



ELSEVIER

 JOURNAL OF
 ADOLESCENT
 HEALTH

www.jahonline.org

Original article

Underestimation of Overweight and Health Beneficial Outcomes in Two Adolescent Cohorts in Norway – The HUNT Study

 Kirsti Kvaløy, D.Phil.^{a,b,c,*}, Eli Sandsgård-Hilmarsen, M.P.H.^a, Trine Tetlie Eik-Nes, Ph.D.^{d,e}, and Grete Helen Bratberg, dr.philos.^f
^aHUNT Research Centre, Department of Public Health and Nursing, Norwegian University of Science and Technology, Trondheim, Norway

^bCentre for Sami Health Research, Department of Community Medicine, UiT The Arctic University of Norway, Tromsø, Norway

^cLevanger Hospital, Nord-Trøndelag Hospital Trust, Levanger, Norway

^dDepartment of Neuromedicine and Movement Science, Norwegian University of Science and Technology, Trondheim, Norway

^eStjørdal Community Mental Health Centre, Nord-Trøndelag Hospital Trust, Stjørdal, Norway

^fFaculty of Nursing and Health Sciences, Nord University, Levanger, Norway

Article history: Received May 26, 2020; Accepted October 26, 2020

 Keywords: Overweight; Body size underestimation; Mental health; Life satisfaction; Adolescents; The HUNT Study

Purpose: Underestimating overweight may prevent efforts toward reducing weight, but simultaneously benefit mental health and well-being. The magnitude of underestimation of overweight and obesity in adolescents is largely unknown, and so is to what extent this underestimation is associated with dieting behaviors, mental distress, and life satisfaction. As overweight has become more common during the past decades, associations between body size underestimation and mental health may have changed.

Methods: Overweight (iso-body mass index, iso-BMI ≥ 25) adolescents (aged 13–19 years) who participated in The Young-HUNT1 (1995–97, $n = 1,338$) or The Young-HUNT3 (2006–08, $n = 1,833$) surveys were included. Being overweight, but perceiving oneself as average-weighted or underweighted was defined as underestimation. Results were based on clinical examinations and self-report questionnaires. Multivariable logistic regression models were used to examine associations between body size underestimation, dieting behaviors, and symptoms of anxiety, depression, and life satisfaction.

Results: Among adolescents with overweight and obesity (iso-BMI ≥ 25), the prevalence of obesity (iso-BMI ≥ 30), body size underestimation, and having symptoms of anxiety and depression had increased from the first survey to the next. At both time points, body size underestimation was more common among boys than girls. In 2006–08, body size underestimation was negatively associated with symptoms of anxiety and depression in both sexes, and overall associated with higher life satisfaction equally over time. Dieting behavior was negatively associated with underestimation of body size.

Conclusions: Body size underestimation in adolescents with overweight/obesity has become more prevalent and a phenomenon associated with less dieting, better life satisfaction and mental health in both boys and girls.

© 2020 Society for Adolescent Health and Medicine. Published by Elsevier Inc. This is an open access article under the CC BY license (<http://creativecommons.org/licenses/by/4.0/>).

IMPLICATIONS AND CONTRIBUTION

For promoting more healthy weight-reducing efforts among overweight/obese adolescents, the awareness of the consequences of body dissatisfaction on mental health and life satisfaction should be considered.

* Address correspondence to: Kirsti Kvaløy, D.Phil., HUNT Research Centre, Department of Public Health and Nursing, Norwegian University of Science and Technology (NTNU), Forskningsveien 2, 7600 Levanger, Norway.

E-mail address: kirsti.kvaloy@ntnu.no (K. Kvaløy).

Overweight and obesity in children and adolescents have increased over the past decades with a range of negative physical and mental health consequences [1]. Actual weight status (e.g. BMI-defined categories), however, may be of less importance for

health outcomes than the way individuals perceive their own weight and body size [2]. The mismatch between actual and perceived body size in an obesity preventive perspective is challenging since overweight individuals who underestimate their body size are considered less amenable to making healthy lifestyle changes to reduce weight [3]. Accordingly, body size underestimation has been associated with less exercise and dieting behaviors [4]. Independent of weight status, those who perceive themselves as overweight are more likely to report weight-reducing behaviors, but over time also to gain more weight than counterparts [5,6].

Body size underestimation has been shown to be prevalent in both sexes but more commonly reported in males than in females [7–9]. However, the sex ratio varies largely between countries, from 3.5 fold higher proportion of men than women in Madagascar (Sub-Saharan Africa) to 1.4 fold in India (South Asia) [8]. The tendency of boys, independent of their BMI status, to perceive themselves as normal weighted and also being satisfied with larger body sizes comply with the present muscular body image ideal in males [10–12]. Intriguingly, this muscular body idealization has also started emerging among females [13,14].

Findings from several studies suggest body size underestimation to be associated with less symptoms of mental distress also against future depression [15–17], suggesting a causal relationship. The possible health-protective consequences of body size underestimation seem to differ between males and females. In adult Koreans, underestimation in individuals with obesity was shown to be inversely associated with depression in women, but not in men [16], and body size underestimation in men in contrast to overestimation in women was associated with depression [18]. In the latter study, women who perceived themselves as overweight were more likely to report symptoms of depression independently of their actual weight, which is in agreement with previous studies [19,20].

