was a tendency to larger differences between 1971-4 and 2003-6 in the preadolescent age groups for all parameters analyzed.

6.2 Current prevalence of overweight and obesity

6.2.1 Comparisons of the current growth of Norwegian children with the WHO growth standard (Paper II)

Comparisons were done for children between birth and 5 years of age, the age range covered by the WHO growth standard. A total of 2231 Norwegian children (1140 boys and 1091 girls) were analyzed in this study that also included comparisons with Belgian children (Flanders). Compared to the WHO growth standards, we generally saw fewer children below –2 SD and more children above +2 SD than expected for all the parameters investigated, weight-for-age, BMI-for-age, length/height-for-age and head circumference-for-age. The largest differences were observed in head circumference. Furthermore, remarkably similar trends were observed in Norwegian and Belgian children. A subsample of Norwegian children of non-smoking mothers and breastfeed according to the WHO recommendations, did grow more similar to the reference material than the WHO growth standard, suggesting that a use of a national reference is more appropriate than the use of the WHO growth standard for monitoring growth of Norwegian children – breastfed or not.

At birth, the percentage of Norwegian children below –2 SD when compared with the WHO growth standard was as expected for length and BMI but lower than expected for weight and head circumference. The percentage of children above +2 SD was highly elevated for all variables, including 8% for weight.

The overall percentage below –2 SD for weight-for-age was 0.56% (95% CI, 0.29-1.04) for Norwegian children and the percentage above +2 SD was respectively 3.39%

(2.56-4.44). There was no apparent trend with age. A similar observation was made for the BMI, where the overall percentage below –2 SD was 0.54% (0.29-0.99). The corresponding percentage above +2 SD was 4.29% (3.30-5.50). For length the prevalence of all children 0-5 years of age below –2 SD was 1.43% (0.90-2.17) and the corresponding percentage above +2 SD was 2.81% (2.11-3.69). For head circumference the overall percentage below –2 SD was only 0.18% (0.05-0.53) and the prevalence of children above +2 SD was 6.40% (5.19-7.83). Apart from birth values, the largest discrepancy was observed between one and three years of age.

6.2.2 The prevalence of overweight and obesity: Comparison with IOTF cut-off values (Paper III)

Because the IOTF cut-off values do not exist below 2 years of age, comparisons were done for all children measured and recruited into the Bergen Growth Study aged 2-19 years. Measurements of 6386 healthy children (3280 boys and 3106 girls) were included into the analysis with 9.8 % of these children having one or both of the parents originating from outside the Nordic countries. In this cohort, the prevalence of overweight including obesity (OWOB) in children aged 2-19 years was 13.8%, whereas the corresponding value for obesity was 2.3% (Figure 2). There were significant variations between age groups; in 2-5 year-old children, the prevalence of OWOB was 12.7%, in the age group 6-11 years, the prevalence increased to 17.0%, but fell to 11.7% in the group of children aged 12-19 years (p <0.001). The corresponding figures for obesity (OB) were 1.4%, 3.6% and 1.6% (p < 0.001), respectively. There were no statistically significant differences in the prevalence between the boys and girls over the age range as a whole. However, in the youngest children, the prevalence was increased in girls when compared to boys (15.8% versus 9.6%; p < 0.001), and this trend was also seen in children aged 6-11 years (18.4% versus 15.7%; p = 0.080). The opposite was true for the oldest children with higher prevalence in boys (12.9% versus 10.2% in girls; p = 0.026).

Figure 2. Prevalence of overweight including obesity (gray bars) and obesity (black bars) in 6386 Norwegian children using International Obesity Task Force (IOTF) cut-off values. (a) All children, (b) boys and (c) girls.

A

B

C

Obesity=black, overweight=grey
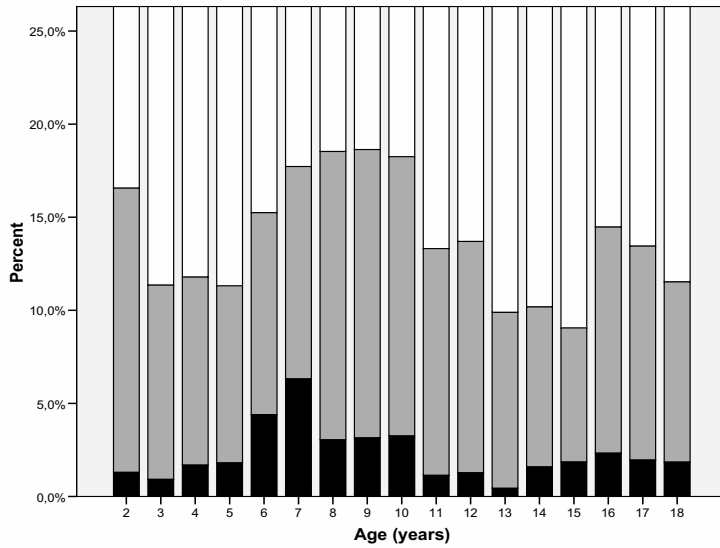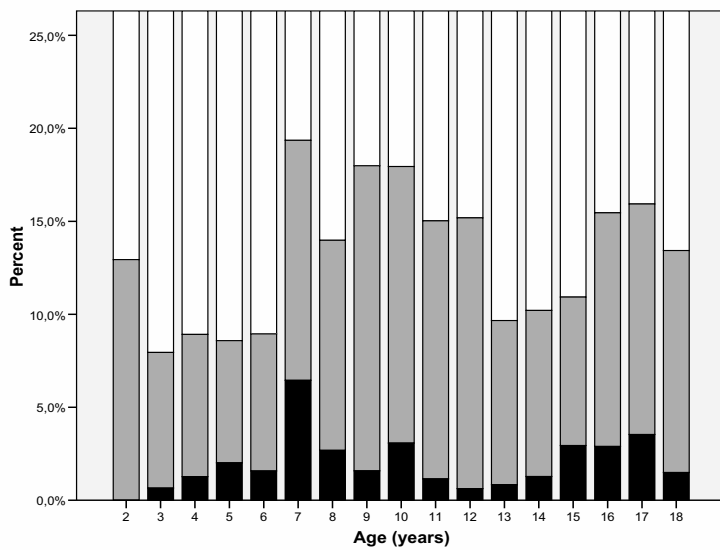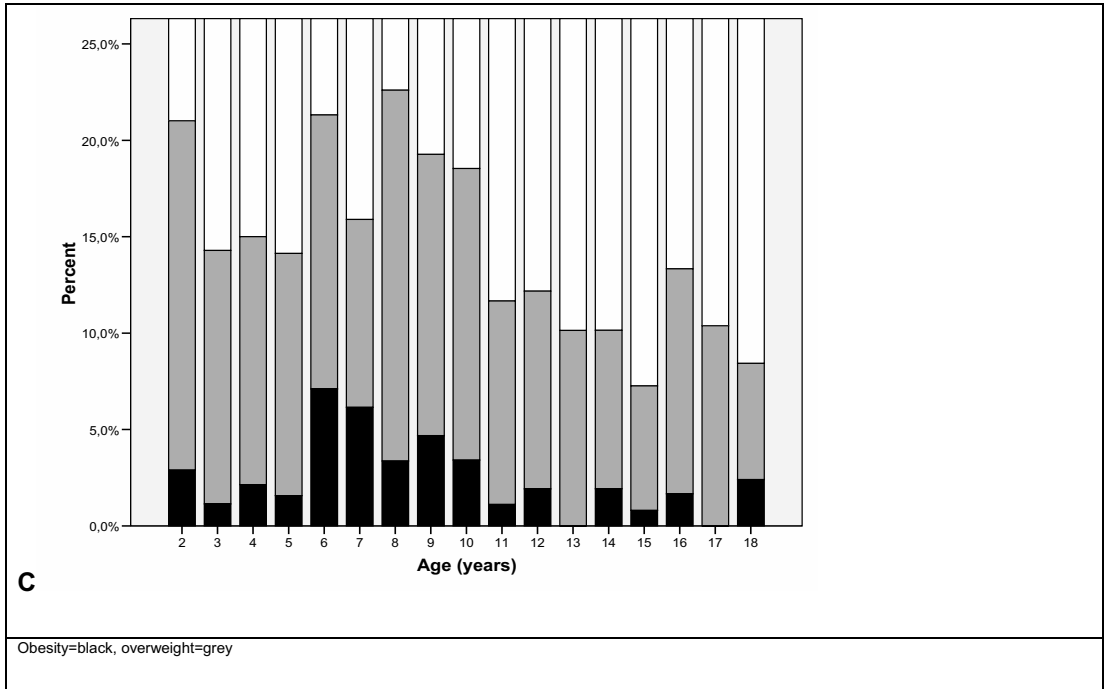
6.3 Study of the effect of socio-demographic risk factors on the prevalence of overweight and obesity (Paper III)

A parental questionnaire, collecting information about socio-demographic variables, was returned for 3793 children above 2 years of age (1914 boys and 1879 girls). This cohort had a marginally lower prevalence of overweight (12.8% OWOB, $p = 0.004$) and obesity (2.0% OB, $p = 0.046$) compared to the total sample. In this questionnaire subgroup, a multiple ordinal logistic regression analysis confirmed the effect of age, with the highest prevalence in the primary school age children. The girls in the questionnaire sample had an increased risk for being OWOB or OB. However, this was not the case in the whole sample, where no sex difference was found. Furthermore, increased numbers of siblings as well as high parental educational level were associated with reduced risk of OWOB and OB. Parental employment status and living in a single or a two-parent family did not affect the risk of being overweight. There was no significant difference between Norwegian children when compared with

the group of all children born of parents originating from outside the Nordic countries (9.8%). When analysed for the continent of origin, the risk of being overweight or obese was increased for children with parents originating from South-America.

