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**Physical Activity, Body Composition and the Risk of  
Mental Health Problems among Norwegian  
Adolescents: The Young-HUNT Study**

BEV 3900

Master Thesis in Human Movement Science

Trondheim, May 2010

NTNU

Norwegian University of Science and Technology

Faculty of Social Science and Technology Management

Human Movement Science Program

## **Preface**

First of all I want to thank my supervisors Liv Berit Augestad and Tom Ivar Lund Nilsen for their help and prolific suggestions. Secondly I will express my gratitude to Nord-Trøndelag Health study (The HUNT Study) allowing me to use the data from Young-HUNT 1 and Young-HUNT 2. I will also like to thank all the adolescents in the county of Nord-Trøndelag who have participated in the Young-HUNT studies.

## Abstract

**Background:** The aim of the study was to examine the associations of physical activity, sport participation, and body composition on the risk of symptoms of mental health problems in a large population-based sample of Norwegian adolescents. **Methods:** Analyses were based on 4-year longitudinal data from the Young-HUNT studies in Norway among adolescents aged 13–19 years. A total of 2399 students participated in both Young-HUNT 1 and Young-HUNT 2, and 2000 of these were eligible for data analysis. We calculated relative risks of anxiety/depression symptoms ( $SCL-5 \geq 2$ ) associated with the various measures of physical activity and sports participation, anthropometric measures, and self-image of body size. **Results:** There was no associations between days of physical activity and the risk for symptoms of anxiety/depression among girls ( $P$ -trend = 0.34). Among boys we found an inverse association ( $P$ -trend = 0.02). For both genders the RR was higher for those who reported that they were not active in sports compared to those who were active (adjusted RR = 1.24; 95% CI= 0.86 – 1.79 for girls and RR = 1.43; 95% CI= 0.84 – 2.44 among boys). Girls with high BMI had a slightly higher risk for symptoms of anxiety/depression (adjusted RR= 1.19; 95% CI= 0.88- 1.62), and boys with low BMI had a higher risk (adjusted RR= 1.59; 95% CI= 0.80 – 3.15). Girls who considered themselves “very fat/chubby” or “thin/very thin” had a higher risk than those who considered themselves as “about the same as others” (adjusted RRs were 1.38; 95% CI= 1.04 – 1.67 and 1.71; 95% CI= 0.80 – 1.40, respectively). In boys, the risk was highest for those who considered themselves as “thin/very thin” (adjusted RR= 1.73; 95% CI= 1.11 – 2.67). **Conclusion:** Our findings indicated that days of physical activity may influence some aspects of mental health in boys, but not in girls. When measuring mental health status, body composition, and amount of physical activity, it is important to consider gender differences. Results encourage a search for further knowledge about physical activity as a possible protective factor in relation to mental health problems in adolescence.

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# **1 Introduction**

## ***1.1 Mental health***

Adolescence is a transitional stage of physical and mental development. Most adolescents successfully navigate the change in life from dependence on caregivers to become an independent member of the society. For some adolescents this is also a vulnerable period due to cognitive, emotional and attitudinal changes. Increased incidence of mental health problems may occur in the teenage years (Paus, Keshavan, & Giedd, 2008; Schonert-Reichl & Muller, 1996). Mental health and mood fluctuations may cause conflicts, but also be a part of the personality development in the adolescent.

WHO define mental health as: "a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life, can work productively and fruitfully, and is able to make a contribution to his or her community". In this positive sense, mental health is the foundation for well-being and effective functioning for an individual (World Health Organization, 2005, p. 23). Mental health problems for adolescents have been defined as the range of all diagnosable emotional, behavioral, and mental disorders including depression, attention- deficit/hyperactivity disorder, as well as anxiety, conduct, and eating disorders (U.S. Department of Health and Human Services, 1997).

## ***1.2 Prevalence of mental health problems among adolescents***

In Norway, the Institute of Public Health (2003) state that 15-20% of all children and adolescents may suffer from mental illness that influence their level of functioning. Among 15-16 years old adolescents, about 17 % suffer from mental illness, 25 % of the girls and 9% of the boys. The Oslo Health study (HUBRO) 2000-2001 revealed that 10 % of the boys and 26% of the girls had high enough symptom level to indicate the existence of symptoms of depression/anxiety (Grøtvedt & Gimmestad, 2002). The 2007 US National Survey on Drug Use and Health (NSDUH) present measures of mental health among 67.870 adolescents aged 12 years and older showing the prevalence to be considerably higher in 16 and 17-years old adolescents (11.8% and 11.1%) than in the 12-years old adolescents (2.8%) (Substance Abuse and Mental Health Services Administration, 2008). These findings are consistent with a

review by Wight, Sepulveda & Anehensel (2004) which showed that most depressive symptoms start at around 12 years of age, and peak between the ages of 15 and 17. A report from the Institute of Public Health (2009) states that from the age of 12- 14, anxiety and depression are the most common groups of mental diagnosis representing 10-15% and 3-8%. The report does also indicate the existence of a strong correlation between the diagnosis of depression and anxiety.

### **1.2.1 Gender differences**

Findings from population-based studies indicate that the prevalence of mental illness among adolescent females is higher than among adolescent males (Grøtvedt & Gimmetstad, 2002; Substance Abuse and Mental Health Services Administration, 2008; the Institute of Public Health, 2003). Wichstrøm (1999) conducted a study in Norway in which 12000 adolescents between 12 and 20 years attended. Results from this study showed that the gender differences emerged between 13 and 14 years of age. Results from the NSDUH survey showed a prevalence of major depression episodes in adolescents aged 12-17 years that was more than twice as high among girls than among boys (Substance Abuse and Mental Health Services Administration, 2008).

### ***1.3 Body composition and mental health***

Several studies have investigated the connection between body composition and mental health in adolescents (Cortese, et al., 2009; J. Daniels, 2005; Erermis, et al., 2004; Ozmen, et al., 2007; Wardle, Brodersen, Cole, Jarvis, & Boniface, 2006). Cortese et al. (2009) claimed that the relationship between body size and depressive symptoms in young adolescents was curvilinear and moderated by sex. Heavier-than-average and underweight girls, as well as obese boys, had the highest depression scores. Erermis et al. (2004) showed a higher ratio of psychopathology (depression, behavioral problems, low-esteem) among obese adolescents than among non- obese adolescents. However, some studies did not confirm these results (J. Daniels, 2005; Ozmen, et al., 2007).