The longstanding and dominating body ideal of thinness in modern societies may explain the high rates of body dissatisfaction and the overestimation of body size. The contemporary, but also contradicting tendency of young people to underestimate their own body size [21] is probably a consequence of both the general increase, but also the increasing acceptance of overweight and obesity that have led to an attitude shift of what is normal body size [21,22]. Deviating from same-aged peers in the surrounding community may be of greater relevance for weight perceptions than body ideals communicated through social media or other sources. Accordingly, a recent study showed that underestimation was more common in schools with higher mean BMI levels [23].

Body image and perceptions of own body size do matter since it may influence both health and wellbeing of young people. Interestingly, more recent studies have suggested that accurate body size perceptions are negatively associated with one's quality of life [17,24,25]. The same underlying mechanisms may explain mental health problems and distress, which is suggested to be related to weight stigma [12,26,27]. Linked to settings such as social relationships, schools, workplaces, and the health care system, individuals with overweight and obesity often encounter stigma and labeling [28], but as emphasized by Cash, the subjective experience of appearance is more psychosocially important than a social or objective assessment of appearance [2]. The diverse response to weight

stigma is better understood through awareness of weight bias internalization (WBI); the extent to which self-imposed weight-related stigma affects self-devaluation due to weight [29]. The degree of WBI is suggested to influence the ability to cope emotionally with overweight/obesity in general, and additionally, the motivation toward weight-reducing behaviors.

Even if obesity has become more common among overweight adolescents, it is unclear if associations between body size underestimation and mental health outcomes have changed over time. Considering the many adverse health consequences of overweight and obesity, but also the high prevalence of body dissatisfaction and unhealthy weight control behaviors, increased knowledge about factors that influence young people's barriers or readiness for lifestyle changes should be explored. Concerning this, more attention should also be paid as to what extent underestimation act as a mediator or moderator in the association between overweight/obesity and symptoms of mental distress and life dissatisfaction.

By the use of cross-sectional data from The Young-HUNT1 Survey (YH1, 1995–97) and The Young-HUNT3 Survey (YH3, 2006–08), which include boys and girls aged 13–19 from a general healthy Norwegian population, our main aim was to investigate if perceptions of ones' body size in adolescents with overweight and obesity is associated with mental health and life satisfaction; further, to explore if perceptions of own body size influence dieting behaviors in adolescents with overweight and obesity and whether this have changed over time along with the rise in overweight and obesity.

Material and Methods

Study population

The study participants originated from The Trøndelag Health Study (HUNT), including repeated cross-sectional surveys, 10–11 years apart, of the total general population in one county situated in the central part of Norway [30]. The present study includes data from the Young-HUNT1 (YH1) and Young-HUNT3 (YH3) surveys, based on self-reported questionnaires, clinical examinations in schools, including standardized height and weight measurements.

A total of 8,981 (response rate 88%) and 8,199 (response rate 78%) adolescents completed the questionnaire in YH1 and YH3, respectively. Of the YH1 participants that had data on weight, height, and self-reported perception of weight, 1,338 (659 boys and 679 girls) were classified as overweight and/or obese and hence included in this study. Likewise, a dataset of 1,833 overweight and/or obese YH3 participants (985 boys and 848 girls) were included (Figure of flow-chart, [Supplementary Figure 1](#)).

Anthropometric measurements

Trained nurses carried out standardized measurements of height and weight during data collection. Participants wore light clothing and no shoes. Weight was measured to the nearest half kilo and height to the nearest cm. Body mass index (BMI) was calculated as weight (kg)/height²(m²). BMI-based weight group characterizations considering age and sex were calculated as provided in guidelines from the International Obesity Task Force (IOTF), according to cut-off points by Cole [31]. BMI

measurements were also transformed into age-specific (yearly) and sex-specific z-scores that indicate the standard deviation of the BMI measure above (positive values) or below (negative values) the mean of the reference population (here Young-HUNT1 or Young-HUNT3). Age was defined as the nearest birthday, e.g., age 14 years included ≥ 13.5 and < 14.5 years of age.

Body size misperception and dieting

Body size misperception was defined as a self-reported body size that was inconsistent with the participant's actual BMI weight-category. The body size perception variable was constructed from the question "How do you perceive yourself (your body)?" by selecting one of the five following response options: "very overweight," "overweight," "about the right weight," "slightly underweight" and "very underweight." Overweight/obese individuals who self-categorized themselves as "average," "slightly underweight," or "very underweight" were defined as misperceiving their weight by underestimation.

Dieting or intention to lose weight was assessed by the following question: "Are you trying to lose weight?" with the answer options: (1) "No, I am comfortable with my weight," (2) "No, but I need to lose weight" or (3) "Yes."

Anxiety and depression

Symptoms of anxiety and depression were assessed by the five-item Hopkins Symptom Checklist (SCL-5). The SCL-5 has previously been developed and validated as a short version of the longer SCL-25 scale ($r = .92$) with sensitivity and specificity with the SCL-25 corresponding to .84 and .89, respectively [32,33]. In our dataset, the Cronbach's alphas were .78 and .84, Young-HUNT1 and Young-HUNT3, respectively. On a four-point Likert scale ranging from 1 "Not bothered" to 4 "Very much bothered," participants were asked whether they the past 14 days had any of the following symptoms; "Feeling nervousness or shakiness inside," "Feeling fearful," "Feeling hopeless about the future," "Worrying too much about things," "Feeling blue." An average item score of 2.0 or higher was used to identify anxiety or depression, following suggestions from Strand et al. [33]. In agreement with previous evaluations of the score [33], participants who had responded only to four of the five questions were also included with the same cut-off threshold as for responding to all five questions ($n = 40$ YH1, and $n = 21$ YH3).