The only positive interaction between the variables was found between age groups and sex (p = 0.022), with an additional risk for being overweight or obese in girls compared to boys in the youngest (pre-school) age group (OR = 2.25, 95% CI = 1.24, 4.07).

6.4 Parental perception on their children's weight status (Paper IV)

A part of the questionnaire was a question addressing parental perception of the child's weight status. Data from a total of 3770 children aged 2-19 were available for the assessment of parental perception according to their BMI, but number of data were fewer for waist circumference (n=3321) and triceps skin fold (n=3036), because these measurements were only performed in children 4 years of age and older.

The question parents were asked was, "What do you think about your child's weight status", with answer categories "Much too thin", "A little too thin", "Normal", "A little too fat", and "Much too fat".

Seventy percent of overweight or obese children and 40.8% of underweight children were perceived to have normal weight by their parents. In pre-school age children, 2-6 years old, as many as 91.2% of overweight children were considered by their parents to have normal weight. Logistic regression analyses of the determinants of parental perception were limited to BMI. Primary school age children and adolescents as well as girls had an increased risk of being assigned as overweight by their parents. There was no effect of parental educational level, parental obesity or underweight. The risk of being assigned as underweight was significantly higher in pre- and primary school children and in boys. Obese parents had an increased risk of assigning their children as underweight, but there was no effect of parental educational level. The answers were

not affected by the origins of the parents (outside the Nordic countries or not) or by who answered the questionnaire (mother, father or both).

7. Discussion

7.1 Methodological issues

7.1.1 Collection of anthropometric data

All the data presented and discussed in this thesis were cross-sectional. This is the most usual design of a growth study. It gives information about status presens, e.g. the prevalence rates of overweight and obesity in the population. It also gives suitable information for constructing growth "distance" charts. In addition, cross-sectional studies are time saving and less costly than longitudinal studies or mixed longitudinal studies. However, such data give no information about growth trajectories, or growth velocity, which claim a longitudinal design. When applying questionnaire survey's in a cross-sectional study, conclusions about causality cannot be drawn. Again, a longitudinal design is needed for a true assessment of cause-effect relationships.

Although Waaler's study had a mixed longitudinal design, the data were treated and presented in a cross-sectional manner (16). The number of measured children was larger in the present study, and the sample is representative for the whole city as the selection of well-baby clinics, kindergartens and schools were randomized and stratified according to districts. The 1971-4 study included measurements only in the area Landås/Slettebakken.

It may be questioned whether the population studied in the Bergen Growth Study is representative for the whole of Norway. However, we have some indications that this may be the case. Children aged 0-5 years have more or less identical length compared to the Norwegian children participating in the WHO MGRS study (70). Furthermore, the height and weight of the adolescence population showed minimal deviations from the data from the Ung-HUNT study originating from the Nord-Trøndelag county (92). The prevalence of overweight and obesity as defined by the IOTF cut-off values, are similar when compared with the Ungkost-study (nationwide, self-reported data from 8 and 12 year old children) (89), an Oslo-based study including measured height and weight from 8 to 12 years old children (91) and a nationwide study conducted by the

Norwegian Institute of Public Health (NIPH), including measurements from 3511 3rd grade primary school children (8 and 9 year old) (87) (Table 2).

Table 2. Prevalence of overweight (IOTF) in the Ungkost and NIPH* studies compared with the Bergen Growth Study				
Study	**Setting**	**Age and number**	**Overweight (IOTF) prevalence**	**Corresponding BGS prevalence's**
Ungkost (89)	Nationwide, self-reported height and weight	8.9 years (n=328 boys, 336 girls) and 12.9 years (400 boys, 425 girls)	8.9 years Boys: 17.3% Girls: 18.8% 12.9 years Boys: 11.5% Girls: 11.5%	9 years** Boys: 18.0% Girls: 19.3% 13 years Boys: 9.7% Girls: 10.1%
NIPH (87)	Nationwide, Measured height and weight	8 - 9 years (n=3511)	Boys: 16% Girls: 18%	8 years Boys: 14.0% Girls: 22.6% 9 years Boys: 18.0% Girls: 19.3%
* National institute of public health *Age at last birthday (calendar age)				

7.1.2 The potential problem of selection bias

The potential problem of selection bias must be addressed. In the growth study conducted by Waaler in Bergen 1971-4, 89.5% of all children in the pre-school age group and virtually all eligible school children, participated in the study (16). Therefore, the topic of selection bias was not an issue. In the current study the participation rate varied between age groups. It was high in the well-baby centres where about 98% of all children invited to the study were included. The informed consent was given to the parents (usually the mother) just prior to the measurement. As all children attend routine controls in the baby-health care centres, the cohort of children included should be representative for this group of children living in the city of Bergen. The logistics for the informed consent was different for the older age

groups. A letter was given to the parents in the kindergartens and to the school-aged children to take home. Only children with returned signed informed consent were measured. Although the participation rate was 57% in the kindergartens non-participation was nevertheless thought of as occurring at random by the study workers. Some of the children were not attending kindergarten full time and sickness or activity outside the kindergarten affected the participation rate. In the primary school classes 1-7 (children 6-12 years of age), 69% of the children were measured. Again, in this age group, there was a general opinion by the study workers that the non-participation was occurring at random. Again, sickness and activities outside the school affected the participation rate. For older primary school children in classes 8-10, 53% were measured and 45% in the secondary schools. Although most of the factors mentioned above were affecting the participation rate, the problem of selection bias was thought of as actual by the measures in these age groups. This was addressed with the selection bias study described in chapter 5.4.3. Although this study did not support the existence of selection bias, it really cannot eliminate the possibility, as not all questionnaires were answered, and again, the answers could have been biased.

7.1.3 The choice of measurement equipment and anthropometric variables

The equipment chosen for measuring length/height, skinfolds and girths, was identical to those used in the growth study performed in Bergen 1971-4. For height, the Portable Harpenden stadiometer® was used, for length the Harpenden Infant Measuring Table®, for skinfolds, the Holtain Tanner/Whitehouse Skinfold Caliper®, for girths, the Lufkin® measurement tape. For comparison with Waaler 1971-4 there were slight modifications done in measurement techniques. When height was measured by Waaler 1971-4, a gentle upward pressure was exerted on the mastoid processes (16), a technique he learned directly from Tanner and Whitehouse, while visiting their practice in Great Ormond Street, London, in 1970 (Per Erik Waaler, personal communication). The aim of this "stretch technique" was to measure more correct height and reduce to a minimum the diurnal variation in height. This was not repeated

in the Bergen Growth Study as this method has later been shown to increase the inter-observational error (160).

The measurement methods of triceps and subscapular skinfolds were broadly comparable with those used in the 1971–4 study. Waaler measured the triceps skinfold on the level midway between the superior and lateral border of acromion and the lateral humerus condyle. The level of the measurement site was found with a tape (16). In the Bergen Growth Study the level between the superior and lateral border of acromion and caput radii was found with a segmometer, and the calliper placed about 1 cm below this point. The Waaler method measured the skinfold about 1 cm above the site of measurement applied in the Bergen Growth Study. To compare the two methods, 21 children were measured by same observer (PBJ) twice with about 20 min. intervals, first with the method applied in the Bergen Growth Study, then with the Waaler's method. The results were highly comparable (BGS mean (SD) 14.0 (5.7), Waaler's method mean (SD) 14.2 (6.3), p=0.587) with the Pearson correlation coefficient 0.98 and the inter-class correlation 0.99. Waaler measured the subscapular skinfold just below the inferior angle of the scapula, applying the calliper above the fingers picking up the skinfold (16). In the Bergen Growth Study, the subscapularis skinfold was measured about 1 cm below the Waaler site. To compare the methods, the same group of 21 children was measured. Again, highly comparable results were seen (BGS mean (SD) 11.3 (7.3), Waaler's method mean (SD) 11.2 (7.9), p=0.678) with a Pearson correlation coefficient 0.98 and the inter-class correlation 0.99. Therefore, the slight differences in the methodology between the studies did not have any consequences for the results.

