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**Overweight and waist circumference among Norwegian 11-year-olds and associations with reported parental overweight and waist circumference: The HEIA-study**

Bjelland M[1], Lien N[1], Bergh IH[3], Grydeland M [1/2], Anderssen SA[2], Klepp K-I[1], Ommundsen Y[3] and Andersen LF[1]

[1]Department of Nutrition, Faculty of Medicine, University of Oslo, Oslo, Norway

[2]Department of Sports Medicine, Norwegian School of Sport Sciences, Oslo, Norway

[3]Department of Coaching and Psychology, Norwegian School of Sport Sciences, Oslo, Norway

Correspondence to:

Mona Bjelland, Department of Nutrition, P.O.Box 1046 Blindern, NO-0316 Oslo, Norway

Tel: +47 22 85 13 49/ +47 997 96 799, Fax: +47 22 85 15 31,

e-mail: mona.bjelland@medisin.uio.no

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**Abstract**

**Aims**

The aim of this paper is to investigate anthropometric characteristics in 11-year-olds Norwegian by gender and parental education, and to study associations between adolescents' overweight and waist circumference (WC) and maternal and paternal overweight and WC.

**Methods**

A total of 1483 adolescents, 1156 mothers and 1016 fathers participated in the baseline survey of the HEIA-study (September 2007). Anthropometric measures of the adolescents were assessed by project staff according to standard procedures. Self reported data about pubertal status were collected through questionnaires. Parental education and anthropometric measures of parents were collected by self report.

**Results**

The prevalence of overweight (including obesity) determined by the cut-offs for BMI suggested by the International Obesity Task Force (IOTF), was 14.6% among girls and 13.6% among boys. The highest prevalence of overweight was observed among adolescents with parents who had less than 12 years of education (18.8%). Overweight and WC in girls was strongly associated with mothers' overweight and WC. For boys, overweight and WC was strongly associated with both mothers' and fathers' overweight and WC.

**Conclusion**

There was a social gradient in anthropometric characteristics and overweight rates among Norwegian 11-year-old adolescents. Maternal overweight and WC was associated with overweight and WC in girls and boys, while paternal overweight and WC were associated with overweight and WC in boys. The results indicate that mothers are key persons in prevention of overweight among adolescents, despite gender. Fathers are important as role

models for their sons. Targeting parental overweight/obesity could be a strategy in future interventions.

**Background**

Overweight and obesity are reaching epidemic proportions among children and adolescents around the world and in many European countries [1,2]. Based on self-reported data, prevalence rates of overweight and obesity among 11-year-olds in Norway is similar to what has been observed in other Scandinavian countries, but rates are generally lower than among 11-year-olds in other parts of Europe [3,4].

Different indicators have been used to assess overweight and obesity in children and adolescents, and body mass index (BMI) is probably the most used. Waist circumference (WC) is a measure of the distribution of body fat, and does better than BMI in predicting future risk of cardiovascular disease or diabetes, especially in adolescents [5]. The waist/hip-ratio (WHR) is not a good index to identify intra-abdominal fat deposition in children and adolescents [6]. However, the waist-to-height ratio (WHTR) has been proposed to be of great value as a simple anthropometric index, because of its ability to explain body fat distribution and its association with cardiovascular health risks [7,8].

When Whitaker et al conducted their study in 1997 it was not known whether parental overweight/obesity altered the probability that the child would become overweight/obese [9]. Since then, several studies have shown that parental (particularly maternal) overweight/obesity increases the risk of a child becoming obese [10-15]. Further, Perez-Pastor et al found that the relationship between parental BMI and weight gain in children (1-8 years old) is gender specific. The rise in childhood obesity over the last decade seems to be largely confined to those whose same-sex parents are overweight/obese [14]. In the studies mentioned above, BMI was the anthropometric measure of adiposity [10-15]. Fewer studies include WC of children and parents and if included, the number of participants is often low [16], WC is

only available for the children and one parent (the mother) [17] or WC is only available for the child [11]. To our knowledge, few studies have examined the associations between parental and child WC in a larger population [16,17]. Investigating gender-specific associations between parents and child may be important in prevention of childhood obesity and in understanding the behavioural influence of parents. We have collected anthropometric data on weight, height and WC from children, mothers and fathers as part of the HEIA-study (HEalth In Adolescents), a school-based randomized intervention trial to promote healthy weight among children.

The aim of this paper is twofold. First, we investigate anthropometric characteristics in 11-year-olds Norwegian by gender and parental education. Second, we study associations between adolescents' overweight and WC and maternal and paternal overweight and WC.

## Methods

*Study design and subjects*

A total of 177 schools from cities in seven counties (Akershus, Buskerud, Hedmark, Oppland, Telemark, Vestfold and Østfold) were invited to participate in the HEIA-study. Selection criteria were that they had a minimum of 40 enrolled 6th graders in the school. In total 37 schools accepted the invitation.