Life satisfaction

Life satisfaction was assessed using a single item asking the respondents to indicate how satisfied they were with their life in general. The question: "thinking about your life at the moment, would you say that you by and large are satisfied with life or are you mostly dissatisfied?" had answer options on a 7-point scale ranging from 1 (very satisfied) to 7 (very dissatisfied). We reduced the 7-point scale to two points by combining the "neither satisfied nor dissatisfied/somewhat dissatisfied/dissatisfied/very dissatisfied" responses into one category and "quite satisfied/very satisfied/extremely satisfied" into another category. The life satisfaction question has been previously reviewed and considered to have adequate reliability and validity [34].

Statistics

Differences between the two study samples (cohorts) were tested by Pearson's Chi-square tests. Associations between body size underestimation and anxiety and depression or life satisfaction were carried out by logistic regressions adjusted for age and sex in the non-sex-stratified analyses and age in the sex-stratified analyses. BMI z-scores were additionally adjusted for to compensate for the weight range within the overweight/obese samples. For testing whether estimates of associations changed dependent on sex or survey, interaction terms were included. The results are shown in odds ratios (ORs) with 95% confidence intervals (CIs). Two-tailed p values $< .05$ were considered statistically significant. All statistical analyses were performed using IBM SPSS Statistics for Windows, Version 25.0 (IBM Corp, Armonk, NY, USA).

Institutional Review Board Statement

This study was approved by the Regional Committee for Medical Research Ethics (2017/592/REK) and the HUNT Data Access Committee. All research participants signed a written informed consent. In Norway, the legal age for providing consent is 16 years, and for participants younger than 16, consents were given by parents or legal guardians. The Norwegian Data Inspectorate and Directorate of Health approved The Young-HUNT Study. All procedures followed were in accordance with the ethical standards of the responsible committee and with the Helsinki Declaration of 1975, as revised in 2000.

Results

Descriptive statistics

Cross-sectional data from 1,338 adolescents with overweight/obesity from 1995–97 (YH1) and 1,833 from 2006–08 (YH3) aged 13–19 years (mean age 16 years both samples) were included in our study. Participants who were overweight or obese (IOTF-adjusted BMI) represented 15.9% (YH1) and 24.1% (YH3) of the source study populations, respectively. Among adolescents with overweight/obesity, obesity became more prevalent over time (boys: 17.3%–24.8%; girls: 16.8%–21.1%) (Table 1 and Figure 1). Symptoms of anxiety and depression increased in both girls (21.4%–32.0%, $p < .001$) and boys (10.0%–13.4%, $p < .001$). There was an increase in life dissatisfaction in girls ($p < .001$), but not in boys (Table 1). The proportions of individuals with overweight/obesity that underestimated their body size increased in both boys (from 31.2% to 44.2%, $p < .001$) and girls (17.1%–30.9%, $p < .001$) (Table 1 and Figure 1). It should be noted that the mean BMI z-scores were slightly lower in those who underestimated their body sizes than those who more accurately perceived themselves as overweight or very overweight in both sexes (Supplementary Figure 2 and Supplementary Table 1). Active dieting among adolescents increased from 1995–97 to 2006–08, while the intention to diet decreased in this time period (Table 1).

Association between underestimation of body size and dieting behaviors

At both time-points (1995–97 and 2006–08), the odds in adolescents with overweight/obesity who underestimated their

Table 1
Descriptive characterization of the study sample of individuals with overweight and obesity

	Boys			Girls		
	YH1	YH3	Total	YH1	YH3	Total
	(n = 659)	(n = 985)	(n = 1,644)	(n = 679)	(n = 848)	(n = 1,527)
	n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
Age (years)						
< 16	333 (50.5)	544 (55.2)	877 (53.3)	329 (48.5)	412 (48.6)	741 (48.5)
≥ 16	326 (49.5)	441 (44.8)	767 (46.7)	350 (51.5)	436 (51.4)	786 (51.5)
p value ^a			p = .061			p = .959
BMI class ^b						
Overweight	545 (82.7)	741 (75.2)	1,286 (78.2)	565 (83.2)	669 (78.9)	1,234 (80.8)
Obese	114 (17.3)	244 (24.8)	358 (21.8)	114 (16.8)	179 (21.1)	293 (19.2)
p value ^a			p < .001			p = .033
Body size estimation						
Average/thin	201 (31.2)	422 (44.2)	623 (39.0)	114 (17.1)	255 (30.9)	369 (24.7)
Fat/too fat	443 (68.8)	533 (55.8)	976 (61.0)	553 (82.9)	570 (69.1)	1,123 (75.3)
Missing	15	30	45	12	23	35
p value ^{a,*}			p < .001			p < .001
Dieting						
No	254 (39.4)	444 (46.5)	698 (43.7)	97 (14.7)	181 (22.2)	278 (18.9)
No, but I should	281 (43.6)	270 (28.3)	551 (34.5)	345 (52.4)	303 (37.2)	648 (44.0)
Yes	109 (16.9)	241 (25.2)	350 (21.9)	217 (32.9)	331 (40.6)	548 (37.2)
Missing	15	30	45	20	33	53
p value ^{a,*}			p < .001			p < .001
Anxiety/depression						
< 2.0	582 (90.0)	819 (86.6)	1,401 (87.9)	521 (78.6)	563 (68.0)	1,084 (72.7)
(SCL-5 mean score)						
≥ 2.0	65 (10.0)	127 (13.4)	192 (12.1)	142 (21.4)	265 (32.0)	407 (27.3)
Missing	12	39	51	16	20	36
p value ^{a,*}			p = .042			p < .001
Life satisfaction						
Satisfied	538 (81.9)	757 (79.1)	1,295 (80.2)	488 (72.3)	516 (62.1)	1,004 (66.7)
Not satisfied	119 (18.1)	200 (20.9)	319 (19.8)	187 (27.7)	315 (37.9)	502 (33.3)
Missing	2	28	30	4	17	21
p value ^{a,*}			p = .167			p < .001