The individual measurement data from the Waaler 1971-4 study are not preserved, but descriptive statistics were published (16). As Waaler did not publish BMI data, our comparisons were limited to weight-for-height.

7.2 Discussion of results

7.2.1 Secular trends towards increased weight in Norwegian children

The data presented in Paper I show a significant secular trend in weight-for-height in Norwegian children during the last three decades. Earlier Norwegian data did not include the BMI, and our comparisons were therefore limited to weight-for-height, a parameter used in Norway in the 1970s. Additionally, we could compare measurements of triceps and subscapularis skinfolds between 1971-4 and 2003-6. The proportion of children in the present study above the 97.5[th] percentile of the 1971-4 reference had about tripled, indicating that the secular trend in overweight in Norwegian children is comparable with other Western countries (10, 79). As measurement of skinfolds is a direct measure of subcutaneous fat tissue (161), the documented increase in triceps and subscapular skinfolds indicates that the relative weight gain was because an increase in fat mass.

An increased positive skewness of the distribution curve was observed with the highest upward shift in the upper percentiles for weight-for-height and skinfolds. For the weight-for-height percentiles the 2.5 and 10 percentiles were practically unchanged whereas the highest centiles showed a marked upward shift. This finding shows that "the heavier children are getting heavier". The distribution curve is not showing a general shift to the right, but the right arm of the distribution curve is increasing in size, a phenomenon also seen among adolescents in the Young-HUNT study conducted in Nord-Trøndelag, Norway (92). This finding suggests that a certain part of the children population is more sensitive to the "overweight epidemic".

Weight-for-height indices cannot differentiate between bone, muscles and fat, particularly not in the normal range (51). Changes in weight-for-height or BMI on a population scale can therefore be explained by changes in other components than fat tissue. Measurement of skinfolds for monitoring population growth can therefore give valuable additional information and may help explaining the nature of secular weight-for-height trend. In our study, skinfold measurements were used as direct measure of

body fatness. The main purpose was to compare our results with those obtained by Waaler et al. in 1971-4 (16) to document secular changes in subcutaneous fat. The observed upward shift in the percentiles was more prominent for skinfolds than for weight-for-height. In the case of skinfolds, the lower percentiles also showed an upward shift. This may be due to the fact that fat tissue is relatively light compared to lean body mass. Other papers have also found a more prominent increase in skinfolds when compared with weight-for-height (31, 32, 162). Another potential explanation for the more moderate increase in weight-for-height compared to skinfolds, is that there was not only a secular trend towards more fat tissue, but that fat tissue increased while other components of the body (e.g. muscles, bone) did show a relative decrease.

Earlier maturation might possibly affect secular trends in body mass (31), with increased tempo of the height/weight development throughout childhood. A mean age of 13 years at menarche has remained unchanged in Norway over the past five decades (163). The mean age of menarche in the Bergen Growth Study was 13.2 years. Although data from the US and a recent publication from Denmark (164, 165) have suggested earlier onset of puberty, studies from The Netherlands and Belgium have not confirmed these observations (156, 166). As the current age of menarche has not changed in Norway, our data does not support the hypothesis of earlier maturation as a factor leading to the observed increase in weight-for-height and subcutaneous fat tissue seen in our population.

7.2.2 Current prevalence of overweight and obesity in Norwegian children

The IOTF criteria have been constructed for the ages 2-18 years. Below age 2, the BMI shows rapid changes and in clinical practice, weight-for-age (combined with length/height-for-age) or weight-for-length/height, are therefore used rather than BMI. In our work we used the IOTF criteria for the definition of overweight and obesity for children above 2 years of age. However, for 0-5 year-old children, the WHO growth standard can, as the IOTF criteria, be used as an independent platform for international comparisons. Comparing weight-for-age of our cohort with the WHO growth standard,

we saw that 3.39% the Norwegian children aged 0-5 years of age were above +2 SD (expected 2.3%) and 0.56% under –2 SD (expected 2.3%). The corresponding figures for BMI were 4.29% and 0.54% (Paper II). These numbers are similar to recent self-reported data from Sweden, but lower than in most other recent European surveys (167). Furthermore, Norwegian children were longer and with a larger head circumference (proportion above +2 SD was 6.40% (5.19-7.83)) when compared to the WHO growth standard. Applying the same inclusion criteria as used in the MGRS, exclusively breastfed Norwegian children of non-smoking mothers grew more similar to the BGS-reference than the WHO growth standard. This suggests that other environmental or genetic factors are responsible for the difference in growth between the studies and that national references should be used when monitoring growth of children in Norway, breastfed or not.

When interpreting the difference in weight-for-age or BMI-for-age between our cohort and the WHO growth standard one must bear in mind that the Norwegian children are longer and have larger head circumferences. The length of the children from Norway participating in the WHO MGRS was more similar to the recent Norwegian growth reference based on data from the Bergen Growth Study, than the WHO growth standard (70). The differences in length and head circumferences might explain the differences in BMI. There is at least no clear evidence that this age group is showing an unhealthy weight development. This is further supported by two national observations. When comparing length-for-age and height-for-age with the SYSBARN study which included data collected in 1982-4 for children aged 0-48 months of age born in Oslo and Hedmark, the differences were minor (70). A study following weight trends in 4 year-old children in Tromsø, Norway, over 25 years, did not show any significant changes in the mean BMI, although the proportion of overweight girls has shown a recent increase (168).

The two Norwegian studies reporting overweight prevalence in national representative samples of 8 and 12 (89), and 8-9 year-old children (87), show figures more or less comparative with the Bergen Growth Study (Table 2). The prevalence of overweight and obesity in our study, as defined by using IOTF criteria (Paper I and III), was

comparable to recent prevalences reported for other Northern and Western European populations. In children 7-11 years of age and of both sexes, the prevalence of overweight (including obesity) was 17.2% in our study. Corresponding figures from other European countries reviewed in 2003 by Lobstein et al. were 18% for Sweden, 15% for Denmark, 12% for The Netherlands and 20% (1997) for the UK (10). Hurk et al. reported data collected 2003 from the Netherlands, showing an increase up to about 17% in the age group 7-11 years (169). More recent estimates from Belgium, collected in 2001-4 (the Flandern Growth Study) for this age group, were 15.3% (Mathieu Roelands, personal communication). Much higher prevalences have been reported from Southern-European countries, 36% in Italy and 34% in Spain (10). US NHANES data from 1999-2004 showed prevalence rates (IOTF-based) above 30% in 6-11 years old children (81).   For the age group 14-17 years the prevalence of overweight (including obesity) was 11.0% for boys and girls combined. Corresponding figures form other European countries published by Lobstein were 21% in the UK, 17% in Denmark and 11% in the Netherlands (10). Recent estimate from the Flandern Growth Study for 14-17 year old children was 14.4% (Mathieu Roelants, personal communication). Again, Hurk published later higher prevalences from the Netherlands, 16.7% for children aged 14-16 years, in 2003 (169).

7.2.3 Socio-demographic factors influencing prevalence of overweight and obesity in Norwegian children – insights into the paediatric obesity epidemic

The socio-demographic factors addressed in this thesis were age, sex, number of siblings ("living with the child most of the time"), parental educational level, parental working status, single-parent family and ethnicity (Paper III).

The weight gain, expressed as percentage above 97.5 percentile (Figure S2 in Paper I), during the last 30 years seems to be most pronounced in primary-school children. The current prevalence rates of overweight and obesity were also highest in this age group, when compared with pre-school children and adolescence (Paper III). There are some potential explanations for the differences in the prevalence of overweight and obesity

between pre-school, primary-school children and adolescence. The recent life-style changes might have been less prominent when the adolescents were younger (cohort effect). Another possibility is that life-style changes affect primary-school children more than pre-school children or older children. A third possibility is that there are biological differences between the children included in the IOTF dataset and Norwegian children (population effect). Finally, one has to address the issue of selection bias. Although we did not see any significant differences in the analysis of self-reported height and weight between participants and non-participants, this does not eliminate the possibility of a selection bias. As shown in Paper III, the prevalence of overweight and obesity in the subsample answering the questionnaire was lower compared to the total cohort, an indication that non-participation in the study might not be random. We only found interaction in our statistical analyses between sex and age-groups, but not between any of the other socio-demographic factors.