All 6th graders in these 37 schools (n = 2165) and their parents/legal guardians were invited to participate. Of these, 1580 returned a parent signed informed consent form for their adolescent. The data collection took place during four weeks in September 2007. On the day of the survey the adolescents filled in an Internet based questionnaire and a short paper questionnaire about pubertal status, and they took part in an examination of anthropometric measures. Further, the adolescents were asked to bring home an envelope with questionnaires to their parents/ legal guardian (hereafter called parents), one questionnaire for the mother and one for the father. We did not collect data from the schools and children/parents declining participation.

The adolescents present at the day of the data collection and willing to take part in the anthropometric measurements are included in this paper, as are their parents reporting anthropometric measures. A total of 1483 adolescents (68.5% of those 2165 invited to participate), 1156 mothers (53.4%) and 1016 fathers (46.9%) with one or more valid body measure were included in the analysis presented here. For 976 of the adolescents both parents returned a questionnaire, of these 965 mothers and 962 fathers reported one or more anthropometric measure. For those 254 adolescents where only one parent returned a questionnaire, 191 mothers and 54 fathers reported one or more anthropometric measure.

Only 6% of the adolescents reported that they lived with other adults than their mother and/or father. Furthermore, 84% of the fathers lived together with the adolescent's mother, and 75% of the mothers lived together with the adolescent's father.

The study was approved by the Regional Committees for Medical Research Ethics and the Norwegian Social Science Data Service.

*Anthropometric measurements*

The height was measured to the nearest 0.1 cm, using a wall-mounted tape with the child standing upright against the wall and without shoes. The adolescent's weight was measured with light clothing, i.e. T-shirt and underwear, to the nearest 0.1 kg using a Tanita scale (Tanita TBF-300, Tanita Corporation of America, Illinois, USA).

Waist circumference was measured in centimetres to the nearest 0.1 cm with a flexible measuring tape midway between the lower rib and the iliac crest at the end of a normal expiration. The adolescent was standing with at straight posture, relaxed arms, body weight equally distributed on both legs. Hip circumference was measured at the widest circumference of the hip.

BMI was calculated as weight/(height x height) ($kg/m^2$). The waist/hip-ratio was calculated as the ratio of waist (cm) and hip (cm) circumference, while the waist-to-height ratio was calculated as the ratio of waist (cm) and height (cm). Body composition (percentages of body fat, BF%) was measured by the Tanita scale (using bioelectrical impedance analysis (BIA)). The adolescents were in light clothing and barefoot when entering the scale.

The age-and gender specific BMI cut-off values proposed by the International Obesity Task Force [18] were used to categorize the adolescents as non-overweight and overweight (including obesity). Due to few obese adolescents (1.8%) these are included in the proportion of overweight in the analyses. There is no consensus about the best cut-off points for WC, WHTR or BF% in young people. Hence, for WC we used the cut-off values proposed by Fredriks et al [19]. The values above the cut-off classify the individuals as at risk of cardiovascular and metabolic diseases. Also WHTR $\geq$ 0.5 has been used as cut-off to identify adolescents with adverse cardiovascular risk factors [8].

The parents were instructed to report their weight in kilograms and their height in centimetres in the questionnaire. They were also asked to use an enclosed flexible measuring tape to measure hip- and waist circumference themselves, following written guidelines (including an illustration). Hip and waist circumference should be measured to the nearest 0.1 centimetres, waist measured midway between the lower rib and the iliac crest and hip circumference measured at the widest circumference of the hip. The self-reported height and weight were used to calculate BMI which was classified into overweight (including obesity) or non-overweight according to cut-off points of 25 kg/m$^2$ defined according to the World Health Organisation (WHO) criteria [20]. For WC the cut-off for WC defined according to the WHO criteria were used (indicating increased risk of metabolic implications) [20]. For the analyses, these variables were dichotomized as non-overweight and overweight (including obesity), above or below the cut-off points.

*Data from questionnaires*

Self-reported information about parental education was collected as part of the informed consent for the adolescent. Education was categorized into three levels: 12 years or less,

between 13 and 15 year and 16 years or more. The information about education from the parent with the longest education was used in the analysis, or else the one available.

Due to ethical reasons the students filled in questions about pubertal status. The Pubertal Development Scale (PDS) utilized in the study is based at the Pubertal Category Scores (PCS) as defined by Carskadon and Acebo [21]. PDS for boys included body hair growth, voice and facial hair. For girls, PDS included body hair growth, breast development and menarche. The adolescents were categorized as Pre pubertal (1), Early pubertal (2), Midpubertal (3), Late Pubertal (4) or Postpubertal (5). For the analyses the scale was reduced (dichotomized into pre-/early pubertal and mid-/late- /postpubertal for girls, and prepubertal and early-/mid-/late-/postpubertal for boys), as suggested in a study comparing PDS and the Sexual Maturation Scale [22].

A reliability study of the measured height and waist (by staff) and the PDS (self-reported) among 114 adolescents were conducted prior to the survey, together with a test-retest of the self-reported height/weight/WC among 44 mothers and 35 fathers. Pearson's test-retest correlation coefficients for body measures ranged from 0.94-0.99 for both the adolescents and their parents. For the questions included in the PDS the correlation ranged from 0.76-0.90 (data not shown).