^a Pearson Chi-Square, Asymptotic significance (2-sided) *Subgroups may not total to this number due to missing values.

^b BMI weight categories were defined according to the International Obesity Task Force (IOTF), according to cut-off points by Cole[31].

body size were lower concerning dieting behaviors compared to those with accurate body size perception (Table 2; Supplementary Table 2). Adjustment for zBMI to compensate for

the wide BMI-range in the samples did not change these associations. In girls, higher age positively affected these relationships.

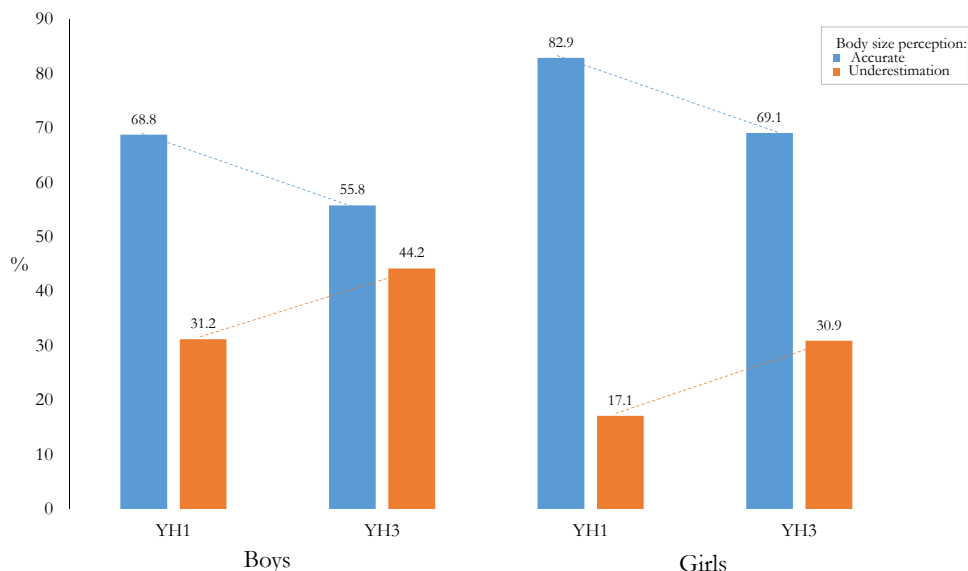


Figure 1. Distribution of body size perception groups (proportions in %) in the adolescent cohorts Young-HUNT1 (YH1, 1995–97) and Young-HUNT3 (YH3, 2006–08).

Table 2

Results from multivariable logistic regression models examining the sex-stratified associations between body size underestimation and dieting in overweight (iso-BMI ≥ 25) adolescents from Young-HUNT1 (1995–97) and Young-HUNT3 (2006–08)

Sex	Predictor: Dieting ^a	Young-HUNT1 (n = 1338)				Young-HUNT3 (n = 1833)			
		Model 1		Model 2		Model 1		Model 2	
		OR (95% CI)	p value	Or (95% CI)	p value	Or (95% CI)	p value	Or (95% CI)	p value
Boys	No, but I need to	.09 (.06–.14)	<.001	.11 (.07–.17)	<.001	.07 (.05–.11)	<.001	.10 (.07–.15)	<.001
	Age	1.03 (.93–1.14)	.633	1.04 (.94–1.16)	.438	1.10 (1.00–1.22)	.060	1.10 (1.00–1.22)	.073
	zBMI			1.50 (1.14–1.97)	.003			1.49 (1.25–1.78)	<.001
	Yes	.06 (.03–.12)	<.001	.08 (.04–.17)	<.001	.09 (.06–.13)	<.001	.10 (.07–.16)	<.001
Girls	No, but I need to	.06 (.04–.11)	<.001	.08 (.04–.14)	<.001	.07 (.04–.10)	<.001	.08 (.05–.13)	<.001
	Age	1.14 (.99–1.31)	.071	1.16 (1.01–1.34)	.034	1.24 (1.09–1.40)	.001	1.29 (1.13–1.46)	<.001
	zBMI			2.08 (1.29–3.36)	.003			1.83 (1.38–2.44)	<.001
	Yes	.04 (.02–.08)	<.001	.05 (.02–.10)	<.001	.09 (.06–.14)	<.001	.11 (.07–.18)	<.001
Girls	Age	1.26 (1.09–1.46)	.002	1.29 (1.11–1.50)	.001	1.23 (1.09–1.39)	.001	1.29 (1.14–1.45)	<.001
	zBMI			2.18 (1.34–3.57)	.002			1.80 (1.35–2.39)	<.001

Odds ratios (OR) and 95% Confidence Interval (CI) indicate the odds of intention to lose weight when underestimating body size. Model 1: age adjustment, Model 2: Model 1 + zBMI (z-score BMI) adjustment.