We did not find any significant gender differences in the prevalences of overweight and obesity in the total sample, an observation that was in agreement with other European studies (10). However, pre-school girls had significantly higher prevalence of overweight and obesity than boys, whereas boys had a higher prevalence than girls in the adolescent group. Higher prevalence of overweight in pre-school girls was also reported in other studies (167, 168). Although ethnical minorities are found to be more prone to overweight and obesity in some European countries (170), we could not verify this in our study with non-Nordic ethnicities pooled. However, when analysing by continent of origin, we found a significant increase in prevalence of overweight and obesity in children originating from South America. The number of children in this subpopulation was nevertheless small. We found low parental educational level, but not parental working status, to be associated with increased risk of having overweight children in our study. Parental educational level has been shown to be inversely associated with overweight and obesity in 15 out of 20 studies and is much more strongly related to childhood overweight than parental working status (105). Children growing up in single-parent families did not have any higher risk of overweight or obesity in the current study. Previous studies have shown the opposite (171-173), some of them hypothesizing that this association is due to lower family income. The lack of

this association in the current study might reflect the low social inequalities in Norway, with very much the same opportunities for single- and two-parental families.

7.2.4 Parental perception of overweight and underweight in Norwegian children

When comparing the parental perception of their offspring's weight with measured height and weight, we found that the parental ability to discover weight deviations was generally poor (Paper IV). Overweight, as defined by the IOTF, used in clinical practice in Norway at the present time, goes unrecognized by a majority of parents, and especially parents of overweight pre-school children. This fact is worrisome while facing an increase in weight-for-height, skinfolds (Paper I), and the current prevalence of overweight and obesity (Paper III). The inability to identify overweight children might simply reflect the fact that overweight is increasingly perceived as a part of normality. This illustrates the importance of routine measurements of weight and height in the children population, an action that might increase parental awareness of appearing weight problems.

The current study included a wider age range than previous studies (152-155). The inability to recognise overweight in their children was poorest by parents of pre-school children when compared to primary-school children and adolescents. Although this might be related to parental satisfaction caused by parents looking at their overweight child as thriving, it is of concern as pre-school age is a sensitive weight gaining period with maturation of activity and eating habits (174).

The sex-difference observed in the parental perception is also of interest. The general conclusion was that girls were more often observed as overweight, a finding also published by Maynard (153), and boys as underweight. Therefore, a thin girl seems to be more easily accepted than a thin boy, and the other way around, an overweight boy is more easily accepted than an overweight girl. This might reflect the ideals of the society, were thinness is seen as a more attractive trait in girls than in boys.

8. Conclusions

8.1 Secular trends in weight-for-height and skinfolds

Our study has shown an upward shift in weight-for-height over the last three decades in Norwegian children, 18.0% of the boys and 20.1% of the girls were above the 90 percentile of the 1971-4 reference, and 8% and 7.2% were above the 97.5 percentile. The lower weight-for-height percentiles did not change in this time period. Comparison of triceps- and subscapularis-for-age percentiles showed more marked increases than weight-for-height. For the triceps skinfold, 30% of the boys and 28% of the girls were above the 90 percentile of the l971-4 reference. The lower skinfold-for-age percentiles showed, although in a lesser degree, an upward shift. Secular trends in skinfold thickness indicate that the increase in weight-for-height was due to increased fat mass.

8.2 The current prevalence of overweight and obesity

The proportion of 0-5 year-old Norwegian children above +2 SD of the WHO standard was 3.39% (2.56-4.44) for weight-for-age, 4.29% (3.30-5.50) for BMI-for-age (expected value 2.3%). These figures were in the lower range of published European estimates.

The overall prevalence of overweight in 2-19 year-old Norwegian children was 13.2% in boys and 14.5% in girls when using the IOTF criteria. The prevalence was highest in primary-school children, 17.0%, 12.7% in pre-school children and 11.7% in adolescents. There was no significant difference between boys and girls. These prevalences were similar to published Northern- and Western-European numbers.

8.3 Socio-demographic risk factors

Demographic data collected by parental questionnaires showed that an increasing number of siblings lowered the risk of childhood overweight or obesity. High parental educational level was found to be protective against overweight in the offspring,

suggesting that higher educated parents make healthier choices for their children. Parental origin, single or dual parent families or parental working situation did not affect the risk of having overweight or obese child.

8.4 Parental perception of their children's weight

Parental ability to recognise weight deviation in their offspring was generally poor, especially in overweight pre-school children. Girls were more often seen as overweight and boys as underweight by their parents.

9. Perspectives

The current study demonstrated that about 14% of the Norwegian children population is overweight. This means that there are about 137 000 overweight children aged 2-18 year-old in Norway. As a majority of these children become overweight as adults, the problem has large dimensions.

The current paediatric obesity epidemic demands a close monitoring of the growth trends in the paediatric population, with routine measurements of weight and height. Such a growth monitoring would also measure the effect of smaller or larger studies, directed at prevention or treatment of overweight, or the efficiency of governmental actions. Routine measurements of height and weight are also important on an individual scale because of the parental inability to identify weight deviations in their children. In Norway, routine measurements of school-aged children have been limited since in the end of the 1970s. This will now be changed with the arrival of new guidelines from the Department of Health supposed to be introduced in 2010.

The current study suggests that measurements of skinfolds and waist circumference might complement weight and height measurements, as these traits are more sensitive to changes in fat tissue. However, these measurements are methodological more demanding and not suited for routine practice. Therefore, they should optimally be collected as a part of well planned growth studies.

Although we have been able to identify several socio-demographic risk factors, there is a further need to explore other risk factors for the development of overweight and obesity. Daily activity and eating habits are examples of such factors that are now being addressed within the Bergen Growth Study. The aim of such research must be to aid coping with this problem on a population scale.

The increase in weight-for-height between 1971-4 and 2003-6 was largest in primary-school aged children. The current prevalence of overweight and obesity is also highest in this age group. Therefore, there is a need to explore the reasons for this increased prevalence.

The paediatric obesity epidemic will not be solved by the primary health care or by the obesity out-patient clinics. There is a need for a more general approach to correct the "obesogenic" environment as much as possible. This will only be done through sensible health politics.

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Errata

p. 44, paragraph 2, line 4, delete: "…with 9.8 % of these children having one or both of the parents originating from outside the Nordic countries."

Page 47, paragraph 4, line 2 and 3, should read: "A little too overweight", and "Much to overweight". Same correction in Paper IV; page 5, paragraph 3, line 6, and in page 7, Table 1.

Paper IV, p. 11, paragraph 2, line 7, should read: "was 12.8% and 2.0% respectively".

Appendix I

The parental questionnaire with a letter containing a corrected question about breast-feeding (sent to 1947 parents that did not answer question 19 in the original questionnaire by giving the numbers of weeks or months).
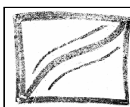
Vekststudien i Bergen
Spørreundersøkelse

Kunnskap om faktorer som påvirker barnas vekst- og vektutvikling

NR. _____

Kjære foresatte!

For en tid tilbake deltok ditt barn i *Vekststudien i Bergen,* hvor målinger av vekst og vekt ble utført. Vi ønsker nå å få mer kunnskap om faktorer som påvirker barnas vekst- og vektutvikling. Derfor oversender vi nå denne forespørselen til foresatte av barn som var under 15 år da målingene ble utført.

Vedlagt finner du et spørreskjema som vi ønsker at du/dere svarer på, vi ber deg/dere om å svare på så mange spørsmålene som mulig og deretter returnere skjemaet i vedlagt konvolutt. Porto på svarkonvolutten er allerede betalt. Vennligst sett kryss (X) på de svarene du mener er mest korrekt, eller fyll inn med blokkbokstaver der det er angitt. Hvis du ved en feil krysser av i en annen rute enn du hadde tenkt, er det fint om du skraverer denne ruten helt svart og så krysser av i riktig rute. Dersom det er spørsmål du ikke ønsker å besvare, så la heller dette stå åpent framfor å la være å sende inn skjemaet.

Det er frivillig å delta i studien, og du kan når som helst trekke din deltakelse hvis du skulle ønske det. Alle opplysninger som samles vil bli behandlet konfidensielt, og det er kun forskere knyttet til prosjektet som har tilgang til datamaterialet. I fremtidig rapportering av resultater fra studien vil det ikke være mulig å identifisere enkeltpersoner. Opplysningene som samles inn ved bruk av spørreskjemaet vil bli registrert og oppbevart sammen med det øvrige materialet fra studien, ved prosjektslutt i 2008 vil materialet overføres til og lagres ved Norsk samfunnsvitenskapelig datatjeneste i påvente av senere oppfølging når barna er voksne.