*Data analysis*

Anthropometric characteristics are presented as means and standard deviations (SD), unless otherwise stated. Continuous variables were tested for differences between gender for both adolescents and parents with independent sample t-tests, and Chi-square test of proportions

was used for categorical variables. One-way ANOVA was used to test for differences between the three levels of parental education.

The association of the selected variables (parental education, parental overweight and pubertal status) with BMI (non-overweight/ overweight) and WC (above/below cut-off) was analyzed by binary logistic regression. For the factors for which significant associations were observed, the analyses were redone controlling for the other significant predictors, in order to examine whether the associations were independent of each other. Pubertal status was always included for clinical reasons.

The models were tested for interaction effects between condition and parental characteristics, and no interaction effects were found except concerning paternal BMI and parental education, for girls only. Clustering effects due to schools being the unit of recruitment was checked by Linear Mixed Model procedure. No clustering effect was found for the adolescent's BMI and WC, only 2% of the unexplained variation was on group level.

Data were analyzed using the IBM SPSS Statistics, version 16 (IBM Corporation, New York, USA).

**Results**

There were significant differences between girls and boys for weight and height ($p \leq 0.02$), waist- and hip circumference, WHR, WHTR and BF% ($p < .001$). The prevalence of overweight (including obesity) was 14.6% among girls and 13.6% among boys, while 1.7% of the girls and 1.8% of the boys were obese (data not shown). No significant differences between genders were found for prevalence of overweight/obesity and BMI. The prevalence of overweight (including obesity) for mothers were 29.9% and for fathers 59.0% (Table I).

TABLE 1 about HERE

Among adolescents classified as overweight using BMI, 99% were also above the WC cut-off. Of those categorized to be normal weight, about 40% were above the WC cut-off. Further, those adolescents classified as having a normal weight using BMI all had a WHTR below cut-off. In adolescents defined as overweight according to BMI, 68.6% of the girls and 49.0% of the boys had a WHTR below cut-off (Table II).

TABLE 2 about HERE

There were significant differences for weight ($p=0.02$), hip circumference ($p=0.003$), BMI, WC, WHR, WHTR, BF% and prevalence of overweight ($p \leq 0.001$) when comparing adolescents who had parents with the lowest educational level and parents with 13-15 years of education, and between parents with the lowest and the highest educational level. The patterns were similar for boys and girls, except for weight for which the differences were significant for girls but not for boys (data not shown).

TABLE 3 about HERE

Overweight in girls was significantly associated with maternal overweight, while overweight in boys was significantly associated with both maternal and paternal overweight (Table IV). Odds ratio (OR) indicated that girls who had overweight mothers, were 2.3 times more likely to be overweight compared to girls having non-overweight mothers, when adjusted for pubertal status, parental education and paternal overweight. The corresponding OR for boys was 3.6 when having overweight mothers and adjusted for pubertal status and father's overweight. Boys, who had overweight fathers, were 4.4 times more likely to be overweight compared to boys having non-overweight fathers, when adjusted for pubertal status and maternal overweight.

TABLE 4 about HERE

Girls' WC was significantly associated with pubertal score and maternal WC. The WC of boys was strongly associated with both maternal and paternal WC. The OR for girls who had mothers with WC above cut-off was 1.5 compared to girls having mothers with WC below cut-off, when adjusted for pubertal status and paternal WC. The girls who had reached the mid-, late or postpubertal level had more than two times higher OR (2.1) for WC above cut-off than girls at pre- or early pubertal level, when adjusted for parental WC. For boys the OR was 1.8 if the mother or the father had WC above cut-off, adjusted for pubertal status, parental education and paternal/maternal WC.

TABLE 5 about HERE

There were no significant differences between adolescents who had one or two parents responding and those adolescents whose parents did not respond, according to weight, BMI, waist- and hip circumference, BF% and overweight. In the parental group which did not return a questionnaire, a higher proportion of the parents had 12 year or less of education, compared to the group of parents responding (data not shown).

**Discussion**

The main findings are that there were significant differences in anthropometric characteristics and prevalence of overweight when stratified by parental education level, and that overweight and WC in girls was associated with maternal overweight and WC, while overweight and WC in boys was associated with both maternal and paternal overweight and WC.

In the HEIA-study several anthropometric measures of 11-year-olds were collected objectively, giving a unique possibility to study overweight/obesity and associations using different indicators for body fatness (BMI/WC/WHTR/BF%). In a study among Hungarian school children, both normal and overweight children (according to BMI) with high BF% had significantly higher WC than their counterparts with normal BF% [23]. Further, Antal et al found a higher prevalence of obesity according to body fat content than to BMI, indicating that the BMI cut off points do not identify all children with high body fat [23]. Our finding that more than 40% of the normal weight adolescents had a WC above cut-off, may support this indication. However, a study by Garnett et al indicates that overweight/obesity by BMI may also overestimate the number of young people at risk compared to WHTR [8]. Our results support these findings, given that 68.6% of the girls and 49.0% of the boys were categorized as overweight/obese, while WHTR was below the cut-off value. When using BMI to estimate the proportion of overweight adolescents we may underestimate and overestimate the proportion of adolescents at risk of cardiovascular and metabolic diseases according to use of cut-off values for WC and WHTR, respectively.