^a Question: “Are you trying to lose weight?” Answer options: (1) “No, I am comfortable with my weight” (reference), (2) “No, but I need to lose weight” or (3) “Yes.”

Associations between underestimation of body size and symptoms of anxiety and depression

In 2006–08 (YH3), both boys (OR, .39, 95% CI .25–.60) and girls (OR, .45, 95% CI .31–.66) who underestimated their overweight were less likely to report symptoms of anxiety and depression than those who did not (Table 2, Figure 2). In 1995–97, this association was statistically significant in girls (OR = .32, 95% CI .16–.64), but not in boys (Table 3, Figure 2).

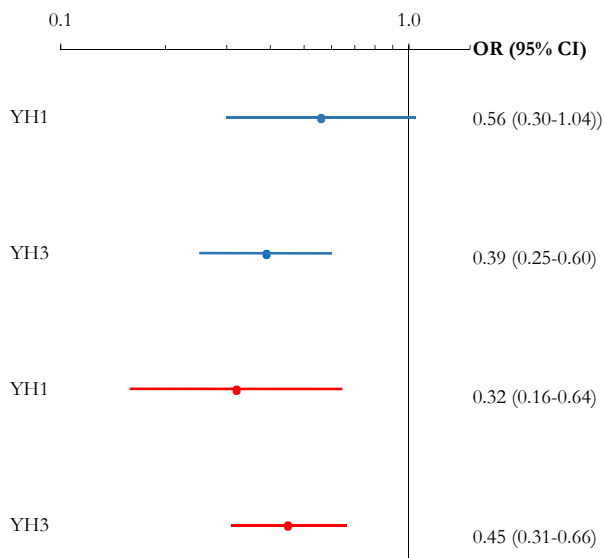


Figure 2. The odds of anxiety and depression symptoms in the body size underestimating groups in the Young-HUNT1 (YH1, 1995–97) and Young-HUNT3 (YH3, 2006–08) surveys, sex stratified (boys labeled blue and girls red) and adjusted for age and zBMI (z-score BMI).

Association between underestimation of weight and life satisfaction

In both surveys conducted 11 years apart, weight underestimation was associated with more life satisfaction. According to Table 3 (Figure 3), those who underestimated their body size were 52%–60% more likely to report higher levels of life satisfaction compared to overweight/obese adolescents who perceived themselves as such.

Discussion

In this study, we investigated the effects of body size underestimation on mental health and life satisfaction in adolescents with overweight/obesity aged 13–19 years and whether these associations had changed over time. The observed increase in overweight/obesity in this study was expected and in accordance with the ongoing global trends [1]. Moreover, our findings showed that body size underestimation as a phenomenon was not only prevalent among boys and girls with overweight but also increased in the study period. Body size underestimation was overall associated with less symptoms of anxiety and depression and higher life satisfaction in both boys and girls. The phenomenon was also negatively associated with dieting behavior in both sexes.

According to our findings, the prevalence of body size underestimation in adolescence was 1.8 fold higher in boys and 1.4 fold higher in girls in 2006–08 than 11 years before. These are trends largely paralleled in previous studies [3,35]. The increasing tendency of people underestimating their own body size, may be rooted in the proposed “visual normalization theory,” which suggests that a shift in weight norms and perceptions depends on the size of the bodies you are exposed to in your environment [21]. In agreement with this, our 11 years apart cross-sectional findings not only showed that overweight has become more prevalent in the general population of teenaged boys and girls (13–19 years), but also that the rate of individuals with obesity increased from 1995–97 to 2006–08. The observed

Table 3 Results from multivariable logistic regression models examining the sex-stratified associations between underestimation of body size with anxiety/depression and life satisfaction in overweight (BMI ≥25) adolescents from Young-HUNT1 (1995–97) and Young-HUNT3 (2006–08)

Outcome	Sex	Predictor	Young-HUNT1 (n = 1,338)			Young-HUNT3 (n = 1,833)				
			Model 1		Model 2		Model 1		Model 2	
			OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value	OR (95% CI)	p value
Anxiety and depression	Boys	Body size underestimation	.64 (.35–1.17)	.150	.56 (.30–1.04)	.068	.47 (.31–.70)	<.001	.39 (.25–.60)	<.001
		Age	1.28 (1.11–1.47)	.001	1.28 (1.11–1.48)	.001	1.13 (1.02–1.26)	.026	1.15 (1.03–1.29)	.012
		zBMI	.30 (.15–.59)	.001	.78 (.55–1.09)	.138	.40 (.28–.57)	<.001	.82 (.68–.99)	.034
Life satisfaction	Girls	Body size underestimation	1.14 (1.03–1.26)	.014	1.15 (1.04–1.28)	.009	1.09 (1.00–1.19)	.039	1.11 (1.01–1.21)	.023
		Age	.46 (.28–.76)	.002	1.12 (.91–1.37)	.283	.45 (.32–.64)	<.001	1.18 (1.04–1.33)	.008
		zBMI	1.15 (1.03–1.28)	.013	1.15 (1.03–1.29)	.016	1.01 (.92–1.11)	.768	1.02 (.93–1.12)	.701
	Boys	Body size underestimation	.42 (.24–.72)	.002	1.06 (.85–1.33)	.623	.42 (.30–.58)	<.001	.88 (.76–1.01)	.076
		Age	.99 (.90–1.08)	.800	.43 (.25–.76)	.003	.95 (.87–1.03)	.208	.46 (.33–.65)	<.001
		zBMI	1.09 (.90–1.31)	.378					.96 (.89–1.05)	.363
								1.14 (1.01–1.29)	.030	

Odds ratios (OR) and 95% Confidence Interval (CI) indicate the odds of anxiety and depression symptoms when underestimating body size. Model 1: age adjustment, Model 2: Model 1 + zBMI (z-score BMI) adjustment.

anthropometric change may well have created a shift of what is perceived as normal or average weight in our adolescent Norwegian population.

