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Understanding suicidal ideation in relation to disordered eating, body size and weight perception: a retrospective cohort of adolescents - The HUNT Study

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1   **Understanding suicidal ideation in relation to disordered eating, body size**

2   **and weight perception: a retrospective cohort of adolescents - The HUNT**

3   **Study**

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1   **Abstract**

2   **Objective:** We conducted a population-based study on a sample of more than 7,000

3   adolescents where we examined the associations between suicidal ideation (SI) and

4   Disordered Eating (DE) and its related traits. **Design:** Retrospective cohort study. **Settings:**

5   Data were drawn from two Norwegian population-based cohorts, the Young-HUNT1 and

6   Young-HUNT3. Junior high schools across the country of Nord-Trøndelag, Norway.

7   **Participants:** A total of 7,268 adolescents (15-19 years) who had completed self-reported

8   questionnaires including items on SI, DE, body size and weight perception were included.

9   **Primary outcome measures:** Odds ratios for SI given DE, body size or weight perception.

10   Analyses were performed in multivariable binary logistic regression models. **Results:** The

11   prevalence of SI was 23.1% in total population. Both girls and boys who reported DE,

12   evaluated their body size as "not like others" or were "unhappy about their weight" had

13   between two to five-fold increase in odds for SI; these incremental risks were observed

14   independent of sex, age, BMI and socioeconomic status. We observed higher odds for SI

15   amongst boys. **Conclusions:** Our findings suggest a clear association between SI and DE and

16   its associated traits, in both genders but specially in males. Special attention should be paid

17   into early detection of DE traits amongst adolescents.

18   **Keywords:** Adolescents, Body size perception, Intention to lose weight, Eating disorder,

19   EAT-12, HUNT, Suicidal ideation.

20

21   **Strength and limitations of this study:**

22   • We have identified detectable yet somewhat overlooked factors that may assist in

23   addressing suicidal ideation in adolescents.

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3   1   • Results are of general relevance as they are observed in a large population based
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5   2   adolescent data of both genders.
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8   3   • We address a vulnerable period with a potential for timely individual and societal
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10 4   interventions.
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13 5   • The limitation of this study was the use of single item question on suicidal ideation.
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19 7   **Introduction**
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22 8   Suicide presides above all other causes of death in individuals aged 15-39 years [1]. The
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24 9   World Health Organization (WHO) has urged countries to invest in comprehensive suicide
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26 10 prevention strategies [2] that identify and address the factors underlying suicide.
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29 11 Suicidal ideation varies in form and degree of severity, from fleeting thoughts to detailed
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31 12 planning. A meta-analysis of 172 longitudinal studies [3] has shown that in adults, SI strongly
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33 13 correlates with suicidal attempt and death by suicide. In a clinical sample, it has been further
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35 14 shown that controlling for the severity of depression and stress-events does not eliminate this
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37 15 correlation [4].
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40 16 In adolescents, suicidal ideation is associated with an array of psychiatric disorders, most
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42 17 significantly mood disorders and eating disorders [5] but also anxiety [5] [6], weight and
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44 18 shape concerns [7], higher body mass index (BMI) [8, 9], and binge/purge symptoms [10, 11].
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47 19 It is widely known that the prevalence of both SI and EDs increases during adolescence [1]
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49 20 [12] [13] [14]. The age for SI onset is reported to be as young as 10 years [15].
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52 21 Since no more than one in four individuals with EDs come to the attention of clinicians[16],
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54 22 results derived from clinical data are less generalizable. Moreover, studies on the associations
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56 23 between SI and 'Disorders of feeding and eating' have been limited to clinical data on EDs
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3 | P a g e

1   with primarily female participants[17]. However, disordered eating (DE), a clinically less

2   severe form of 'disorders of feeding and eating' [18], seems to occur more frequently than

3   EDs amongst adolescents[19-21] specially in those with higher BMI [22].

4   Large cross-gender population-based research is essential in reliably understanding SI and its

5   associated factors amongst adolescents with DEs[23]. Accordingly, the purpose of our

6   investigation was to first examine the prevalence of DEs and SI in a sample of more than

7   7,000 Norwegian adolescents, including large numbers of male participants. Based on the

8   evidence available from adults, we hypothesized that SI is associated with DEs and its related

9   traits such as body size or weight perception. We investigated whether such potential

10   associations were independent of BMI, anxiety/ depression and socioeconomic status.