Dersom vi ikke hører noe fra deg/dere, tillater vi oss å sende dere en påminning om dette skjemaet en gang. Utover det vil dere ikke få noen påminning om skjemaet fra oss. Ønsker dere ikke å delta i denne spørreskjemaundersøkelsen kan dere således bare la være å returnere skjemaet. Hvis barnet er nå over 16 år når spørreskjemaet er utfylt, ber vi foresatte om å vise det til barnet som har rett til å reservere seg. Vi håper at så mange som mulig tar seg tid til å besvare og sende inn skjemaet.

Studien er tilrådd av Regional komité for medisinsk forskningsetikk og av Personvernombudet for forskning, og konsesjon er gitt fra Norsk samfunnsvitenskapelig datatjeneste og Datatilsynet.

Skulle dere ha spørsmål til studien kan disse rettes til
Overlege Pétur Júlíusson
Barneklinikken
Haukeland Universitetssykehus
5021 Bergen
Tlf 55 97 52 00

Så over til spørsmålene:

Hvilken dag har du fylt ut dette spørreskjemaet? _____ / _____ / _____ (dag/mnd/år)
Skjemaet er fylt ut av ❑ mor ❑ far ❑ stemor ❑ stefar ❑ bestemor ❑ bestefar

SPØRSMÅL OM FAMILIEN

Spørsmålene handler om den familien som barnet oftest bor hos (mer enn halvparten av tiden).
Med far og mor mener vi den personen som har denne funksjonen i familien, selv om denne
personen ikke er den biologiske far/mor.

1. Sett kryss for alle som bor i det huset barnet bor det meste av eller hele tiden
     ❑ Mor
     ❑ Far
     ❑ Stemor (eller fars kjæreste)
     ❑ Stefar (eller mors kjæreste)
     ❑ Bestemor
     ❑ Bestefar

2. Hvor mange søsken har barnet _____
     Hvor mange av disse er halvsøsken _____
     Hvor mange søsken/halvsøsken bor sammen med barnet det meste av tiden _____

Spørsmål 3 og 4 handler om hvilken yrkessituasjon eller utdanning foreldrene har, i den familien
hvor barnet er oftest. Hvis du er enslig forsørger fyller du kun inn det som passer for deg.

3. Kryss av slik som din nåværende situasjon er:

FAR	MOR
❑ Arbeidstaker, heldagsstilling	❑ Arbeidstaker, heldagsstilling
❑ Arbeidstaker, deltid (mer enn 8 timer per uke)	❑ Arbeidstaker, deltid
❑ Selvstendig næringsdrivende	❑ Selvstendig næringsdrivende
❑ Hjemmeværende	❑ Hjemmeværende
❑ Skoleelev/student	❑ Skoleelev/student
❑ Sykemeldt med sykepenger eller attføring	❑ Sykemeldt med sykepenger eller attføring
❑ Arbeidsledig med stønad	❑ Arbeidsledig med stønad
❑ Arbeidsleding uten stønad	❑ Arbeidsleding uten stønad
❑ Uførepensjonist i folketrygden	❑ Uførepensjonist i folketrygden
❑ Annen situasjon	❑ Annen situasjon

4. Mor og fars utdannelse

	MOR		FAR	
	Fullført	Holder på med	Fullført	Holder på med
9-årig grunnskole	❏	❏	❏	❏
1-2-årig videregående	❏	❏	❏	❏
Videregående yrkesfaglig	❏	❏	❏	❏
3-årig videregående allmennfaglig, gymnas	❏	❏	❏	❏
Distrikthøyskole, universitet inntil 4 år (cand mag., sykepleier, lærer, ingeniør)	❏	❏	❏	❏
Universitet, høyskole, mer enn 4 år (hovedfag, embetseksamen)	❏	❏	❏	❏
Annen utdannelse	❏	❏	❏	❏

SPØRSMÅL OM ARVELIG BAKGRUNN

5. Disse spørsmålene er om de **biologiske** foreldrene. Svar på disse spørsmålene selv om de biologiske foreldrene ikke er en del av familien. Hvis du ikke vet alle disse svarene f.eks. hvis de biologiske foreldrene ikke er tilgjengelige, eller barnet er adoptert, er det fint om du fyller inn så mye som du kjenner til.

FAR   MOR
Alder _____ (år)   Alder _____ (år)
Høyde _____ cm   Høyde _____ cm
Vekt _____ kg   Vekt _____ kg

Opprinnelse: Norsk? ❏ ja ❏ nei   Opprinnelse: Norsk? ❏ ja ❏ nei
Hvis nei, hvilke opprinnelse* har far: _____
Hvis nei, hvilke opprinnelse har mor _____

*Eksempler om opprinnelse: Annen skandinavisk, annen europeisk (vest-, øst-, sydeuropeisk), afrikansk, asiatisk, nordamerikansk (kaukasisk, afroamerikaner, asiatisk, spansk), sydamerikansk

SPØRSMÅL OM SVANGERSKAP, FØDSEL OG DEN FØRSTE TIDEN

Spørsmålene handler om den **biologiske** mor, hennes svangerskap og informasjon rundt fødselen til barnet som dette spørreskjemaet handler om. Se evt. i helsestasjonsboken.

6. Hvor mange barn har moren fått? _____ ❏ vet ikke

7. Hvor i rekken kommer dette barnet? Barn nr. _____   ❏ vet ikke

8. Er barnet en av tvilling eller trilling? ❏ tvilling ❏ trilling   ❏ vet ikke

9. Hvor lang tid tok svangerskapet (antall uker eller måneder ut fra ultralydundersøkelse eller fra første dagen av siste menstruasjonen før svangerskapet)?
___ uker eller ___ måneder ❑ vet ikke

Hvis du ikke er sikker på hvor lenge svangerskapet varte, ble barnet født for tidlig eller for sent?
　　　❑ til normal tid
　　　❑ mer enn to uker for tidlig
　　　❑ mer enn to uker for sent
　　　❑ vet ikke

10. Kan du gi følgende informasjon om barnet som nyfødt:
　　　Fødselsvekt _____ g　　　❑ vet ikke
　　　Lengde _____ cm　　　❑ vet ikke
　　　Hodeomkrets _____ cm　　　❑ vet ikke

11. Ble barnet forløst med keisersnitt?
　　　❑ ja　❑ nei　　　❑ vet ikke

12. Var det noen komplikasjoner i forbindelsen med fødselen?
　　　❑ ja　❑ nei　　　❑ vet ikke
　　　I så fall, hvilken _____

13. Hvor mye veide mor på slutten av svangerskapet?
　　　___ kg　　　❑ vet ikke

14. Hvor mye gikk mor opp i vekt i forbindelse med svangerskapet?
　　　Ca. ___ kg　　　❑ vet ikke

15. Hadde mor svangerskapsdiabetes?
　　　❑ ja　❑ nei　　　❑ vet ikke

16. Var det noen andre komplikasjoner i forbindelse med svangerskapet?
　　　❑ ja　❑ nei　　　❑ vet ikke
　　　I så fall, hvilke _____

17. Røykte mor under svangerskapet?
　　　❑ ja　❑ nei　　　❑ vet ikke

　　　Hvis ja, under hele svangerskapet
　　　❑ ja　❑ nei, kun i begynnelsen　　❑ nei, kun i slutten　　　❑ vet ikke

　　　Hvor mange sigaretter røykte mor i gjennomsnitt per dag under svangerskapet
　　　❑ 1-5 ❑ 6-10 ❑ 11-20 ❑ mer enn 20 daglig　　　　　❑ vet ikke

18. Brukte mor alkohol under svangerskapet?
　　　❑ nei ❑ mindre enn 1 glas per uke ❑ noen få glas per uke ❑ 1-2 daglig ❑ mer enn 2 daglig ❑ vet ikke

19. Ble barnet ammet?

❑ ja ❑ nei ❑ vet ikke

I tilfelle ja, hvor lenge fikk barnet bare morsmelk uten annet tillegg enn tran/vitaminer?

❑ uker eller ❑ måneder ❑ vet ikke

Hvis du ga morsmelk, hvor gammelt var barnet da du helt sluttet å amme som tillegg til annen mat?

❑ uker eller ❑ måneder ❑ vet ikke

SPØRSMÅL OM HELSE OG UTVIKLING

20. Har barnet et genetisk sykdom eller kromosomavvik (f. eks. Down, Turner, Klinefelter syndrom …)?

❑ ja ❑ nei ❑ vet ikke

Hvis ja, hvilket _____

21. Har barnet en kronisk sykdom (f.eks astma, diabetes, cøliaki, kronisk hjerte- eller nyresykdom?)

❑ ja ❑ nei ❑ vet ikke

Hvis ja, hvilken/hvilke _____

Hvor gammelt var barnet da diagnosen ble stilt_____

22. Har barnet hatt en alvorlig eller langvarig sykdom, som varte flere måneder eller trengte krevende behandling (f.eks leukemi)?