The prevalence of overweight/obesity reported in the present study is in accordance with national representative studies among 8-, 9- and 15-year-olds [24,25], and so are the BMI. The mean WC for girls in our study (62.4 cm) is lower than for the WC reported among the 9-

year-olds (63.1 cm) in the national study [25], which could be caused by a selection bias and/or pubertal development. The prevalence of overweight among the adults in the HEIA-study is in accordance with the prevalence in another Norwegian study from 2001, using self-reported weight and height (51.3% among men and 29.3% for women) [26]. In a Norwegian study parental education showed the clearest inverse gradients with self-reported overweight/obesity among 15-16 year olds compared to other indicators for socio economic status [27]. These findings are in accordance with the results from the HEIA-study, showing a clear inverse gradient for overweight and the anthropometric characteristics among 11-year-olds.

The results from the HEIA-study are in agreement with other studies reporting that children with an overweight parent (defined by BMI) are between 2 and 4 times more likely to be overweight compared to children having a non-overweight father or mother [10-13,15]. In the two studies presenting OR by gender both for children and parents (using BMI), the odds are in the range between 2 and 4 and thus close to the odds found in our study [10,12]. There are fewer studies reporting associations by OR for WC, but those which do indicate an OR between 2 and 3 [11,17]. No conclusion can be made separately for the obese adolescents in this study, due to the low prevalence.

The association between parental BMI and WC and adolescents BMI and WC in the HEIA-study did not differ. In both cases maternal overweight and WC was associated with overweight/WC in girls and boys, while paternal overweight and WC were associated with overweight/WC in boys. A possible explanation for the association observed for girls/boys and mothers could be that mothers are still the primary caregivers of adolescents in Norway, and therefore the mothers might have a stronger influence. Overweight/WC among boys

seems to be more closely related to father's overweight/WC, due to behavioural influence: the mothers acting as role models for daughters and the fathers for sons. This is supported by the findings of Perez-Pastor et al [14].

Generalizability of our findings is limited because a local sample was recruited from a limited geographic area, in urban areas mainly. Furthermore, the recruitment of schools and participants may have caused a non-response bias, restricting the range of values on our anthropometric measures. The response rate among the parents may also affect the representativeness of the parental data.

Another limitation may be the choice of cut off points for waist and WHTR in adolescents. There is no consensus about the best cut-off points for age and sex-specific WC and WHTR in young people, but by using cut-off points defined by others this study may contribute to reach a consensus. Finally, validity studies of self-reported height, weight and BMI among adults show trends of under-reporting for weight and over-reporting for height both for men and women [28]. Despite this, BMI is commonly used in studies investigating overweight and obesity [28]. Furthermore, men and women underestimate their WC and the underestimation is larger with higher BMI in both sexes [29]. Still, self-reported waist measurements are sufficiently accurate in identifying relationships with risk of disease and mortality in epidemiological studies [29]. Parents reported their relation to the child when giving the consent, not in the questionnaire where weight, height, waist- and hip circumference were reported, limiting the possibility to assess biological associations in anthropometry. To be able to do the regression analyses presented in Table IV and V the number of subjects were reduced, due to the moderate response rates among parents. This might explain why the

parental education did not show a significant association, as reported in the descriptive analysis (Table III).

Data on pubertal status were collected making it possible to take maturation status into consideration, which strengthened the study. Moderate to high correlations between adolescents' self-administration of the PDS and physician ratings using Tanner stages have been reported in two small studies [21,30]. Another strength is that parental education is reported by the parents themselves, not the adolescents, and that we were able to collect these data from nearly all the parents giving their adolescents consent to participate in the study, not only from those parents answering the questionnaire.

## Conclusions

In conclusion, we observed a clear inverse social gradient for overweight and the anthropometric characteristics among the Norwegian 11-year-olds. Our findings confirm that having parents who are overweight or have a WC above cut-off may increase the risk of adolescents being overweight or having a WC above cut-off. Maternal overweight and WC was associated with overweight and WC in girls and boys, while paternal overweight and WC were associated with overweight and WC in boys. The results from the HEIA-study indicate that mothers are key persons in prevention of overweight among adolescents, despite gender. Fathers are important as well, in particular as role models for their sons. These findings may contribute to develop more effective strategies in obesity prevention and interventions, by targeting parental overweight/obesity in the interest of the adolescent. To assess overweight and future health risk among adolescents, measurement of both BMI and WC is recommended.

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Reference List


[1] Wang Y, Lobstein T. Worldwide trends in childhood overweight and obesity. Int J Pediatr Obes 2006;1(1):11-25.