11

Materials and methods

Study design and population

14   Research subjects participated in the Young-HUNT (YH) Study, which is the adolescent arm

15   (13–19 years) of the Nord-Trøndelag Health Study (https://www.ntnu.edu/hunt). The HUNT

16   Study was primarily designed to investigate major public health issues in residents of the

17   county of Nord-Trøndelag, Norway. The YH Study comprises three cross-sectional surveys so

18   far: YH1 (1995–97), YH2 (a smaller follow-up of YH1 in 2000-01) and YH3 (2006–08). The

19   YH1 and YH3 surveys were carried out at schools (response rates between 83% and 90%).

20   Data was collected through self-reported questionnaires. Clinical measurements were

21   undertaken by specially trained nurses. The Young-HUNT database includes anonymized data

22   on 17,820 participants. Cohort profiles of both the adult HUNT Study and the Young-HUNT

23   Study have been previously described [24, 25].

1 Data from the YH1 and YH3 were combined and used for the present analyses. Only

2 participants older than 15 years of age were asked about SI and therefore eligible for our

3 study. The total of 7,268 participants, (4,057 individuals from YH1 and 3,211 from YH3) that

4 had both questionnaire and clinical examination data were included in our study. Age and

5 gender distribution in the Young-HUNT1 (mean age: 17.62, female: 52.1%) and Young-

6 HUNT3 (mean age 17.63, female: 49.0%) were similar.

7

8 **Measurements**

9 **Suicidal ideation**

10 SI was measured by a single question asking participants: "Have you ever had thoughts of

11 takin your own life?" to which they could answer "Yes" or "No".

12

13 **Disordered eating**

14 EAT-7, a shortened version of The EAT (Eating Attitude Test) was used to identify

15 participants with DE (See Appendix). Individuals who were identified as having DE were

16 then grouped into two groups: EAT-A or "poor appetite/undereating" and EAT-B or

17 "uncontrolled appetite/overeating". Association analyses were performed on sex stratified

18 groups with EAT-A or EAT-B compared to those without DE (reference group). For more

19 detail on EAT-7 and its psychometric properties See Appendix.

20

21 **Body size perception**

1   Body size perception (BSP) was measured by asking: "Do you consider yourself to be: "very

2   fat", "quite fat", "about the same as others", "quite thin" or "very thin". Participants who

3   perceived their body size as "like others" have been used as reference group.

4

Intention to lose weight

6   Intention to lose weight was assessed by the following question: "Are you trying to lose

7   weight?" to which participants could answer: 1) "No, I am comfortable with my weight", 2)

8   "No, but I need to lose weight" or 3) "Yes". Participants who were comfortable with their

9   weight (alternative 1) were used as reference group.

10

Mental distress

12   The Five-item Hopkins Symptom Checklist (SCL-5) [26], a valid and reliable measure of

13   mental distress [27] was used to identify participants with higher degree of mental distress

14   (See Appendix). Based on previously reported cut-off points, participants were grouped into

15   those with "high" degree of mental distress (anxiety or depression) as opposed to those with

16   "low" levels of mental distress who were used as reference group.

17

Anthropometric measures

19   Standardized measurements of height and weight were carried out by trained nurses where

20   participants wore light clothing and no shoes. Weight was measured to the nearest half kilo

21   and height to the nearest cm. BMI was calculated as weight (kg)/height^2 (m^2). Based on

22   standard definitions outlined by Cole and colleagues where age and gender are taken into

1   consideration whilst interpreting BMI [28, 29], participants were grouped into four categories:

2   obese, overweight, normal weight and underweight.