#### ***1.4 Physical activity and mental health***

The prevalence of mental illness and depression increase during adolescence, especially among females (Substance Abuse and Mental Health Services Administration, 2008; Wight, et al., 2004). It is important with early health promotion to reduce the occurrence of mental problems. There is evidence supporting that living a physically active life is beneficial to one's mental health (Erikssen, et al., 1998). Some studies in adolescents have shown that physical activity has a favorable effect on mental problems like depression, anxiety and conduct problems (Calfas & Taylor, 1994; Larun, Nordheim, Ekeland, Hagen, & Heian, 2003; Motl, Birnbaum, Kubik, & Dishman, 2004; Mutrie & Parfitt, 1998; Steptoe & Butler, 1996).

A review of a total of 54 studies of adolescents aged 13-18 showed that the majority of these studies have found an inverse relation between depression and physical activity (Sallis, Prochaska, & Taylor, 2000) Another study completed by Steptoe & Butler (1996) concluded that participating in sport and vigorous recreational activity among adolescents were positively associated with emotional well-being. Larun, et al. (2003) conducted a Cochrane review on exercise in prevention and treatment of anxiety and depression among adolescents.

They concluded that among children and adolescents, exercise has only a minor effect in reducing depression and anxiety (Larun, et al., 2003). A longitudinal study conducted in Norway, found that weekly hours of physical activity at age 15-16 years may influence some aspects of mental health three years later in boys, but not in girls (Sagatun, Sjøgaard, Bjertness, Selmer, & Heyerdahl, 2007).

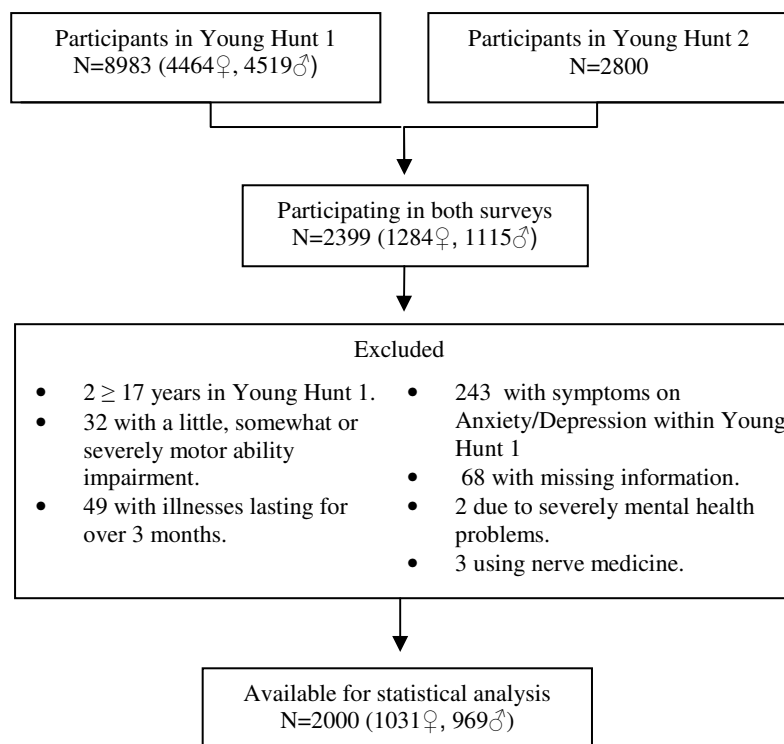
#### ***1.5 Objective***

The aim of this study was to prospectively examine associations of physical activity, sport participation, and body composition on the risk for symptoms of mental health problems in a large population-based sample of Norwegian adolescents. More specifically we studied the risk for symptoms of anxiety/depression classified from a five item version of Hopkins Symptom Check List (SCL-5), and in supplementary analyses we examined these factors in relation to risks of reporting low mood and low satisfaction with life.

## 2 Material and Methods

### 2.1 Subjects

The county of Nord-Trøndelag, in central Norway, has approximately 127 000 inhabitants. Nord-Trøndelag County is demographically comparable to Norway as a whole regarding geography, economy, industry, income, age distribution, morbidity, and mortality. In 1995-1997 all inhabitants older than 13 years old was invited to join a large population study, The Nord-Trøndelag Health Study (HUNT- II). Students in junior high schools (12-16 years old) and students in high schools (16-19 years old) were invited to attend in the adolescent part of the study, Young-HUNT 1. A total of 8983 adolescents agreed to participate, which comprised 90 % of the adolescent population in the county. In 2000-2001 a follow-up, Young-HUNT 2 found place. Young-HUNT 2 included the youngest participants from Young-HUNT 1, when they were in the last 2 years of high school. Totally 2800 adolescents (81 %) took part in the study. In all, it was 2399 adolescents that participated in both surveys. As shown in Figure 1, 399 of these were excluded, leaving 2000 adolescent for statistical analysis.



**Figure 1.** Flowchart showing the selection of participants of the current study



## **2.2 Study variables**

In both surveys the adolescents completed a self administered questionnaire in school hours. The adolescents did also participate in a clinical examination, including measurements of height, weight, and waist/hip circumference. The main outcome variable in the completed study was mental health problems.

### **2.2.1 Mental Health**

Symptoms of depression and anxiety were measured with Hopkins Symptom Check List-5 (SCL-5) (Appendix I). SCL-5 is a five-item scale version based on Hopkins Symptoms Check List 25 (SCL-25). Previous studies have proven the short version SCL-5 reliable. (Strand, Dalgard, Tambs, & Rognerud, 2003; Tambs & Moum, 1993). Answers were scored according to a scale ranging from “not at all bothered” (coded as 1) to “extremely bothered” (coded as 4). The mean score was calculated. To determine whether or not the adolescents were troubled with symptoms of anxiety and depression, a cut-off point was set at 2.0, as suggested in earlier studies. (Strand, et al., 2003).

Two questions measured general well-being (Appendix I). To answer these questions the participants should choose category from a 7-point scale ranging from very satisfied (coded as 1) to very dissatisfied (coded as 7) on the first question, and from very downhearted (coded as 1) to very cheerful (coded as 7) on the second question. From these responses we computed two new dichotomous outcome variables. Adolescents who responded 1-3 were classified as cheerful and satisfied with life, and those who responded 4-7 were classified as downhearted and dissatisfied with life.

### **2.2.2 Physical activity**

Information on leisure time physical activity was obtained from a questionnaire containing items on frequency, duration and intensity of training. The questionnaire has been used in previous studies (Holmen, Barrett-Connor, Clausen, Holmen, & Bjermer, 2002; Tollefsen, Bjermer, Langhammer, Johnsen, & Holmen, 2006) (Appendix I). The adolescents were also asked what kind of physical activity they were participating. The answers on the amount of physical activity (days and hours) were divided in 4 groups (e.g., answers from the questions of “days of physical activity” was divided in: "exercising 4 days a week or more", "exercising

2 to 3 days a week", "exercising 1 day a week, and "exercising less than 1 day a week"). Participation in different kind of sports was divided in 5 groups; "endurance", "strength", "esthetics", "ball-sports", and "other sports". In addition one single item question was included in the analyses; "Are you actively involved in sports". The question had three possible answers: "Yes, No, and No but I was before".