[2] Jackson-Leach R, Lobstein T. Estimated burden of paediatric obesity and co-morbidities in Europe. Part 1. The increase in the prevalence of child obesity in Europe is itself increasing. Int J Pediatr Obes 2006;1(1):26-32.

[3] Yngve A, De B, I, Wolf A, et al. Differences in prevalence of overweight and stunting in 11-year olds across Europe: The Pro Children Study. Eur J Public Health 2008 Apr;18(2):126-30.

[4] Currie C, Gabhainn SN, Godeau E, et al. Inequalities in young people's health, HBSC international report from the 2005/2006 survey. 2009.

[5] Himes JH. Challenges of accurately measuring and using BMI and other indicators of obesity in children. Pediatrics 2009 Sep;124 Suppl 1:S3-22.

[6] Semiz S, Ozgoren E, Sabir N. Comparison of ultrasonographic and anthropometric methods to assess body fat in childhood obesity. Int J Obes (Lond) 2007 Jan;31(1):53-8.

[7] Ashwell M, Hsieh SD. Six reasons why the waist-to-height ratio is a rapid and effective global indicator for health risks of obesity and how its use could simplify the international public health message on obesity. Int J Food Sci Nutr 2005 Aug;56(5):303-7.

[8] Garnett SP, Baur LA, Cowell CT. Waist-to-height ratio: a simple option for determining excess central adiposity in young people. Int J Obes (Lond) 2008 Jun;32(6):1028-30.

[9] Whitaker RC, Wright JA, Pepe MS, Seidel KD, Dietz WH. Predicting obesity in young adulthood from childhood and parental obesity. N Engl J Med 1997 Sep 25;337(13):869-73.

[10] Wang Z, Patterson CM, Hills AP. Association between overweight or obesity and household income and parental body mass index in Australian youth: analysis of the Australian National Nutrition Survey, 1995. Asia Pac J Clin Nutr 2002;11(3):200-5.

[11] Ortega FB, Ruiz JR, Sjostrom M. Physical activity, overweight and central adiposity in Swedish children and adolescents: the European Youth Heart Study. Int J Behav Nutr Phys Act 2007;4:61.

[12] Kosti RI, Panagiotakos DB, Tountas Y, et al. Parental Body Mass Index in association with the prevalence of overweight/obesity among adolescents in Greece; dietary and lifestyle habits in the context of the family environment: the Vyronas study. Appetite 2008 Jul;51(1):218-22.

[13] Kleiser C, Schaffrath RA, Mensink GB, Prinz-Langenohl R, Kurth BM. Potential determinants of obesity among children and adolescents in Germany: results from the cross-sectional KiGGS Study. BMC Public Health 2009;9:46.

[14] Perez-Pastor EM, Metcalf BS, Hosking J, Jeffery AN, Voss LD, Wilkin TJ. Assortative weight gain in mother-daughter and father-son pairs: an emerging source of childhood obesity. Longitudinal study of trios (EarlyBird 43). Int J Obes (Lond) 2009 Jul;33(7):727-35.

[15] Whitaker KL, Jarvis MJ, Beeken RJ, Boniface D, Wardle J. Comparing maternal and paternal intergenerational transmission of obesity risk in a large population-based sample. Am J Clin Nutr 2010 Apr 7.

[16] Reis EC, Kip KE, Marroquin OC, et al. Screening children to identify families at increased risk for cardiovascular disease. Pediatrics 2006 Dec;118(6):e1789-e1797.

[17] Hirschler V, Roque MI, Calcagno ML, Gonzalez C, Aranda C. Maternal waist circumference and the prediction of children's metabolic syndrome. Arch Pediatr Adolesc Med 2007 Dec;161(12):1205-10.

[18] Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: international survey. BMJ 2000 May 6;320(7244):1240-3.

[19] Fredriks AM, van BS, Fekkes M, Verloove-Vanhorick SP, Wit JM. Are age references for waist circumference, hip circumference and waist-hip ratio in Dutch children useful in clinical practice? Eur J Pediatr 2005 Apr;164(4):216-22.

[20] Obesity: preventing and managing the global epidemic. Report of a WHO consultation. World Health Organ Tech Rep Ser 2000;894:i-253.

[21] Carskadon MA, Acebo C. A self-administered rating scale for pubertal development. J Adolesc Health 1993 May;14(3):190-5.

[22] Bond L, Clements J, Bertalli N, et al. A comparison of self-reported puberty using the Pubertal Development Scale and the Sexual Maturation Scale in a school-based epidemiologic survey. J Adolesc 2006 Oct;29(5):709-20.

[23] Antal M, Peter S, Biro L, et al. Prevalence of underweight, overweight and obesity on the basis of body mass index and body fat percentage in Hungarian schoolchildren: representative survey in metropolitan elementary schools. Ann Nutr Metab 2009;54(3):171-6.

[24] Hovengen R, Meisfjord J, Biehl A, Nordhagen R. Child Growth in Norway 2008. Height, weight and waist circumference for children in 3rd grade [Nor]. Oslo: The Norwegian Institute of Public Health; 2009.