❑ ja ❑ nei ❑ vet ikke

Hvis ja, hvilken _____

Hvor gammel var barnet da _____ år

23. Har lege noen gang påvist vekstforstyrrelse/vekstproblem hos barnet

❑ ja ❑ nei ❑ vet ikke

Hvis ja, hvilken _____

Hvor gammel var barnet da _____ år

24. Hva synes du om barnets kropp?

Den er:

❑ altfor tynn
❑ litt for tynn
❑ omtrent passe
❑ litt for tykk
❑ altfor tykk

Følgende spørsmål besvares bare hvis ditt barn er nå 4 år eller eldre:

SPØRSMÅL OM MAT

25. Har barnet vegetariansk kosthold?
  ❑ ja   ❑ nei   ❑ vet ikke
  Hvis ja, spiser hun/han melkeprodukter eller egg? ❑ ja   ❑ nei   ❑   vet ikke

26. Går barnet på en diett, som er blitt anbefalt av lege?
  ❑ ja   ❑ nei   ❑ vet ikke
  Hvis ja, hvilken diett? _____

27. Hvor ofte pleier barnet å spise følgende måltider i løpet av en uke?

	Aldri/sjelden	1 gang i uken	2 ganger i uken	3 ganger i uken	4 ganger i uken	5 ganger i uken	6 ganger i uken	7 ganger i uken
Frokost	❑	❑	❑	❑	❑	❑	❑	❑
Formiddagsmat/lunsj	❑	❑	❑	❑	❑	❑	❑	❑
Middag	❑	❑	❑	❑	❑	❑	❑	❑
Kveldsmat	❑	❑	❑	❑	❑	❑	❑	❑

28. Hvor mange ganger i uken spiser eller drikker barnet ditt noe av dette?

	Aldri	Sjeldnere enn en gang pr. uke	En gang pr. uke	2-4 dager i uken	5-6 dager i uken	En gang hver dag	Flere ganger hver dag
a) frukt	❑	❑	❑	❑	❑	❑	❑
b) grønnsaker	❑	❑	❑	❑	❑	❑	❑
c) sukkertøy (drops og sjokolade)	❑	❑	❑	❑	❑	❑	❑
d) Cola, brus eller andre leskedrikker med sukker	❑	❑	❑	❑	❑	❑	❑
e) fast food (hamburger, pølser og lignende)	❑	❑	❑	❑	❑	❑	❑

29. Har barnet hatt spiseforstyrrelse (anorexia nervosa, bulimi)?
  ❑ ja   ❑ nei   ❑vet ikke
  Hvis ja, hvor gammelt var barnet da han/hun fikk det? _____ år   og _____ måneder
  Hvis ja, hvor gammelt var barnet da problemet var over   _____ år og _____måneder
  ❑ barnet er fortsatt syk

30. Har det vært noen endringer i barnets spisevaner de siste to årene?
  ❑ ja   ❑ nei
  Hvis ja, hvilke_____

SPØRSMÅL OM FYSISK AKTIVITET OG ANDRE AKTIVITETER

31. Utenom skoletid: **Hvor ofte** driver barnet deres idrett, eller mosjonerer så mye at barnet blir andpusten og /eller svett
  ❑ aldri ❑ mindre enn en gang i måneden   ❑ 1-3 ganger i måneden   ❑ en gang i uka   ❑ 2-3 ganger i uke   ❑ 4-6 ganger i uka   ❑ hver dag

32. Utenom skoletid: **Hvor mange timer** i uka driver barnet deres idrett, eller mosjonerer så mye at barnet blir andpusten og/eller svett?
  ❑ ingen   ❑ omtrent ½ time   ❑ omtrent 1 time   ❑ omtrent 2-3 timer ❑ omtrent 4-6 timer   ❑ 7 timer eller mer

33. **Hvor mange timer** gjennomsnittlig sitter barnet daglig foran TV (TV, DVD, video, TV-spill) og/eller foran PC´en?
  ❑ ikke i det hele tatt   ❑ mindre enn en ½ time om dagen   ❑ 1/2-1 time ❑ 2-3 timer
  ❑   4 timer   ❑ mer enn 4 timer

34. Hvor mange dager i uka går eller sykler barnet TIL skolen?
  ❑ ingen   ❑ 1   ❑ 2   ❑3   ❑4   ❑5 dager

35. Hvor mange dager i uka går eller sykler barnet FRA skolen?
  ❑ ingen   ❑ 1   ❑ 2   ❑ 3   ❑ 4   ❑ 5 dager

36. Hvis barnet går eller sykler: Hvor lang TID bruker barnet vanligvis til eller fra skolen?
  ❑ mindre enn 5 min ❑   5 til 15 min   ❑ 15 til 30 min ❑ 1/2 til 1 time
  ❑   mer enn 1 time

37. Har barnet TV inne på soverommet?
  ❑ ja   ❑ nei

38. Har det vært noen endringer i fysisk aktivitet/passivitet de siste par årene?
  ❑ ja   ❑ nei
  Hvis ja, hvilken _____

● ● ● ● ●

Vekt- og vekstutviklingen i de første leveårene har vist seg å være viktig for senere vekstutvikling. Derfor er det for oss av stor interesse å hente inn informasjon om lengde, vekt og hodeomkrets fra helsestasjonene. Dette kan kun gjøres med samtykke fra foresatte og barna som er blitt 16 år eller eldre:

Vi gir herved tillatelse til at informasjon over lengde og vekt til vårt barn
_____blir hentet fra helsestasjonen.
(Navn på barn)

_____
Sted   Dato   **Underskrift foreldre/foresatte**

Hvis barnet er 16 år eller eldre, ber vi også om dets underskrift:

_____
Sted   Dato   **Underskrift barn 16 år eller eldre**

SPØRRESKJEMAET RETURNERES I VEDLAGT FRANKERT KONVOLUTT

TAKK FOR AT DERE TOK DERE TID TIL Å FYLLE UT SKJEMAET!

Deres ref.:	Vår ref.:	Bergen, 22. august, 2008

Kjære foresatte!

For en stund tilbake ble ditt barn målt og du svarte på et spørreskjema som ledd i deltagelse i Vekststudien i Bergen. Ved gjennomgang av svarene ble det klart at et spørsmål om amming dessverre var uklart utformet, og vi er derfor nødt til å sende ut dette spørsmålet på nytt. Vi ber dere derfor vennligst om å svare på spørsmålet nedenfor og sende svaret tilbake i vedlagt frankerte svarkonvolutt.

Vi vil ellers bruke anledningen til å informere om at mer enn 8000 barn nå er inkluderte i Vekststudien og takke dere for godt samarbeid!

Spørsmål:

Ble barnet ammet?
  ❑ ja ❑ nei ❑ vet ikke
  I tilfelle ja, hvor lenge fikk barnet bare morsmelk uten annet tillegg enn tran/vitaminer (fyll ut antall uker eller måneder)?
  ___ uker eller ___ måneder ❑ vet ikke

Hvis du ga morsmelk, hvor gammelt var barnet da du helt sluttet å amme som tillegg til annen mat (fyll ut antall uker eller måneder)?
  ___ uker eller ___ måneder ❑ vet ikke

Vennlig hilsen

Pétur B. Júlíusson   Robert Bjerknes (sign.)
Seksjonsoverlege/stipendiat   Professor dr. med./Overlege
Barneklinikken   Barneklinikken
Haukeland Universitetssykehus   Haukeland Universistetssykehus

Besøksadresse: Haukeland Universitetssykehus, Jonas Liesvei 65, Postadresse: Helse Bergen HF, Postboks 1, 5021 Bergen
Telefon 55 97 50 00 – Innvalg 55 97 52 00 – Telefaks 55 97 51 47, E-post: postmottak@helse-bergen.no
Foretaksnr. NO 983974724 mva. Internett: www.helse-bergen.no

Appendix II

The selection bias study.

Kjære foresatte!

Barneklinikken ved Haukeland Universitetssykehus gjennomfører for tiden et forskningsprosjekt hvor målet er å skaffe informasjon om norske barns vekst- og vektutvikling. Prosjekt gjennomføres fordi et er sterkt behov for oppdatert kunnskap om disse faktorene for norske barn. Dette arbeidet er godt i gang, og vi har hatt rundt 70 % deltakelse på skolene i Bergen. Dette oppfattes som god deltakelse sammenlignet med studier fra andre land.

Fordi vi ikke har hatt 100 % deltakelse ønsker vi likevel å se om det foreligger forskjell i høyde eller vekt mellom de barna som ble målt og dem som ikke ble målt.