### **2.2.3 Body composition**

Anthropometry was measured with the participants wearing light clothes and no shoes. Height and waist and hip circumference were read to the nearest centimeter (cm), and weight to the nearest half kilogram (kg). To define BMI we used the International Obesity Task Force classification described by Cole et al (2000). It includes percentile cut-off points for each sex and age (by half year) category to define overweight and/or obesity among children and adolescents. We also used waist circumference and waist-hip ratio to define the body composition of the adolescents. Validation studies have shown high correlation between waist circumference and trunk fat measured by DEXA- scan, measuring both fat and lean body-mass, among 3–19 years old children and adolescents (S. R. Daniels, Khoury, & Morrison, 2000; Goran, Gower, Treuth, & Nagy, 1998). The cut-offs for the waist circumference were divided into five equal groups (fifths) based on percentiles; people in the lowest and highest fifth were respectively defined as low and high, whereas the three middle fifths were collapsed into a medium category. The same procedure was completed for the waist-hip ratio. In addition to the clinical measurements of anthropometry, a question about how the adolescents consider their body size was included in the analyses. Alternative answers were "very fat/chubby, about the same as others and thin/very thin".

### **2.3 Statistical analyses**

Descriptive statistics include numbers (and percents) of various factors according to the presence or absence of anxiety/depression symptoms (i.e. a SCL-5 scores  $\geq 2$ ).

To estimate the relative risk (RR) of anxiety/depression symptoms (SCL-5  $\geq 2$ ) associated with the various measures of physical activity and sports participation, with anthropometric measures, and with self-image of body size we used a log-binomial model, with a log link function. In similar analyses we estimated the RR for feeling downhearted and being dissatisfied with life. Precision of the estimated associations was assessed by a 95% confidence interval.

All analyses were conducted separately for boys and girls, and all results were adjusted for age. In additional analyses we also adjusted for school bullying (never, sometimes/very often, and unknown) and for pubertal development (early, on-time, late, and unknown). Regarding pubertal development, the adolescents rated themselves according to growth spurt and pubic hair growth. Girls were asked about age at menarche and breast development, while boys were asked to assess changes in voice and facial hair growth. The adolescents were asked to report the extent of pubertal changes on a scale ranging from 1 (have not begun) to 4 (development completed). Menarche was dichotomized into yes (coded 4) and no (coded 1). The score for the four items was summarized into a total pubertal development score (PDS-score) and divided by 4. The adolescents with PDS-scores in the lowest fifth, according to age and gender, were classified as “late”, while those within the highest fifth as “early”. Participants between the 20<sup>th</sup> and 80<sup>th</sup> percentile were classified as “on time”. This procedure was adopted from Bratberg et al, (2007). Moreover, in the analyses of physical activity we also adjusted for BMI (normal weight, underweight, overweight, and unknown). In the analyses for body composition we adjusted for days of physical activity per week (4-7 days, 2-3 days, 1 day and less than 1 day of physical activity per week).

When relevant, trend tests across categories of physical activity and BMI were calculated by treating the categories as an ordinal variable in the regression model.

All statistical tests were two-sided, and all statistical analyses were completed using SPSS for Windows, version 15.0 (SPSS Inc. Headquarters, 233 S. Wacker Drive, 11th floor, Chicago, Illinois 60606, USA).

## ***2.4 Ethics***

All participants gave their written consent to take part in the study. For students under 16, parents also gave their written consent. The study was approved by the Regional Medicine Ethical Committee and the Norwegian Data Inspectorate. HUNT Research Center gave permission to analyze the data from Young-HUNT 1 and Young-HUNT 2. Nord-Trøndelag Health Study (The HUNT Study) is a collaboration between HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology NTNU), Nord-Trøndelag County Council and The Norwegian Institute of Public Health.

## **3 Results**

### ***3.1 Descriptive Statistics***

Descriptive characteristics of the study population are presented in Table 1. Since all adolescents did not respond to all questions, the total number of respondents for each variable may vary. Based on information of SCL-5 scores for 1009 girls and 950 boys, we found that 229 girls (22.7 %) and 105 boys (11.1 %) could be classified as having symptoms of anxiety/depression. Moreover, information on general well-being classified 131 (12.7 %) girls and 68 (7.0 %) boys as dissatisfied with life, and 120 (11.6 %) girls and 103 (10.6 %) boys as downhearted.

**Table 1.** Characteristics of the study population

General factors and physical activity		Girls			Boys		
		N	Symptoms of Depression/Anxiety		N	Symptoms of Depression/Anxiety	
			Yes (N)	%		Yes(N)	%
<b>Age:</b>	<=13	365	91	24.9	367	43	11.7
	14	372	92	24.7	342	37	10.8
	>=15	272	46	16.9	272	25	9.19
	Total	1009	229	22.7	950	105	11.1
<b>BMI<sup>1</sup>:</b>	Underweight	62	13	20.6	44	7	15.9
	Normal weight	777	162	20.8	739	83	11.2
	Overweight	129	35	27.1	76	8	10.5
	Obese	20	6	30.0	66	6	9.1
<b>Waist circumference<sup>2</sup>:</b>	Low	168	34	20.2	161	23	14.3
	Medium	604	129	21.4	563	60	10.7
	High	206	49	23.8	197	21	10.7
<b>Waist-hip ratio<sup>2</sup>:</b>	Low	193	39	20.2	115	16	13.9
	Medium	588	126	21.4	437	33	7.6
	High	197	47	23.9	365	33	9.0
<b>Active in sports:</b>	Yes	668	142	21.3	653	69	10.6
	No, but I was before	230	59	25.7	201	22	10.9
	No	109	27	24.8	94	14	14.9
<b>Days of PA:</b>	4-7 days a week	247	57	23.1	346	30	8.7
	2-3 days a week	489	106	21.7	409	49	12.0
	1 day a week	132	31	23.5	108	12	11.1
	less than 1 day a week	137	34	24.8	81	14	17.3
<b>Hours of PA:</b>	7 or more hours	73	14	19.2	162	15	9.3
	4-6 hours	292	65	22.3	293	29	9.9
	1-3 hours	357	78	21.8	269	32	11.9
	Less than 1 hour	279	70	25.1	219	28	12.8
<b>Sport activities:</b>	No sports	101	25	24.8	91	14	15.4
	Endurance	159	36	22.6	226	23	10.2
	Strength	10	5	50.0	49	4	8.2
	Ball	423	88	20.8	425	45	10.6
	Esthetics	253	61	24.1	64	5	7.8
	Others	40	8	20.0	45	4	8.9
<b>Divorced parents:</b>	Yes	178	64	36.0	149	22	14.8
	No	813	161	19.8	767	79	10.3
<b>School bullying:</b>	Yes	81	21	25.9	163	28	17.2
	No	916	202	22.1	773	75	9.7
<b>PDS score:</b>	Low	162	30	18.5	131	8	6.1
	Medium	478	106	22.2	382	47	12.3
	High	308	74	24.0	245	27	10.6