[25] Anderssen S, Kolle E, Steene-Johannessen J, Ommundsen Y, Andersen L. Physical activity in children and adolescents in Norway. A cross sectional study of the activity level and fitness among 9- and 15-year-olds [Nor]. Oslo: The Directorate of Health; 2008.

[26] Reas DL, Nygard JF, Svensson E, Sorensen T, Sandanger I. Changes in body mass index by age, gender, and socio-economic status among a cohort of Norwegian men and women (1990-2001). BMC Public Health 2007;7:269.

[27] Lien N, Kumar BN, Holmboe-Ottesen G, Klepp KI, Wandel M. Assessing social differences in overweight among 15- to 16-year-old ethnic Norwegians from Oslo by register data and adolescent self-reported measures of socio-economic status. Int J Obes (Lond) 2007 Jan;31(1):30-8.

[28] Gorber SC, Tremblay M, Moher D, Gorber B. A comparison of direct vs. self-report measures for assessing height, weight and body mass index: a systematic review. Obes Rev 2007 Jul;8(4):307-26.

[29] Spencer EA, Roddam AW, Key TJ. Accuracy of self-reported waist and hip measurements in 4492 EPIC-Oxford participants. Public Health Nutr 2004 Sep;7(6):723-7.

[30] Brooks-Gunn J, Warren MP, Rosso J, Gargiulo J. Validity of self-report measures of girls' pubertal status. Child Dev 1987 Jun;58(3):829-41.

**Table I. Anthropometric characteristics by gender in a group of 11-year-old Norwegian adolescents, and their parents [Mean (SD), except for overweight/obese (%)]**

| | **Girls ($n^b$ =717) Mean (SD)** | **Boys ($n^b$ =764) Mean (SD)** | **$p^c$** | **Mothers ($n^b$ = 1115) Mean (SD)** | **Fathers ($n^b$ = 1006) Mean (SD)** |
|---|---|---|---|---|---|
| Age | 11.2 (0.3) | 11.2 (0.3) | 0.42 | 41 (5) | 43 (5) |
| Weight (kg) | 40.4 (8.2) | 39.5 (7.9) | **0.02** | 68 (11) | 86 (12) |
| Height (cm) | 149.0 (7.3) | 148.1 (6.5) | **0.01** | 168 (6) | 182 (6) |
| BMI ($kg/m^2$) | 18.1 (2.7) | 17.9 (2.7) | 0.13 | 24 (4) | 26 (3) |
| Waist circumference (cm) | 62.4 (6.5) | 64.1 (6.8) | **<.001** | 81 (11) | 93 (10) |
| Hip circumference (cm) | 77.6 (7.1) | 75.3 (7.1) | **<.001** | 96 (9) | 98 (7) |
| Waist/hip-ratio | 0.80 (0.05) | 0.85 (0.05) | **<.001** | 0.8 (0.1) | 0.9 (0.1) |
| Waist-to-height ratio (WHTR) | 0.42 (0.04) | 0.43 (0.04) | **<.001** | 0.5 (0.1) | 0.5 (0.1) |
| Percentages of body fat | 19.4 (7.5) | 15.1 (5.9) | **<.001** | - | - |
| Overweight/Obese [a] (%) | 14.6 | 13.6 | 0.57 | 29.9 | 59.0 |

[a]Adolescents: defined by International Obesity Task Force's cutoffs for overweight/obesity at age from 10.5 to 12.5 [19]. Adults: defined by WHO's cutoffs for overweight/obesity [22].
[b]The number vary slightly for the different measures, n for BMI is reported. [c]Difference between gender.

**Table II. Body fatness in a group of 11-year-old Norwegian adolescents with normal weight versus overweight (according to BMI)**

| | Girls (n[c] =717) | | Boys (n =764) | |
|---|---|---|---|---|
| **BMI[a]** | **Normal weight** | **Overweight/ Obese** | **Normal weight** | **Overweight/ Obese** |
| | n = 612 | n = 105 | n = 660 | n = 104 |
| **Waist circumference[b] (cm), % (n)** | | | | |
| < cut-off | 56.9 (348) | 1.0 (1) | 54.1 (357) | 0.0 (0) |
| ≥ cut-off | 43.1 (264) | 99.0 (104) | 45.9 (303) | 100.0 (104) |
| **Waist-to-height ratio (WHTR), % (n)** | | | | |
| < 0.5 | 99.3 (608) | 68.6 (72) | 98.5 (650) | 49.0 (51) |
| ≥ 0.5 | 0.7 (4) | 31.4 (33) | 1.5 (10) | 51.0 (53) |
| **Percentages of body fat, mean (SD)** | 17.4 (6.1) | 30.7 (4.8) | 13.5 (3.8) | 25.4 (6.3) |

[a]Adolescents: defined by International Obesity Task Force's cutoffs for overweight/obesity at age from 10.5 to 12.5 [19].
[b]Number of adolescents with WC ≥ cut off criteria, based on suggested gender specific cut-off points for WC among 11 year olds based on IOFT cut-off criteria (10.0 – 12.5 years) [20].
[c] For the percentages of body fat the number is 715 for girls.