As evidenced by others [36], the underperception of overweight/obesity was associated with lower odds of dieting desires and behaviors in both cross-sectional surveys of our study. The paralleling tendency of the increasing number of individuals who underestimate their body size and the decreasing numbers of individuals with the intention to lose weight supports the perception shift of what is considered a normal and healthy body size.

We demonstrated a convincingly positive association between body size underestimation and life satisfaction in both sexes. The association between life satisfaction and underestimation of overweight was also observed in an Iranian study of 10 to 18-year-olds (n = 5,570) [37]. Furthermore, better self-rated health [37] and Health-Related Quality of Life (HRQoL) have been associated with under perception of body size in adolescents with overweight or obesity [9,24]. Interestingly, these associations have been reported to be stronger in boys compared to girls [9,37]. The important trend that males compared to females are more prone to underestimate their overweight/obesity may be explained by the muscular male ideal body type; hence, attempts to gain weight [11], and thus, they may make less effort to reduce weight when overweight. The association between body size underestimation and life satisfaction is equal or even stronger, and therefore, important to consider in future obesity prevention programs. Decades of health-related concerns linked to body image, eating disorder, and related behaviors with an exclusive focus on females, has led to less knowledge and fewer tools to initiate suitable male-focused investigations. Recent research efforts have revealed an increasing prevalence of weight-gain attempts [38] and muscularity-oriented eating behaviors [13] in adolescent boys and young men. With the consequential future increased risk of depressive symptoms, dieting, binge drinking, and the use of muscle-building substances [39], these are public health issues worth addressing promptly.

Strengths and limitations

Participation rates in both Young-HUNT surveys were high, giving reasons to suggest that respondents largely are representative of the general population of adolescents aged 13–19. It is unclear if and to what extent adolescents in this part of Norway may differ from others, but the Nord-Trøndelag adult population has been shown to be very similar to the general population of Norway in many health aspects <https://www.khs.fhi.no/en/health-in-the-municipalities/>

Since this county lacks major cities, however, the proportion of overweight may be somewhat higher than in the urban parts of Norway. Such possible geographic variation is not suggested to influence respondents' relative body size perceptions and the other study questions under investigation.

One strength is that the county surveyed has a very stable and homogenous population [40], with little migration and few cultural disparities related to religion and ethnicity. The repeated cross-sectional surveys of the general population located within the same geographic area strengthen the likelihood of reliable estimates of change and comparisons across age groups and sexes. The participation rate of 88% (YH1) and 78% (YH3) [41] were considered good, and the proportion of girls and boys were

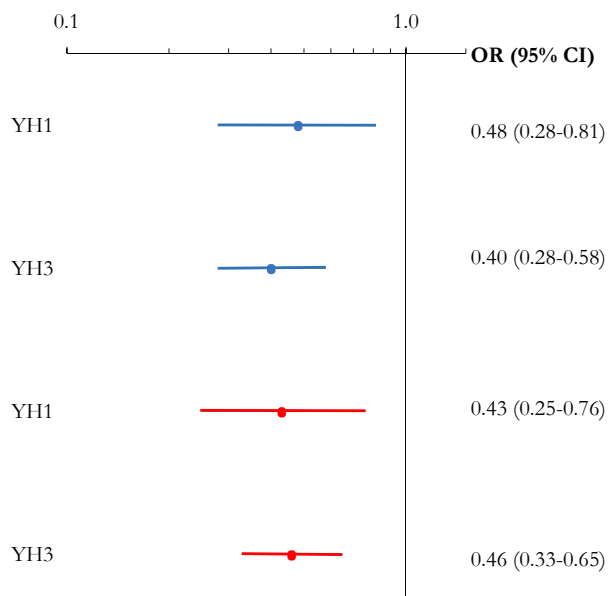


Figure 3. The odds of life dissatisfaction in the body size underestimating groups in the Young-HUNT1 (YH1, 1995–97) and Young-HUNT3 (YH3, 2006–08) surveys, sex stratified (boys labeled blue and girls red) and adjusted for age and zBMI (z-score BMI).

equal. Furthermore, an important strength was the objective weight measurement instead of self-reported, avoiding under-report or misreport [42].

The five-item Hopkins Symptom Checklist (SCL-5) was used to assess symptoms of anxiety and depression. The SCL-5 is widely used and has previously been developed and validated as a short version of the longer SCL-25 scale [32,33]. Compared with SCL-25, SCL-5 has, in addition to good reliability, shown sound specificity (82%) and excellent sensitivity (96%) to detect mental health problems [33].