3

4   **Socioeconomic status**

5   Occupation, financial wealth or deprivation have previously been used as measures of

6   socioeconomic status (SES), but education level has been reported as the best measurement to

7   identify health inequalities[30]. In our study, maternal education level is used as a proxy for

8   SES.

9   Every Norwegian citizen has a unique personal 11-digit identification number, which was

10   used to identify participants' mothers from the Norwegian Family Register. The data on

11   education was then obtained from the Statistics Norway database (SSB) on 6,852 mothers.

12   The educational levels were coded according to the Norwegian Standard Classification of

13   Education (NUS) into three: primary (0-10 years school attendance, reference category),

14   secondary (11-14 years of school attendance) and tertiary (> 14 years of school attendance)

15   [31].

16

17   **Statistical analysis**

18   Multivariable logistic regression models were employed in sex stratified samples to

19   investigate the associations between disordered eating, BSP and intention to lose weight and

20   SI in separate models for each exposure factors. Models were adjusted for age, BMI, mental

21   distress and SES. Results are reported as Odds Ratios (OR) with 95% confidence intervals.

22   Overall missingness was < 5% and considered missing at random (MAR). We performed a

23   complete case analysis. Models were fitted in IBM SPSS Statistics 25.

7 | P a g e

1 Independent-samples t-tests and Chi-square tests of independence (both significant at the 0.05

2 level) were performed to determine whether participants from YH1 and YH3 differed in ways

3 that would affect the validity of our results derived from pooled data. Participants were

4 compared on all exposure variables. Wherever no statistically significant differences were

5 observed, the association analyses were done on pooled data from YH1 and YH3 cohorts.

6 Otherwise, association analyses were done separately in YH1 and YH3 as well as on the

7 pooled data; comparing the results from these separate analyses detected no meaningful

8 difference. Results are therefore reported for pooled data.

9

10 **Ethics statement**

11 Our study was conducted in accordance to the Helsinki Declaration and was approved by the

12 Regional and National Committees for Medical and Health Research Ethics (2009/740-2) as

13 well as by the Norwegian Data Inspectorate. In Norway, the legal age for consent is 16 years.

14 Written consents were obtained from participants older than 16, and from their parents or

15 legal guardians for younger participants.

16

17 **Patient and Public Involvement statement**

18 Patients and the public were not involved in the design and conception of the study.

19 Recruitment phase was entry level for the public. There are no plans to disseminate the results

20 to patients.

21

22 **Results**

1

Population characteristics

2 Overall prevalence of SI in our study population was 23.0 %. Prevalence of SI was similar

3 between YH1 and YH3 (Table 1). The prevalence of SI amongst adolescents in the poor

4 appetite/undereating group was 44.1% and 35.0% amongst those in the uncontrolled

5 appetite/overeating group, as opposed to 20.5% in participants without DE.

Table 1. Sample characteristics (n=7 628†; 3659 girls, 3609 boys, mean age=17.63 years):

	Total N (%)	Boys N (%)	Girls N (%)
Suicidal ideation			
Young-HUNT1	939(23.1)	417(20.1)	522(26.3)
Young-HUNT3	742(23.1)	311(20.2)	431(25.3)
Weight categories (BMI)‡			
Obese	296(4.5)	143(4.3)	153(4.7)
Overweight	1072(16.4)	552(16.8)	520(16.1)
Normal weight	4855(74.5)	2443(74.1)	2412(74.8)
Underweight	296(4.5)	157(4.8)	139(4.3)
Body size perception			
Very fat	154(2.1)	41(1.1)	113(3.1)
Quite fat	1639(22.7)	606(17.0)	1033(28.4)
Like others	4119(57.2)	2097(58.7)	2022(55.7)
Quite thin	1210(16.8)	771(21.4)	439(12.1)
Very thin	84(1.2)	58(1.6)	26(0.7)
Intention to lose weight			
Yes	1085(15.1)	256(7.2)	829(22.9)
No, but I need to lose weight	1282(17.8)	428(12.0)	854(23.6)
No, I am comfortable with my weight	4827(67.1)	2890(80.9)	1937(53.5)
Disordered eating			
Poor appetite/undereating	338(4.7)	74(2.1)	264(7.3)
Uncontrolled appetite/overeating	843(11.8)	363(10.2)	480(13.3)
Anxiety/depression	1484(20.9)	439(12.5)	1045(29.2)