Abbreviations: BMI = body mass index, PA = physical activity, PDS = pubertal development score

<sup>1</sup> Defined by International Obesity Task Force classification described by Cole et al (2000)

<sup>2</sup> Waist circumference, and waist-hip ratio classified according to age, - and gender specific cut-offs

### ***3.2 Physical activity and anxiety/depression risk***

The association between participating in physical activity and the risk for symptoms of anxiety/depression is shown in Table 2. Relative risks are presented both age- and multivariably adjusted. For the variables that deal with amount of physical activity, adolescents who reported 4 days or more a week, and adolescents who reported 7 hours or more a week, constitute the reference group.

Table 2 shows that there was little effect of exercise (days and hours per week) on the risk for symptoms of anxiety/depression among girls (P-trend = 0.34 and 0.16, respectively), whereas among boys we found that days of physical activity per week showed an inverse association with the risk for symptoms of anxiety/depression (P-trend = 0.02). Although not statistically significant, boys who were active one day or two to three days had a somewhat higher risk for symptoms of anxiety/depression than the reference group (adjusted RRs = 1.37; 95% CI= 0.89 – 2.11 and 1.34; 95% CI = 0.71 – 2.51, respectively). Furthermore, boys who reported to be physical active less than one day a week had twice the risk for symptoms of anxiety/depression compared to those who reported to be physically active four days or more per week (adjusted RR= 2.06; 95% CI= 1.15 – 3.70).

There was no evidence of a linear association with hours of weekly physical activity and risk for symptoms of anxiety/depression neither for girls nor boys (P-trend = 0.24). However girls and boys who reported to be active less than one hour per week had a slightly increased risk for anxiety/depression-symptoms, with an adjusted RR of 1.37 (95% CI = 0.83 – 2.23) among girls, and an adjusted RR of 1.34 (95% CI= 0.74 – 2.44) among boys.

For both genders the RR was higher for those who reported that they were not active in sports compared to those who were active (adjusted RR = 1.24; 95% CI= 0.86 – 1.79 for girls and RR = 1.43; 95% CI= 0.84 – 2.44 among boys). Moreover, girls who reported no present, but former activity had an adjusted RR of 1.31 (95% CI = 1.03 – 1.66) compared to active girls, whereas a similar comparison among boys gave an adjusted RR of 1.01 (95% CI= 0.84 – 2.44).

The results also show that adolescents who participated in different kind of sports mainly have lower risks (RR < 1.0) compared with the reference group of no activity, but small numbers of adolescents in the different sport categories make the estimated risks unstable.

**Table 2.** Relative risks for symptoms of Anxiety/Depression (SCL-5  $\geq 2$ ) associated with physical activity among 2000 Norwegian adolescents

Variable name	Girls					Boys						
	No. persons	No. cases	RR (age-adjusted)	RR (Multi adjusted) <sup>1</sup>	95 % CI	P-trend <sup>2</sup>	No. persons	No. cases	RR (age-adjusted)	RR (Multi adjusted) <sup>1</sup>	95 % CI	P-trend <sup>2</sup>
<b>Physical activity: days per week</b>												
$\geq 4$ days	247	57	1.00	1.00	Reference		346	30	1.00	1.00	Reference	
2-3 days	489	106	0.92	1.01	0.78 – 1.32		409	49	1.38	1.37	0.89 – 2.11	
1 day	132	31	1.02	1.08	0.74 – 1.57		108	12	1.28	1.34	0.71 – 2.51	
< 1 day	137	34	1.08	1.20	0.84 – 1.70	0.34	81	14	1.99	2.06	1.15 – 3.70	0.02
<b>Physical activity: Hours per week</b>												
$\geq 7$ hours	73	14	1.00	1.00	Reference		162	15	1.00	1.00	Reference	
4-6 hours	292	65	1.14	1.15	0.84 – 2.25		293	29	1.06	1.07	0.59 – 1.94	
2-3 hours	357	78	1.08	1.11	0.68 – 1.81		269	32	1.26	1.28	0.71 – 2.28	
$\leq 1$ hour	279	70	1.28	1.37	0.83 – 2.23	0.16	219	28	1.39	1.34	0.74 – 2.44	0.24
<b>Active in sports?</b>												
Yes	668	142	1.00	1.00	Reference		653	69	1.00	1.00	Reference	
No, but I was before	230	59	1.26	1.31	1.03 – 1.66		201	22	1.06	1.01	0.64 – 1.60	
No	109	27	1.19	1.24	0.86 – 1.79	-----	94	14	1.44	1.43	0.84 – 2.44	-----
<b>Sport activities?</b>												
No activity	101	25	1.00	1.00	Reference		91	14	1.00	1.00	Reference	
Endurance	159	36	0.91	0.88	0.56 – 1.37		226	23	0.64	0.64	0.35 – 1.18	
Strength	10	5	1.96	1.96	0.95 – 4.04		49	4	0.53	0.58	0.21 – 1.63	
Ball	423	88	0.82	0.79	0.53 – 1.17		425	45	0.67	0.66	0.38 – 1.16	
Esthetics	253	61	0.96	0.95	0.64 – 1.42		64	5	0.50	0.53	0.20 – 1.39	
Others	40	8	0.77	0.81	0.40 – 1.67	-----	45	4	0.57	0.62	0.22 – 1.78	-----

Abbreviations: *RR* = relative risk, *CI* = confidence interval

<sup>1</sup>Adjusted for age, school bullying, pubertal development, and body mass index

<sup>2</sup>P-value from trend test when categories were entered as an ordinal variable in the regression model



### ***3.3 Body composition and anxiety/depression risk***

The association between different measures on body composition and the risk for symptoms of anxiety/depression is presented in Table 3. Both age- and multivariably adjusted risks are presented.

Girls who were classified as being overweight had a slightly higher risk for symptoms of anxiety/depression (adjusted RR= 1.19; 95% CI= 0.88- 1.62) than the reference group of normal weight girls, whereas the risk among underweight girls were largely similar to the reference group (adjusted RR= 1.04; 95% CI= 0.62 – 1.75). Boys, on the other hand, who were classified as overweight, represented a lower risk (adjusted RR= 0.75; 95% CI= 0.44 – 1.29) compared to the reference group, while being classified as underweight contributed to a considerable increase of the risk (adjusted RR= 1.59; 95% CI= 0.80 – 3.15).