Barnet kan ha vært borte fra skolen på måledagen, foreldrene eller barnet har ikke ønsket deltakelse eller samtykkeerklæringen har kommet på avveier.

For å se om det er forskjell i høyde eller vekt mellom de to gruppene sender vi dette brevet til en utvalgt gruppe barn som ble invitert, men ikke målt, og til en like stor gruppe barn som ble målt.

Vi ber dere herved om å utføre målinger av barnet hjemme og følge veiledningen nedenfor. Utfylt skjema må returenes sykehuset i den ferdig frankerte svarkonvolutten.

Vi gjør oppmerksom på at innsendte opplysninger vil bli behandlet anonymt og vil ikke senere kunne bli knyttet opp mot barnet.

Takk for hjelpen!

Med vennlig hilsen
HELSE BERGEN HF

Robert Bjerknes
professor, klinikksjef

Pétur B. Júlíusson
seksjonsoverlege

Besøksadresse: Haukeland Universitetssykehus, Jonas Liesvei 65, Postadresse: Helse Bergen HF, Postboks 1, 5021 Bergen
Telefon 55 97 50 00 – Innvalg   – Telefaks   , E-post: postmottak@helse-bergen.no
Foretaksnr. NO 983974724 mva. Internett: www.helse-bergen.no

Hvordan måle vekt og høyde hjemme

Vekt:
- Plasser en personvekt på et stødig, flatt underlag (ikke på teppe).
- Kontroller at vekten er innstilt på null.
- Vei barnet nakent eller med undertøy.
- Noter vekten med 0.1 kg nøyaktighet hvis vekten har en så nøyaktig avlesning (noen vekter med elektronisk avlesning), eller med 1 kg nøyaktighet i andre tilfeller.

Høyde:
Høyden kan måles hjemme ved hjelp av et målebånd eller målestokk og en gjenstand med en rett vinkel som for eksempel en vinkelhake eller en stiv bok. Du må utføre målingen med hjelp av en annen person:
- Velg et egnet sted for målingen: en vegg hvor du uten hinder kan stå helt inntil (helst uten eller med tynne lister); og et hardt, flatt gulv (ikke teppe).
- Still deg uten sko inntil veggen, med hælene inntil hverandre.
- Sørg for at føttene, baken og skuldrene kommer inntil veggen.
- La armene henge løst langs kroppen.
- Hold hodet rett og se rett frem.
- Personen som hjelper deg plasserer en gjenstand med en rett vinkel (for eksempel en vinkelhake eller en stiv bok) med den ene rette siden oppå hodet og den andre inntil veggen.
- Denne personen lager et merke der hvor underkanten av den rette gjenstanden kommer inntil veggen.
- Avstanden fra dette merket til bakken (med 1 millimeters nøyaktighet) er din høyde.

Barnets kjønn: ___ jente   ___ gutt

Hvilket år er barnet født i?   _____ årstall
Hvilken måned er barnet født?   _____ måned

Vekt: _____ kg

Høyde: _____ cm

M

Vennligst returner dette arket i vedlagt frankert konvolutt.

Tusen takk for hjelpen!

Returadresse: Vekststudien i Bergen v/Pétur B. Júlíusson, Barneklinikken, Haukeland Universitetssykehus, 5021 Bergen

Appendix III

Informed consent letters for well-baby centres (a), kindergartens (b), primary (c) and secondary schools (d).

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKT

 Vekststudien i Bergen

Kjære foreldre/foresatte!

Med dette brevet ber vi om deres samtykke til å gjøre lengde- og vektmålinger av barnet deres i forbindelse med ordinært helsestasjonsbesøk. I tillegg til de vanlige målingene av lengde, vekt og hodeomkrets, ønsker vi hos de barna som er 4 år og eldre å bestemme sittehøyde, armspenn, underarmslengde, legglengde, hudfoldtykkelse og mageomfang.

Alle barn som kommer til helsestasjonen de dagene studiesykepleier er tilstede blir invitert til å delta i studien. Generelt blir barna målt kun en gang men halvparten av barn 3 år og eldre blir fulgt opp med undersøkelse av høyde og vekt ett år senere. Dersom ditt barn begynner på skolen i løpet av den tiden studien går, vil dere bli innkalt til Barneklinikken, Haukeland Universitetssykehus for å få gjennomført den andre målingen.

Hensikten er å få kunnskap om friske norske barns vekst og vekt helt fra fødsel til fylte 18 år. På grunnlag av de innsamlede data ønsker vi å lage nye og oppdaterte nasjonale vekstkurver, et arbeidsredskap som er svært viktige både for helsestasjonene og landets barneavdelinger. I tillegg ønsker vi spesielt å kartlegge den økende tendens det er til overvekt i den norske barnebefolkningen.

Undersøkelsene er ufarlige og innebærer ingen smerter. De blir utført av studiesykepleier som besøker helsestasjonen. Barn som viser seg å ha uttalt vekst- eller vektavvik vil få tilbud om poliklinisk legeundersøkelse ved Barneklinikken, Haukeland Universitetssykehus.

Alle måleresultatene behandles konfidensielt og oppbevares i arkiv ved Barneklinikken fram til prosjektet er ferdig om seks år. Deretter blir resultatene lagret hos Norsk Samfunnsvitenskapelige Datatjeneste, Universitetet i Bergen. Grunnen til dette er at det kan bli aktuelt å invitere deltakerne til en oppfølgingsstudie når barna er blitt voksne. Ingen enkeltbarn vil kunne bli gjenkjent i det som blir skrevet i vår oppsummering når undersøkelsen er ferdig. Dersom resultater fra undersøkelsen blir publisert i legetidsskrifter, vil det skje i anonymisert form.

Prosjektet er vurdert og klarert av Regional komite for medisinsk forskningsetikk Vest-Norge og det er innhentet konsesjon fra Datatilsynet.

Vedlagt er svarslipp for samtykke. Selv om du/dere svarer ja nå, kan barnet når som helst trekke seg fra videre undersøkelse. Alle opplysninger fra studien vil da bli slettet hvis du/dere ønsker det.

Vennlig hilsen

Pétur B. Júlíusson   Robert Bjerknes
Overlege   Professor, dr. med.
Barneklinikken   Avd.overlege/Avd.leder
Haukeland Universitetssykehus   Barneklinikken
                                    Haukeland Universitetssykehus

Vekststudien i Bergen

Svarslipp for samtykke

Vi gir herved tillatelse til at vårt barn:

Navn: _____ Fødselsdato: _____

kan delta i *"Vekststudien i Bergen"* i henhold til informasjonsskrivet.

Vi har fått informasjon om følgende:

- At vi når som helst kan trekke oss fra undersøkelsen uten nærmere forklaring.

- At personidentifiserbare data vil bli oppbevart etter at studien er avsluttet i påvente av en eventuell oppfølgingsundersøkelse.

- At personidentifiserbare data ikke vil bli offentliggjort sammen med resultater fra undersøkelsen.

_____
Sted   Dato   Underskrift foreldre/foresatte

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKT

 Vekststudien i Bergen

Kjære foreldre/foresatte!

Med dette brevet ber vi om deres samtykke til å gjøre lengde- og vektmålinger av barnet deres i barnehagen. I tillegg til de vanlige målingene av lengde, vekt og hodeomkrets, ønsker vi hos de barna som er 4 år og eldre å bestemme sittehøyde, armspenn, underarmslengde, legglengde, hudfoldtykkelse og mageomfang.

Alle barn i barnehagen som er 2 år og eldre er invitert til studien.

Hensikten er å få kunnskap om friske norske barns vekst og vekt helt fra fødsel til fylte 18 år. På grunnlag av de innsamlede data ønsker vi å lage nye og oppdaterte nasjonale vekstkurver, et arbeidsredskap som er svært viktige både for helsestasjonene og landets barneavdelinger. I tillegg ønsker vi spesielt å kartlegge den økende tendens det er til overvekt i den norske barnebefolkningen.

Undersøkelsene er ufarlige og innebærer ingen smerter. De blir utført av studiesykepleiere som besøker barnehagen. I de tilfeller der studiemedarbeider identifiserer barn med uttalt vekst- eller vektavvik vil foreldrene bli kontaktet med tilbud om poliklinisk legeundersøkelse ved Barneklinikken, Haukeland Universitetssykehus.

Alle måleresultatene behandles konfidensielt og oppbevares i arkiv ved Barneklinikken fram til prosjektet er ferdig om seks år. Deretter blir resultatene lagret hos Norsk Samfunnsvitenskapelige Datatjeneste, Universitetet i Bergen. Grunnen til dette er at det kan bli aktuelt å invitere deltakerne til en oppfølgingsstudie når barna er blitt voksne. Ingen enkeltbarn vil kunne bli gjenkjent i det som blir skrevet i vår oppsummering når undersøkelsen er ferdig. Dersom resultater fra undersøkelsen blir publisert i legetidsskrifter, vil det skje i anonymisert form.