†Subgroups may not sum to total number due to missing values.
‡Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

6

7 Uncontrolled appetite/overeating was more prevalent (11.8%) than poor appetite/undereating

8 (4.7%) with girls more affected than boys in both groups (Table 1). The prevalence of poor

appetite/undereating was similar in YH1 and YH3 (4.5% and 5.0% respectively) whilst the

prevalence of uncontrolled appetite/overeating decreased from YH1 to YH3 (13.7% to 9.4%).

Compared to those without DEs, more participants with DE perceived themselves as "not like

others" (Table 2). In the total sample, 57.2% perceived their body size "like others", whereas

more girls compared to boys perceived themselves as "fat" or "very fat" whilst more boys,

perceived themselves as "thin" or "very thin" (Table 1). Irrespective of BMI, a general trend

of underestimation of body size in boys and overestimation in girls was found (Supplementary

table 1 and Supplementary table 2).

Table 2. Intention to lose weight and body size perception in individuals with disordered eating in pooled data:

	Uncontrolled appetite/ overeating group			Poor appetite/ undereating group		
	Total N (%)	Boys N (%)	Girls N (%)	Total N (%)	Boys N (%)	Girls N (%)
Intention to lose weight						
Yes	128(15.3)	20(5.6)	108(22.7)	166(49.7)	13(18.1)	153(58.4)
No, but I need to lose weight	89(10.7)	17(4.7)	72(15.2)	71(21.3)	13(18.1)	58(22.1)
No, I am happy with my weight	617(74.0)	322(89.7)	295(62.1)	97(29.0)	46(63.8)	51(19.5)
Body size perception						
Very fat	15(1.8)	4(1.1)	11(2.3)	27(8.1)	7(9.9)	20(7.6)
Quite fat	118(14.0)	25(6.9)	93(19.4)	146(43.6)	19(26.8)	127(48.1)
Like others	356(42.3)	133(36.7)	223(46.5)	124(37.0)	27(38.0)	97(36.7)
Quite thin	298(35.4)	163(45.0)	135(28.1)	33(9.9)	16(22.5)	17(6.4)
Very thin	55(6.5)	37(10.2)	18(3.8)	5(1.5)	2(2.8)	3(1.1)

Majority of participants (67.1%) were comfortable with their weight and did not engage in

weight reduction measures (Table 1). Compared to boys and irrespective of their actual BMI,

more girls were unhappy with their weight (Supplementary table 1). Such gender differences

became even more pronounced in participants with DE (Table 2).

Girls and boys differed very little in terms of BMI distribution in the total sample (Table 1).

Compared to the YH1 sample, BMI distribution shifted towards obese and overweight in

YH3, with a greater shift towards obese and overweight in boys (Supplementary table 2).

1   2   3   4   5   6   7   8   9   10   11   12   13   14   15   16   17   18   19   20   21   22   23   24   25   26   27   28   29   30   31   32   33   34   35   36   37   38   39   40   41   42   43   44   45   46   47   48   49   50   51   52   53   54   55   56   57   58   59   60

1   Overall, 20.9% of the participants reported having higher levels of mental distress as defined

2   by SCL-5 (Table 1). Independent of presence or absence of DE, girls showed significantly

3   higher prevalence of mental distress (Data not shown).