There was no association between waist circumference/waist-hip ratio and the risk for developing anxiety/depression-symptoms among the adolescent girls. The RR varied between 0.94 and 1.05. Among boys, Table 3 shows that having a low waist circumference, or low waist-hip ratio, increase the risk for symptoms of anxiety/depression (adjusted RRs were 1.45; 95% CI= 0.93 – 2.26 and 1.15; 95% CI= 0.69 – 1.93, respectively). Having a high waist circumference and waist-hip ratio decrease the risk compared to the reference group (adjusted RR= 0.86; 95% CI= 0.54 – 1.38 for boys with high waist circumference and adjusted RR= 0.72; 95% CI= 0.47 – 1.08 for boys with high waist-hip ratio).

Table 3 shows the risk for symptoms of anxiety/depression in relation to self-image of body size. Girls who considered themselves “very fat/chubby” or “thin/very thin” had a higher risk than those who considered themselves as “about the same as others” (adjusted RRs were 1.38; 95% CI= 1.04 – 1.67 and 1.71; 95% CI= 0.80 – 1.40, respectively). In boys, the risk was highest for those who considered themselves as “thin/very thin” (adjusted RR= 1.73; 95% CI= 1.11 – 2.67), whereas those who considered themselves as “very fat/chubby” had nearly the same risk as the reference group (adjusted RR= 1.06; 95 % CI= 0.65 – 1.72).

**Table 3.** Relative risks for symptoms of Anxiety/Depression (SCL-5  $\geq 2$ ) associated with body composition among 2000 Norwegian adolescents

Variable name	Girls					Boys						
	No. persons	No. cases	RR (age-adjusted)	RR (Multi adjusted) <sup>1</sup>	95 % CI	P-trend <sup>2</sup>	No. persons	No. cases	RR (age-adjusted)	RR (Multi adjusted) <sup>1</sup>	95 % CI	P-trend <sup>2</sup>
<b>BMI<sup>3</sup></b>												
Underweight	162	13	1.00	1.04	0.62 – 1.75		44	7	1.41	1.59	0.80 – 3.15	
Normalweight	777	162	1.00	1.00	Reference		739	83	1.00	1.00	Reference	
Overweight	615	31	1.29	1.19	0.88 – 1.62	0.31	142	14	0.87	0.75	0.44 – 1.29	0.10
<b>Waist circumference<sup>4</sup></b>												
Low	168	34	0.95	0.99	0.70 – 1.39		161	23	1.34	1.45	0.93 – 2.26	
Medium	604	129	1.00	1.00	Reference		563	60	1.00	1.00	Reference	
High	206	49	1.11	1.05	0.78 – 1.41	0.68	197	21	1.00	0.86	0.54 – 1.38	0.07
<b>Waist-hip ratio<sup>4</sup></b>												
Low	193	39	0.95	0.94	0.68 – 1.29		115	16	1.15	1.15	0.69 – 1.93	
Medium	588	126	1	1.00	Reference		437	53	1.00	1.00	Reference	
High	197	47	1.10	1.05	0.78 – 1.42	0.56	365	33	0.75	0.72	0.47 – 1.08	0.06
<b>How do you consider yourself?</b>												
Very fat/chubby	282	78	1.34	1.38	1.04 – 1.67		168	20	1.25	1.06	0.65 – 1.72	
About the same as others	590	119	1.00	1.00	Reference		604	57	1.00	1.00	Reference	
Thin/very thin	122	27	1.15	1.71	0.80 – 1.40	-----	158	24	1.62	1.73	1.11 – 2.67	-----

Abbreviations: RR = relative risk, CI = confidence interval

<sup>1</sup>Adjusted for age, school bullying, pubertal development, and days of physical activity (11 participants excluded due to missing data)

<sup>2</sup>P-value from trend test when categories were entered as an ordinal variable in the regression model

<sup>3</sup>Defined by International Obesity Task Force classification described by Cole et al (2000)

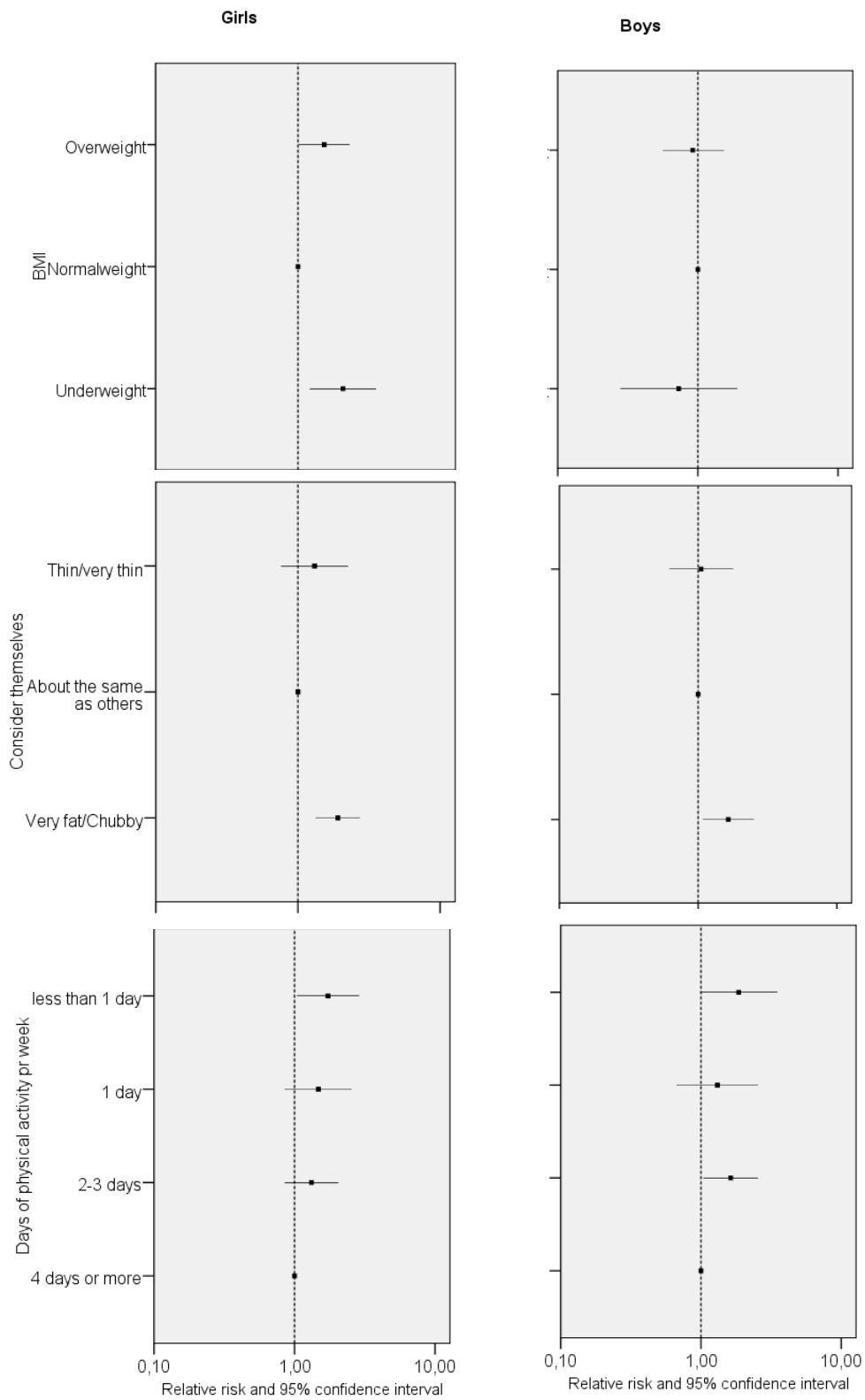
<sup>4</sup>Waist circumference, and waist-hip ratio classified according to age, - and gender specific cut-offs