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Vedlagt er svarslipp for samtykke. Selv om du/dere svarer ja nå, kan barnet når som helst trekke seg fra videre undersøkelse. Alle opplysninger fra studien vil da bli slettet hvis du/dere ønsker det.

Vennlig hilsen

Pétur B. Júlíusson   Robert Bjerknes
Overlege   Professor, dr. med.
Barneklinikken   Avd.overlege/Avd.leder
Haukeland Universitetssykehus   Barneklinikken
                                            Haukeland Universitetssykehus

BARNEHAGER

Vekststudien i Bergen

Svarslipp for samtykke

Vi gir herved tillatelse til at vårt barn:

Navn: _____ Fødselsdato: _____

kan delta i *"Vekststudien i Bergen"* i henhold til informasjonsskrivet.

Vi har fått informasjon om følgende:

- At vi når som helst kan trekke oss fra undersøkelsen uten nærmere forklaring.

- At personidentifiserbare data vil bli oppbevart etter at studien er avsluttet i påvente av en eventuell oppfølgingsundersøkelse.

- At personidentifiserbare data ikke vil bli offentliggjort sammen med resultater fra undersøkelsen.

_____
Sted   Dato   Underskrift foreldre/foresatte

Vennligst svar følgende spørsmål:

1. Kommer en eller begge foreldrene fra land utenfor Norge, Sverige, Danmark, Finland eller Island?   Ja__   Nei__

2. Har barnet et kronisk helseproblem?   Ja__   Hvilken _____ Nei__

3. Bruker barnet medisiner?   Ja__   Nei__

BARNEHAGER

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKT

Vekststudien i Bergen

Kjære foreldre/foresatte og skoleelev!

Med dette brevet ber vi om deres samtykke til å gjøre vekst- og vektmålinger av barnet deres to år på rad. Våre studiesykepleiere vil utføre den første undersøkelsen om ca. to uker. I tillegg til de vanlige målingene av lengde, vekt og hodeomkrets, ønsker vi å måle sittehøyde, underarmslengde, armspenn, legglengde, hudfoldtykkelse og mageomfang. Ved neste undersøkelse (omtrent et år etter første undersøkelsen) måles kun høyde og vekt.

Studien gjennomføres ved ca. 20 skoler i Hordaland, der alle barna vil bli forespurt om å delta.

Hensikten er å få kunnskap om friske norske barns vekst og vekt helt fra fødsel til fylte 18 år. På grunnlag av de innsamlede data ønsker vi å lage nye og oppdaterte nasjonale vekstkurver, et arbeidsredskap som er svært viktige både for helsestasjonene og landets barneavdelinger. I tillegg ønsker vi spesielt å kartlegge den økende tendens det er til overvekt i den norske barnebefolkningen.

Undersøkelsene er ufarlige og innebærer ingen smerter. De blir utført av to studiesykepleiere i skoletiden og selve målingene tar rundt 5 minutter. Barna blir undersøkt hver for seg. I de tilfeller der studiemedarbeider identifiserer barn med uttalt vekst- eller vektavvik vil foreldrene bli kontaktet med tilbud om poliklinisk legeundersøkelse ved Barneklinikken, Haukeland Universitetssykehus.

Alle som deltar i studien vil hvert år være med i trekning av 3 verdikort i en sportsbutikk på kr. 5000, samt 50 kinobesøk for to personer.

Alle måleresultatene behandles konfidensielt og oppbevares i arkiv ved Barneklinikken fram til prosjektet er ferdig om tre år. Deretter blir resultatene lagret hos Norsk Samfunnsvitenskapelige Datatjeneste, Universitetet i Bergen. Grunnen til dette er at det kan bli aktuelt å invitere deltakerne til en oppfølgingsstudie når barna er blitt voksne. Ingen enkeltbarn vil kunne bli gjenkjent i det som blir skrevet i vår oppsummering når undersøkelsen er ferdig. Dersom resultater fra undersøkelsen blir publisert, vil det skje i anonymisert form. Prosjektet er vurdert og klarert av Regional komite for medisinsk forskningsetikk Vest-Norge og det er innhentet konsesjon fra Datatilsynet.

Vedlagt er svarslipp for samtykke. Vi ber om at svarslippen returneres i utfylt stand til skolen så snart råd er. Selv om du/dere svarer ja nå, kan barnet når som helst trekke seg fra videre undersøkelse. Alle opplysninger fra studien vil da bli slettet hvis du/dere ønsker det. Dersom ditt barn begynner på ny skole i løpet av den tiden studien går, vil dere bli innkalt til Barneklinikken, Haukeland Universitetssykehus for å få gjennomført de siste målingene der.

Takk for hjelpen!

Vennlig hilsen

Pétur B. Júlíusson   Robert Bjerknes
Overlege   Professor, dr. med.
Barneklinikken   Avd.overlege/Avd.leder
Haukeland Universitetssykehus   Barneklinikken
                                       Haukeland Universitetssykehus

SKOLE

Vekststudien i Bergen

Svarslipp for samtykke

Vi gir herved tillatelse til at vårt barn:

Navn: _____ Fødselsdato: _____

kan delta i *"Vekststudien i Bergen"* i henhold til informasjonsskrivet.

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_____
Sted   Dato   Underskrift foreldre/foresatte

Hvis barnet er 12 år eller eldre, ber vi om at også denne delen av svarslippen fylles ut:

_____
Sted   Dato   Underskrift deltaker

Vekststudien i Bergen

FORESPØRSEL OM DELTAKELSE I FORSKNINGSPROSJEKT

Kjære skoleelev!

Med dette brevet ber vi om deres samtykke til å gjøre vekst- og vektmålinger. Våre studiesykepleiere vil utføre undersøkelsen om ca. to uker. I tillegg til de vanlige målingene av lengde og vekt, ønsker vi å måle sittehøyde og mageomfang.

Studien gjennomføres ved ca. 20 skoler i Hordaland, der alle barna vil bli forespurt om å delta. Førskolebarn måles i barnehager og på helsestasjoner. Elevene i halvparten av skolene blir bedt om å stille opp til oppfølgingsundersøkelse kun av høyde og vekt ett år senere. **Hvis du allerede har deltatt i studien kan du se bort i fra denne henvendelsen.**

Hensikten er å få kunnskap om friske norske barns vekst og vekt helt fra fødsel til fyllte 20 år. På grunnlag av de innsamlede data ønsker vi å lage nye og oppdaterte nasjonale vekstkurver, et arbeidsredskap som er svært viktige både for helsestasjonene og landets barneavdelinger. *Ved å delta bidrar du faktisk med kunnskap som vil hjelpe syke barn.* I tillegg ønsker vi spesielt å kartlegge den økende tendens det er til overvekt i den norske barnebefolkningen.

Undersøkelsene er ufarlige og innebærer ingen smerter. De blir utført av to studiesykepleiere i skoletiden på *helsesøsters kontor* og selve målingene tar rundt 5 minutter. De som deltar blir undersøkt hver for seg. Elever identifisert av studiemedarbeider med uttalt vekst- eller vektavvik vil få tilbud om poliklinisk legeundersøkelse ved Barneklinikken, Haukeland Universitetssykehus.

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Vedlagt er svarslipp for samtykke. Selv om du/dere svarer ja nå, kan du når som helst trekke seg fra videre undersøkelse. Alle opplysninger fra studien vil da bli slettet hvis du/dere ønsker det. Dersom du begynner på ny skole i løpet av den tiden studien går, vil du eventuelt bli innkalt til Barneklinikken, Haukeland Universitetssykehus for å få gjennomført den siste målingene der.

Takk for hjelpen!

Vennlig hilsen

Pétur B. Júlíusson   Robert Bjerknes
Overlege   Professor, dr. med.
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Haukeland Universitetssykehus   Barneklinikken
                                             Haukeland Universitetssykehus

SKOLE

Vekststudien i Bergen

Svarslipp for samtykke

Jeg/vi gir herved mitt/våres tillatelse til å delta i *"Vekststudien i Bergen"* i henhold til informasjonsskrivet.

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oppfølgingsundersøkelse.

- At personidentifiserbare data ikke vil bli offentliggjort sammen med resultater fra undersøkelsen.

_____   _____

Sted   Dato   Underskrift elev   Født

Hvis du ikke har fylt 16 år, ber vi om at også denne delen av svarslippen fylles ut:

_____

Sted   Dato   Underskrift foreldre/foresatte