Due to ensuring acceptable statistical strength, individuals with overweight and obesity were merged in both study samples. Consequentially, the study participants that were included represented quite a wide range of BMI values. In fact, mean BMI values within the body size underestimating groups were lower than the accurate weight perceiving groups, which could have led to a bias concerning the direct comparability between the two body size perception categories. However, the negligible effects of zBMI adjustments to compensate for BMI-range in the association analyses showed that the bias was minimal. Due to a cross-sectional design, assessing potential causal relationships due to temporal bias was not possible. Thus, we cannot exclude adolescents that underestimating their body size to potentially feeling better both mentally and regarding life in general than counterparts do.

Conclusions

The proportion of overweight adolescents has increased, and obesity became more prevalent between 1995–97 and 2006–08. Simultaneously, the underestimation of own body size became more common in both sexes. Underestimation of overweight/obesity, however, was associated with less symptoms of anxiety and depression and a higher degree of life satisfaction in both

sexes. Even if there is a pressing need for effective preventive measures to prevent further obesity development in children and adolescents, continuous awareness toward healthy weight management, addressing the negative consequences of body dissatisfaction is also essential.

Data Availability Statement

Due to restrictions imposed by the HUNT Research Centre, in accordance with the Norwegian Data Inspectorate's guidelines, data cannot be made publicly available. The data are currently stored in the HUNT Databank, and there are restrictions for handling data files. Data may be available upon request to the HUNT Data Access Committee (hunt@medicine.ntnu.no). The HUNT data access information (available at <http://www.ntnu.edu/hunt/data>) describes in detail the policy regarding data availability.

Acknowledgments

The Nord-Trøndelag Health Study (The HUNT Study) is a collaboration between HUNT Research Centre (Faculty of Medicine and Health Sciences, NTNU, Norwegian University of Science and Technology), Nord-Trøndelag County Council, Central Norway Regional Health Authority, and the Norwegian Institute of Public Health. The work was supported by the Liaison Committee for Education, Research, and Innovation in Central Norway, comprising committee members from the Norwegian University of Science and Technology and the Central Norway Regional Health Authority. The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript.

Contributors: KK and ES-H initiated the study. KK acquired the data, did the analysis, and wrote most of the first draft of the paper, with GB writing the initial version of the introduction. All coauthors were involved in the interpretation of results, critically reviewed, and approved the final version of the manuscript.

Supplementary Data

Supplementary data related to this article can be found at <https://doi.org/10.1016/j.jadohealth.2020.10.026>.

References

- [1] NCD-RisC. Worldwide trends in body-mass index, underweight, overweight, and obesity from 1975 to 2016: A pooled analysis of 2416 population-based measurement studies in 128.9 million children, adolescents, and adults. *Lancet* (London, England) 2017;390:2627–42.
- [2] Cash TF. Body image: Past, present, and future. *Body image* 2004;1:1–5.
- [3] Muttarak R. Normalization of Plus size and the Danger of unseen overweight and obesity in England. *Obesity* (Silver Spring) 2018;26:1125–9.
- [4] Lim H, Wang Y. Body weight misperception patterns and their association with health-related factors among adolescents in South Korea. *Obesity* (Silver Spring) 2013;21:2596–603.
- [5] Haynes A, Kersbergen I, Sutin A, et al. A systematic review of the relationship between weight status perceptions and weight loss attempts, strategies, behaviours and outcomes. *Obes Rev* 2018;19:347–63.
- [6] Cuypers K, Kvaløy K, Bratberg G, et al. Being normal weight but feeling overweight in adolescence may affect weight development into young Adulthood—an 11-year Followup: The HUNT study, Norway. *J Obes* 2012; 2012:601872.
- [7] Edwards NM, Pettingell S, Borowsky IW. Where perception meets reality: Self-perception of weight in overweight adolescents. *Pediatrics* 2010;125: e452–8.