### ***3.4 Body mass index, self-image of body composition, and physical activity related to risks of reporting downheartedness and dissatisfaction with life.***

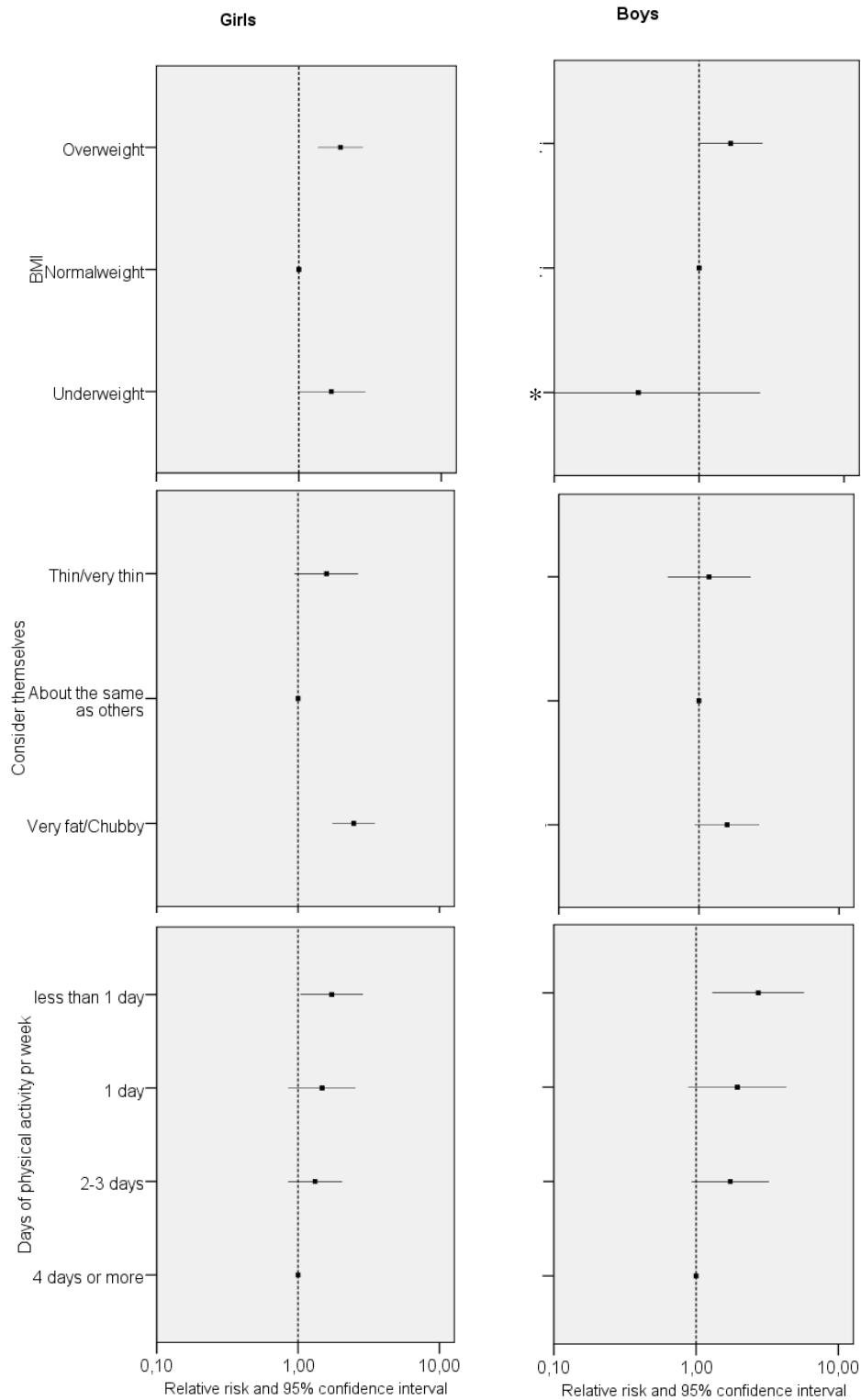
We also examined body mass index, self-image of body composition, and physical activity in relation to two measures of general well-being, i.e. feeling downhearted (Figure 2) and feeling dissatisfied with life (Figure 3).

Figure 2 shows that the risk of being downhearted were higher for both underweight and overweight girls, compared to normal weighted girls (adjusted RR= 2.07; 95% CI= 1.21 – 3.53 and 1.53; 95% CI= 1.01 – 1.31, respectively), whereas among boys there were no clear associations. Analysis of self-image of body composition showed that boys and girls who considered themselves as “very fat/chubby” had a substantial higher risk of feeling downhearted than the reference group (adjusted RR = 1.91; 95% CI= 1.33 – 2.73 among boys and 1.65; 95% CI= 1.08 – 2.52 among girls). We found an inverse association between days of physical activity and risk of reporting low mood both among girls and boys. Being physical active less than one day per week represent a RR of 2.28 (95% CI = 1.24 – 4.16) among girls and 1.86 (95% CI= 0.99 – 3.51) among boys.