**Table III. Anthropometric characteristics by parental education in a group of 11-year-old Norwegian adolescents [Mean (SD), except for overweight/obese (%)]**

| | 12 years or less (n = 431) Mean (SD) | Between 13 and 15 year (n = 515) Mean (SD) | 16 years or more (n = 483) Mean (SD) | p[b] |
|---|---|---|---|---|
| Weight (kg) | 40.8 (9.0) | 39.6 (7.7) | 39.5 (7.2) | **0.02** |
| Height (cm) | 148.5 (6.8) | 148.5 (7.0) | 148.8 (6.7) | 0.64 |
| BMI (kg/m$^2$) | 18.4 (3.0) | 17.8 (2.6) | 17.7 (2.4) | **<.001** |
| Waist circumference (cm) | 64.5 (7.6) | 63.1 (6.4) | 62.3 (5.9) | **<.001** |
| Hip circumference (cm) | 77.4 (7.8) | 76.0 (7.0) | 76.0 (6.5) | **0.003** |
| Waist/hip-ratio (WHR) | 0.83 (0.06) | 0.83 (0.05) | 0.82 (0.05) | **<.001** |
| Waist-to-height ratio (WHTR) | 0.43 (0.05) | 0.42 (0.04) | 0.42 (0.04) | **<.001** |
| Percentages of body fat | 18.4 (7.7) | 16.7 (6.7) | 16.4 (6.5) | **<.001** |
| Overweight/Obese [a] (%) | 18.8 | 12.4 | 10.5 | **0.001** |

[a] Adolescents: defined by International Obesity Task Force's cutoffs for overweight/obesity at age from 10.5 to 12.5 [20].

[b]The differences are significant between group one (≤12 years) and two (13-15 years), and between group one and three (≥16 years). No significant difference between group two and three. The pattern are similar for boys and girls, except for weight where the differences are significant for girls but not for boys.

**Table IV. Association between overweight/obesity among 11-year-old adolescents and selected characteristics of their parents**

| | N total | N o [a] | Prevalence overweight [b] | Crude | | | Adjusted [c] | | |
|---|---|---|---|---|---|---|---|---|---|
| GIRLS | **434** | **52** | **%** | **OR** | **95% CI** | **p** | **OR** | **95% CI** | **p** |
| **Parents' education** | | | | | | | | | |
| ≤ 12 years | 105 | 18 | 17.1 | 1 | | | 1 | | |
| 13-15 years | 156 | 18 | 11.5 | 0.6 | (0.3-1.3) | | 0.6 | (0.3-1.3) | |
| ≥ 16 years | 173 | 16 | 9.2 | 0.5 | (0.2-1.0) | 0.06 | 0.6 | (0.3-1.2) | 0.12 |
| **Mothers' overweight [d]** | | | | | | | | | |
| BMI < 25 kg/m$^2$ | 293 | 25 | 8.5 | 1 | | | 1 | | |
| BMI ≥ 25 kg/m$^2$ | 141 | 27 | 19.1 | 2.5 | (1.4- 4.6) | **0.001** | 2.3 | (1.3– 4.2) | **0.006** |
| **Fathers' overweight [d]** | | | | | | | | | |
| BMI < 25 kg/m$^2$ | 175 | 17 | 9.7 | 1 | | | | | |
| BMI ≥ 25 kg/m$^2$ | 259 | 35 | 13.5 | 1.5 | (0.8-2.7) | 0.23 | 1.2 | (0.6-2.3) | 0.53 |
| **Girls' pubertal score** | | | | | | | | | |
| Pre- and early pubertal | 130 | 11 | 8.5 | 1 | | | | | |
| Mid-, late and postpubertal | 304 | 41 | 13.5 | 1.7 | (0.8-3.4) | 0.14 | 1.5 | (0.7-3.1) | 0.26 |
| | **N total** | **N o [a]** | **Prevalence overweight [b]** | **Crude** | | | **Adjusted [c]** | | |
| BOYS | **415** | **47** | **%** | **OR** | **95% CI** | **p** | **OR** | **95% CI** | **p** |
| **Parents' education** | | | | | | | | | |
| ≤ 12 years | 96 | 15 | 15.6 | 1 | | | | | |
| 13-15 years | 171 | 16 | 9.4 | 0.6 | (0.3-1.2) | | | | |
| ≥ 16 years | 148 | 16 | 10.8 | 0.7 | (0.3-1.4) | 0.32 | | | |
| **Mothers' overweight [d]** | | | | | | | | | |
| BMI < 25 kg/m$^2$ | 303 | 21 | 6.9 | 1 | | | 1 | | |
| BMI ≥ 25 kg/m$^2$ | 112 | 26 | 23.2 | 4.1 | (2.2-7.6) | **<.001** | 3.6 | (1.9-7.0) | **<.001** |
| **Fathers' overweight [d]** | | | | | | | | | |
| BMI < 25 kg/m$^2$ | 178 | 7 | 3.9 | 1 | | | 1 | | |
| BMI ≥ 25 kg/m$^2$ | 237 | 40 | 16.9 | 5.0 | (2.2-11.4) | **<.001** | 4.4 | (1.9-10.5) | **0.001** |
| **Boys' pubertal score** | | | | | | | | | |
| Prepubertal | 146 | 16 | 11.0 | 1 | | | 1 | | |
| Early-, mid-, late and postpubertal | 269 | 31 | 11.5 | 1.1 | (0.6-2.0) | 0.86 | 1.0 | (0.5-2.0) | 0.97 |