- [8] Peltzer K, Pengpid S. Underestimation of weight and its associated factors in overweight and obese university students from 21 low, middle and emerging economy countries. *Obes Res Clin Pract* 2015;9:234–42.
- [9] Southerland JL, Wang L, Slawson DL. Weight misperception and health-related quality of life in Appalachian adolescents in the United States. *Matern Child Health J* 2017;21:168–76.
- [10] Aloufi AD, Najman JM, Mamun AA. Predictors of adolescents' weight misclassification: A longitudinal study. *Obes Res Clin Pract* 2017;11:576–84.
- [11] Calzo JP. Unpacking the Bulk: The need to Contextualize weight gain attempts among adolescent boys. *J Adolesc Health* 2019;64:423–4.
- [12] Sonnevile KR, Thurston IB, Milliren CE, et al. Helpful or harmful? Prospective association between weight misperception and weight gain among overweight and obese adolescents and young adults. *Int J Obes* (2005) 2016;40:328–32.
- [13] Nagata JM, Murray SB, Bibbins-Domingo K, et al. Predictors of muscularity-oriented disordered eating behaviors in U.S. Young adults: A prospective cohort study. *Int J Eat Disord* 2019;52:1380–8.
- [14] Girard M, Rodgers RF, Chabrol H. Prospective predictors of body dissatisfaction, drive for thinness, and muscularity concerns among young women in France: A sociocultural model. *Body image* 2018;26:103–10.
- [15] Christoph MJ, Jarrett ES, Gower AL, Borowsky IW. Weight status and weight perception in relation to mental distress and psychosocial protective factors among adolescents. *Acad Pediatr* 2018;18:51–8.
- [16] Kim Y, Austin SB, Subramanian SV, Kawachi I. Body weight perception, disordered weight control behaviors, and depressive symptoms among Korean adults: The Korea National Health and Nutrition Examination Survey 2014. *PLoS One* 2018;13:e0198841.
- [17] Thurston IB, Sonnevile KR, Milliren CE, et al. Cross-sectional and prospective examination of weight misperception and depressive symptoms among youth with overweight and obesity. *Prev Sci* 2017;18:152–63.
- [18] Byeon H. Association between weight misperception patterns and depressive symptoms in Korean young adolescents: National cross-sectional study. *PLoS One* 2015;10:e0131322.
- [19] Xie B, Chou CP, Spruijt-Metz D, et al. Weight perception, academic performance, and psychological factors in Chinese adolescents. *Am J Health Behav* 2006;30:115–24.
- [20] Xie B, Liu C, Chou CP, et al. Weight perception and psychological factors in Chinese adolescents. *J Adolesc Health* 2003;33:202–10.
- [21] Robinson E. Overweight but unseen: A review of the underestimation of weight status and a visual normalization theory. *Obes Rev : official J Int Assoc Study Obes* 2017;18:1200–9.
- [22] Twarog JP, Politis MD, Woods EL, et al. Is obesity becoming the new normal? Age, gender and racial/ethnic differences in parental misperception of obesity as being 'about the right weight'. *Int J Obes (Lond)* 2016;40:1051–5.
- [23] Kim Y, Kawachi I. School- and Individual-level predictors of weight status misperception among Korean adolescents: A National online survey. *PLoS One* 2016;11:e0154826.
- [24] Hayward J, Millar L, Petersen S, et al. When ignorance is bliss: Weight perception, body mass index and quality of life in adolescents. *Int J Obes (Lond)* 2014;38:1328–34.
- [25] Heard C, Scuffham PA, Ratcliffe J, Whitty JA. The association between misperceptions around weight status and quality of life in adults in Australia. *Health Qual Life Outcomes* 2017;15:53.
- [26] Robinson E, Haynes A, Sutin AR, Daly M. Telling people they are overweight: Helpful, harmful or beside the point? *Int J Obes* 2017;41:1160.
- [27] Voelker DK, Reel JJ, Greenleaf C. Weight status and body image perceptions in adolescents: Current perspectives. *Adolesc Health Med Ther* 2015;6:149–58.
- [28] Puhl RM, Heuer CA. Obesity stigma: Important considerations for public health. *Am J Public Health* 2010;100:1019–28.
- [29] Pearl RL, Puhl RM. Weight bias internalization and health: A systematic review. *Obes Rev* 2018;19:1141–63.
- [30] Krokstad S, Langhammer A, Hveem K, et al. Cohort profile: The HUNT study, Norway. *Int J Epidemiol* 2013;42:968–77.
- [31] Cole TJ, Bellizzi MC, Flegal KM, Dietz WH. Establishing a standard definition for child overweight and obesity worldwide: International survey. *BMJ* 2000;320:1240–3.
- [32] Tambs K, Moum T. How well can a few questionnaire items indicate anxiety and depression? *Acta psychiatrica Scand* 1993;87:364–7.
- [33] Strand BH, Dalgard OS, Tambs K, Rognerud M. Measuring the mental health status of the Norwegian population: A comparison of the instruments SCL-25, SCL-10, SCL-5 and MHI-5 (SF-36). *Nord J Psychiatry* 2003;57:113–8.
- [34] Lysberg F, Gjerstad P, Smastuen MC, et al. Has life satisfaction in Norway increased over a 20-year period? Exploring age and gender differences in a prospective longitudinal study. *HUNT Scand J Public Health* 2018;46:132–40.
- [35] Burke MA, Heiland FW, Nadler CM. From "overweight" to "about right": Evidence of a generational shift in body weight norms. *Obesity (Silver Spring, Md)* 2010;18:1226–34.
- [36] Quick V, Nansel TR, Liu D, et al. Body size perception and weight control in youth: 9-year international trends from 24 countries. *Int J Obes (Lond)* 2014;38:988–94.
- [37] Heshmat R, Kelishadi R, Motamed-Gorji N, et al. Association between body mass index and perceived weight status with self-rated health and life satisfaction in Iranian children and adolescents: The CASPIAN-III study. *Qual Life Res : Int J Qual Life aspects Treat Care Rehabil* 2015;24:263–72.
- [38] Nagata JM, Bibbins-Domingo K, Garber AK, et al. Boys, Bulk, and body ideals: Sex differences in weight-gain attempts among adolescents in the United States. *J Adolesc Health* 2019;64:450–3.
- [39] Eik-Nes TT, Austin SB, Blashill AJ, et al. Prospective health associations of drive for muscularity in young adult males. *Int J Eat Disord* 2018;51:1185–93.
- [40] Krokstad S, Langhammer A, Hveem K, et al. Cohort profile: The HUNT study, Norway. *Int J Epidemiol* 2013;42:968–77.
- [41] Holmen TL, Bratberg G, Krokstad S, et al. Cohort profile of the young-HUNT study, Norway: A population-based study of adolescents. *Int J Epidemiol* 2014;43:536–44.
- [42] Park JY, Mitrou PN, Keogh RH, et al. Effects of body size and sociodemographic characteristics on differences between self-reported and measured anthropometric data in middle-aged men and women: The EPIC-Norfolk study. *Eur J Clin Nutr* 2011;65:357–67.