The relative risks associated with reporting dissatisfaction with life (Figure 3) followed a largely similar pattern as those associated with feeling downhearted. The relative risk was higher among underweight and overweight girls (adjusted RR= 1.69; 95% CI= 0.98 – 2.93 and 1.36 – 2.82; 95% CI= 1.36 – 2.82, respectively), compared to those who were normal weight. Furthermore, boys who were classified as overweight had a somewhat higher risk than normal weighted boys (adjusted RR = 1.65; 95% CI= 0.99 – 2.74). Girls and boys who considered themselves “very fat/chubby” had an adjusted RR of 2.48 (95% CI= 1.75 – 3.50) and 1.59 (95% CI= 0.93 – 2.69), respectively, whereas girls who considered themselves “thin/very thin” had an adjusted RR of 1.59 (95% CI= 0.94 – 2.66). Figure 3 also shows that the risk of reporting dissatisfactions with life was inversely associated with days of physical activity per week, both among girls and boys.



**Figure 2.** Relative risks of reporting low mood at follow up in relation to body mass index, self-image of body composition, and physical activity. Adjusted for age, school bullying, and, pubertal development. Also adjusted for BMI in the analyses of physical activity and for days of physical activity in the analyses for body composition.



**Figure 3.** Relative risks of reporting dissatisfaction with life at follow up in relation to body mass index, self-image of body composition, and physical activity. Adjusted for age, school bullying, and pubertal development. Also adjusted for BMI in the analyses of physical activity and for days of physical activity in the analyses for body composition. \*Lowest confidence limit was set to 0.1 to make the axes comparable (original value 0.05).

## 4 Discussion

### 4.1 Main findings

After follow-up, the symptoms of anxiety/depression were twice as high among girls as among boys. Among boys, days of physical activity per week showed an inverse association with the risk for symptoms of anxiety/depression. Among girls, there was no statistical association. The risk for symptoms of anxiety/depression was higher for girls and boys who reported they were not active in sports, compared to those who were active, but the results were not statistically significant. Days of physical activity did also associate inversely with the risk of reporting downheartedness and dissatisfaction with life for both genders. Even if not statistically significant, the results for body composition showed that boys with a low waist circumference or low waist-hip ratio, had an increased risk for symptoms of anxiety/depression compared to the reference group with middle values. Girls who considered themselves as “very fat/chubby” and boys who considered themselves “thin/very thin” had a significantly higher risk for symptoms of anxiety/depression compared to the reference group who considered themselves as “about the same as others”.

Self-image of body size did also influence the risk for reporting downheartedness and dissatisfaction with life. Boys and girls who considered themselves as “very fat/chubby” had a considerable higher risk, both for feeling downhearted and for feeling dissatisfied with life. Additionally, girls who considered themselves “thin/very thin” also had a higher risk of reporting dissatisfaction with life.

Additionally were the risks of feeling downhearted and dissatisfied with life higher for both underweight and overweight girls, compared to normal weighted girls. Boys classified as overweight, did also represent a somewhat higher risk (though not statistically significant) to report dissatisfaction with life compared to normal weighted boys.

## ***4.2 Comparison with existing literature***

### **4.2.1 Existence of symptoms of anxiety/depression**

The higher occurrence of symptoms of anxiety/depression among girls (22.7 %) compared to boys (11.1%) in this study, is consistent with findings of other studies (Grøtvedt & Gimmetstad, 2002; Substance Abuse and Mental Health Services Administration, 2008; Wichstrøm, 1999). One of the reasons that can explain a higher occurrence of symptoms of depression/anxiety in adolescent girls is that they may be more socially oriented than boys. A positive social relationship may be more important for girls than boys. In addition, girls are more vulnerable to losses of social relationships than boys are (Allgood-Merten, Lewinsohn, & Hops, 1990). Therefore, the inter-human stress that is common in adolescence may increase girls' vulnerability. Another reason might be that girls use different methods to cope with stress than boys do. It has been claimed that girls methods for handling stress may lead to less denial, and more repetitive thinking, with greater focus on the event involved (Nolen-Hoeksema & Girgus, 1994). Our results showed that among adolescents with divorced parents, 36% of girls, and 14,8% of boys were classified as having symptoms of anxiety/depression. This may support the theories suggested by Nolen-Hoeksema & Girgus.

The biological and hormonal changes occurring during puberty may also be important for the large increase in rates of symptoms of depression among adolescent girls (Hankin & Abramson, 2001). Some studies suggest that girls experiencing early menarche and early pubertal development have an increased risk for symptoms of depression in adolescence (Kaltiala-Heino, Marttunen, Rantanen, & Rimpelä, 2003). A study done by Calvete and Cardenso (2005) showed that girls had more doubts about themselves and their abilities to solve problems, than boys. Within this context, depressive symptoms were more common among girls. It seems that girls need a higher degree of approval and success to feel confident than boys do.

#### **4.2.2 Physical activity and mental health**

In accordance to our results an American longitudinal study with over 4500 adolescents found that increased physical activity was significantly associated with fewer depressive symptoms over a 2-year period (Motl, et al., 2004). The inverse relationship between physical activity and depressive symptoms was independent of possible confounding factors, including social economic status, gender and alcohol consumption. Sallis, Prochaska & Taylor (2000) reviewed a total of 54 studies of potential correlates for physical activity among adolescents aged 13–18. The majority of these studies indicated that there was an inverse relationship between depression and physical activity.

A Norwegian longitudinal study found somewhat similar results as the findings of our study (Sagatun, et al., 2007). The findings indicated that physical activity at age 15–16 years may influence some aspects of mental health three years later in boys, but not in girls. Another study did also support our results (Brosnahan, Steffen, Lytle, Patterson, & Boostrom, 2004). They found that attendance in physical education class was inversely related to feelings of sadness. However, participation in physical education (PE) classes in high school in US is often optional, and may be influenced by factors such as motivation and familial socioeconomic status. However the present study did not include information of physical activity during school hours, and the results may thus not be directly comparable.

There can be different reasons why physical activity and exercise may influence mood in a positive way. Participating in exercise may lead to less negative thoughts. The feeling one gets when managing a skill may also be important (Lepore, 1997). The social contact following participation in physical activity may also have a positive effect on mood. In addition, physical activity may have physiological effects. Changes in endorphin and monoamine levels or reduction in the levels of the stress hormone cortisol are all physiological effects resulting from exercise - that may improve mood (Duclos, Gouarne, & Bonnemaïson, 2003). Some recent studies have also found that exercise stimulates the growth of new nerve cells and release proteins known to improve health and survival of nerve cells (Calfas & Taylor, 1994; Ernst, et al., 2006; Mutrie & Parfitt, 1998).



### **4.2.3 Body composition**

Adolescence is a vulnerable period including development and maturation to adulthood. Biological, psychological and social aspects all interact with each other. Adolescents may often be concerned with their body size. Common concerns include being above or below acceptable height or weight (Erermis, et al., 2004). Obese adolescents may be exposed for social rejection, discrimination and negative stereotyping. It is hypothesized that such experiences may lead to negative feelings, in terms of self-image, self-esteem and mood (Wardle & Cooke, 2005). Previous studies has focused on the relationship between body size and mental health problems among adolescents (Cortese, et al., 2009; Erermis, et al., 2004; Vila, et al., 2004; Wardle & Cooke, 2005).