[a]Number of overweight/obese adolescents in each group defined by International Obesity Task Force's gender specific cutoffs for overweight/obesity at age from 10.5 to 12.5 [19]. [b]Proportion of overweight/obese adolescents in each group. [c]Girls: Adjusted for parents' education, mothers' BMI, fathers' BMI and pubertal status. Boys: Adjusted for mothers' BMI, fathers' BMI and pubertal status. [d] Defined by WHO's cutoffs for overweight/obesity [22].

**Table V. Association between 11-year-old adolescent's waist circumference and selected characteristics of their parents**

| | N total | N w [a] | Waist ≥ cut off [b] | Crude | | | Adjusted [c] | | |
|---|---|---|---|---|---|---|---|---|---|
| GIRLS | **419** | **207** | | **OR** | **95% CI** | **p** | **OR** | **95% CI** | **P** |
| **Parents' education** | | | | | | | | | |
| ≤ 12 years | 101 | 49 | 48.5 | 1 | | | | | |
| 13-15 years | 147 | 81 | 55.1 | 1.3 | (0.8-2.2) | | | | |
| ≥ 16 years | 171 | 77 | 45.0 | 0.9 | (0.5-1.4) | 0.42 | | | |
| **Mothers' waist [d]** | | | | | | | | | |
| Waist < 80 cm | 187 | 78 | 41.7 | 1 | | | 1 | | |
| Waist ≥ 80 cm | 232 | 129 | 55.6 | 1.8 | (1.2-2.6) | **0.005** | 1.5 | (1.0-2.3) | **0.03** |
| **Fathers' waist [d]** | | | | | | | | | |
| Waist < 94 cm | 223 | 102 | 45.7 | 1 | | | 1 | | |
| Waist ≥ 94 cm | 196 | 105 | 53.6 | 1.4 | (0.9-2.0) | 0.11 | 1.3 | (0.8-1.9) | 0.24 |
| **Girls' pubertal score** | | | | | | | | | |
| Pre- and early pubertal | 125 | 45 | 36.0 | 1 | | | 1 | | |
| Mid-, late and postpubertal | 294 | 162 | 55.1 | 2.2 | (1.4-3.4) | **<0.001** | 2.1 | (1.3-3.2) | **0.001** |
| | **N total** | **N w [a]** | **Waist ≥ cut off [b]** | **Crude** | | | **Adjusted [c]** | | |
| BOYS | **405** | **213** | **%** | **OR** | **95% CI** | **p** | **OR** | **95% CI** | **P** |
| **Parents' education** | | | | | | | | | |
| ≤ 12 years | 93 | 54 | 58.1 | 1 | | | 1 | | |
| 13-15 years | 160 | 84 | 52.5 | 0.8 | (0.5-1.3) | | 0.9 | (0.5-1.5) | |
| ≥ 16 years | 152 | 75 | 49.3 | 0.7 | (0.4-1.2) | 0.19 | 0.8 | (0.5-1.4) | 0.42 |
| **Mothers' waist [d]** | | | | | | | | | |
| Waist < 80 cm | 221 | 99 | 44.8 | 1 | | | 1 | | |
| Waist ≥ 80 cm | 184 | 114 | 62.0 | 2.0 | (1.3-3.0) | **0.001** | 1.8 | (1.2-2.7) | **0.005** |
| **Fathers' waist [d]** | | | | | | | | | |
| Waist < 94 cm | 230 | 104 | 45.2 | 1 | | | 1 | | |
| Waist ≥ 94 cm | 175 | 109 | 62.3 | 2.0 | (1.3-3.0) | **0.001** | 1.8 | (1.2-2.8) | **0.004** |
| **Boys' pubertal score** | | | | | | | | | |
| Prepubertal | 139 | 71 | 51.1 | 1 | | | 1 | | |
| Early-, mid-, late- and postpubertal | 266 | 142 | 53.4 | 1.1 | (0.7-1.7) | 0.66 | 1.0 | (0.7-1.6) | 0.87 |

[a]Number of adolescents with WC ≥ cut off criteria, based on suggested gender specific cut-off points for WC among 11 year olds based on IOFT cut-off criteria (10.0 – 12.5 years) [20] [b]Proportion of adolescents with WC ≥ cut off criteria. [c]Girls: Adjusted for mothers' waist, fathers' waist and pubertal score. Boys: Adjusted for parents' education, mothers' waist, fathers' waist and pubertal score. [d]Defined by WHO's cutoffs indicating increased risk of metabolic implications [22]