Wardle and Cooke (2005) reviewed the most recent studies in this area. They concluded that even if levels of body dissatisfaction were higher in community samples of overweight and obese adolescents than in their normal counterparts, few were significantly depressed or had low self-esteem. Results from a recent study completed by Cortese, et al (2009) claimed that the relationship between body size and depressive symptoms in young adolescents is curvilinear and is moderated by sex. Heavier-than-average and underweight girls, as well as obese boys, had the highest depression scores.

Our findings interpret that overweight girls and underweight boys represent a higher risk (though not statistical significant) for symptoms of anxiety/depression compared to normal weighted adolescents. The association between self-image of body size and risk for symptoms of anxiety/depression show considerable noteworthy results. The risk was statistical significantly higher for girls who considered themselves very fat/chubby and thin/very thin compared to girls who considered themselves about the same as others. Among boys, those who considered themselves as underweight represented the highest risk.

A question of interest will then be whether it is the actual body size or the self-image of body size that may correlate with the adolescents' psychological well-being. Daniels' (2005) study underscored the importance of addressing adolescents perception of weight in relation to their actual body mass index and psychological well-being. This study found somewhat similar result as our study, which was no relationship between depressive symptoms and body mass index. However, perception of weight as either underweight or overweight was related to depressive symptoms.

### ***4.3 Strengths and limitations***

The most obvious strength of the present study is the longitudinal study design, studying the association between body composition, physical activity and mental health problems among adolescents. The fact that adolescents with known mental health problems at study start were excluded from the analyses, must be considered as an advantage with this study design. Additionally it is a strength that this study design makes it possible to adjust for possible confounding factors. However, biased estimates due to confounding by unmeasured and unknown factors cannot be excluded in this type of study.

Something that may have influenced our results is that mental health problems such as anxiety/depression are mental health problems that might come and go. We only have access to the adolescents' mental health conditions based on the Young-HUNT questionnaires. We can't tell whether the adolescents have been troubled with their mental health before or in between the studies.

This study was accomplished in the general adolescent population, with a rather high participation rate. In spite of the rather high participation rate, about 20% did not take part in Young-HUNT 2. This health study was organized through the local school system. A result of this was that they were not able to invite all target subjects to participate in Young HUNT 2. The adolescents dropping out of school or changing school are not included in this study. If it had been possible to include those who dropped out of school, it may have altered the results. However, the direction and the magnitude of such an effect are difficult to predict.

Self-report was used to gather information of physical activity and mental health status among the adolescents. Measuring physical activity using self-report may affect the studies reliability and validity (Shephard, 2003). The results are dependent on the subject's ability to recall or report physical activity. Response-set bias can occur if a person reports activity levels that match the goal of the intervention rather than actual behavior (Ainsworth, Richardson, Jacobs, Leon, & Sternfeld, 1999). Self-report measures of physical activity may overestimate levels of physical activity compared to directly measurements. (Shephard, 2003). After all, using self-report questionnaire in assessment of physical activity is the most practical and easiest way to collect a broad range of data from a large number of adolescents (Kohl, Fulton, & Caspersen, 2000). However, validation studies have shown that questionnaires may be useful in classifying

people into broad categories of physical activity (Shepard, 2003), such as those that are used in the present study. Two studies have found that the reliability and validity of the physical activity questions used in the present study was acceptable. (Booth, Okely, Chey, & Bauman, 2001; Rangul, Holmen, Kurtze, Cuypers, & Midthjell, 2008)

Symptoms of anxiety/depression were measured using SCL-5, and previous studies have shown that a classification based on these questions is quite reliable (Strand, et al., 2003; Tambs & Moum, 1993). However, misclassification of anxiety/depression symptoms cannot be ruled out. We used only two single questions to say something about general well-being among the adolescents. The results may give a picture of some aspects of the adolescents' general well being, but we might not catch the whole truth.

#### ***4.4 Conclusions***

The results showed gender differences according to factors affecting the risk for symptoms of anxiety/depression. The findings indicated that days of physical activity per week may influence some aspects of mental health in boys, but not in girls. Considering the associations between self-image of body size and risk for symptoms of anxiety/depression, gender differences also were present. Additional, self-image of body size was stronger related to symptoms of anxiety/depression compared with objective measures. Our study confirms the need to perform further gender-specific studies that may contribute to the understanding of associations between physical activity, body composition, and mental health problems among adolescents.

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## Appendix I

Questions used in the present study to collect information on leisure time physical activity, and mental health status among the adolescents. (You can find the original questionnaire used in the Young-HUNT studies at: <http://www.ntnu.no/hunt/english/data/que>).

### *Physical activity*

**Not during the average school day: How many days a week do you play sports or exercise to the point where you breathe heavily and/or sweat?**

- Everyday
- 4-6 days a week
- 2-3 days a week
- 1 day a week
- Not every week, but at least once every two weeks
- Not every 14th day, but at least once a month
- Less than once a month
- Never

**Not during the average school day: How many hours a week do you play sports or exercise to the point where you breathe heavily and/or sweat?**

- None
- About ½ hour
- About 1 hour
- About 2-3 hours
- About 4-6 hours
- 7 or more hours

**Are you actively involved in sports?**

- Yes
- No, but I was before
- No

**Which sport(s) do/did you participate in?**

(Put an X in one or more boxes)

- A** Skiing (cross country, biathlon)
- B** Skiing (downhill/slalom, ski jump)
- C** Football/soccer
- D** Horse riding
- E** Skating, ice hockey
- F** Handball, basketball, volleyball
- G** Martial arts, boxing
- H** Body building
- I** Cycling
- J** Weight lifting
- K** Track and field, orienteering
- L** Swimming
- M** Gymnastics



***SCL-5***

**Below is a list of some problems. Have you been bothered by any of these in the last 14 days?**

(Put an X in one box on each line)

<Not at all, A little, Quite a bit, Very>

Been constantly afraid and anxious

Felt tense or uneasy

Felt hopelessness when you think of the future

Felt dejected or sad

Worried too much about various things

***General well-being***

**Thinking about your life at the moment, would you say that you by and large are satisfied with life, or are you mostly dissatisfied? (Put an X in only one box)**

Very satisfied

Satisfied

Somewhat satisfied

Neither satisfied nor dissatisfied

Somewhat dissatisfied

Dissatisfied

Very dissatisfied

**Would you say you are usually cheerful or downhearted? (Put an X in only one box)**

Very downhearted

Downhearted

Somewhat downhearted

Some of both

Somewhat cheerful

Cheerful

Very cheerful