4

5   **Association between SI and disordered eating**

6   Compared with those without DE and in both genders, the odds for SI were more than

7   doubled in the poor appetite/undereating group, and almost doubled in the uncontrolled

8   appetite/overeating group. Adjustment for age made negligible changes in the OR for SI;

9   however, adjustments for BMI further increased the odds in both sexes without losing

10   statistical significance (Table 3 and Table 4). With further adjustments for mental distress, the

11   odds for SI remained statistically significant in both sexes in the respective DE subgroups

12   although the effect sizes decreased. Boys had higher odds for SI compared to girls in both DE

13   groups (Table 3 and Table 4).

14

15   **Association between SI and body size perception**

16   In both sexes, perceiving body size as not like others ("very fat", "quite fat", "quite thin" or

17   "very thin") was associated with higher odds for SI. For instance, boys who perceived their

18   body size as "very fat" showed an odds ratio of 4.45 (2.38-8.31) compared to boys who

19   perceived their body size as "like others". The same comparison in girls yielded an odd ratio

20   for SI of 5.54 (3.75-8.18). Similar observations were made in boys or girls who perceived

21   their body size as "quite fat". Higher odds for SI in groups with body size perception as "quite

22   thin" or "very thin" were only statistically significant in boys (see Table 3 and Table 4). All

23   results were robust to adjustment for age, BMI and SCL-5. In both sexes, odds ratios for SI

24   were higher the farther BSP deviated from the population norm ("like others"), in either

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1   direction. With some small exceptions, adjustment for mental distress reduced the odds for SI

2   across all BSP groups in both girls and boys (Tables 3 and 4). Compared to boys, girls who

3   considered their body size as "very fat" showed slightly higher odds of SI after adjustments

4   for age and BMI. We found no statistical evidence that sex have significant moderator effect

5   on the association between BSP "very fat" and SI (p-value: 0.118). Our findings were also

6   robust to adjustments for mental distress.

7

8   **Association between SI and intention to lose weight**

9   In the crude analyses, "intention to lose weight", even without actively engaging in weight

10 reduction measures, more than doubled the odds for SI in both genders (Tables 3 and 4).

11 Compared to those who "did not try to lose weight", the odds ratio for SI in those who

12 intended to lose weight was doubled in boys and nearly tripled in girls. These findings were

13 robust to adjustments made for age, BMI and mental distress (Table 3 and Table 4).

14

15 **Testing for possible confounding effect of socioeconomic status (SES)**

16 A subsample of 6,852 participants with available information on highest maternal education

17 level was used to investigate possible confounding effect of SES on the associations between

18 SI and DE, BSP or intention to lose weight. Adjusting for SES made very slight change to our

19 findings (Table 3 and Table 4).

20

Table 3. Odds ratios for suicidal ideation (SI) given disordered eating, body size perception or intention to lose weight in boys:

	Non adjusted		Adj. for age		Adj. for age/BMI		Adj. for age/BMI/SCL-5		Adj. for age/BMI/SCL-5/SES	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Disordered eating										
Poor appetite/Undereating	2.47*	1.53-3.98	2.47*	1.53-3.97	2.87*	1.75-4.71	2.10**	1.19-3.73	2.28**	1.26-4.11
Uncontrolled appetite/Overeating	1.95*	1.53-2.47	1.95*	1.53-2.47	2.09*	1.61-2.71	1.77*	1.34-2.35	1.81*	1.35-2.42
Body size perception										
Very fat	4.45*	2.38-8.31	4.44*	2.38-8.30	5.68*	2.78-11.61	4.20*	1.96-9.02	4.43*	2.02-9.71
Quite fat	1.93*	1.56-2.39	1.93*	1.56-2.39	2.13*	1.63-2.78	1.74*	1.31-2.32	1.64**	1.22-2.21
Quite thin	1.44**	1.17-1.76	1.44**	1.17-1.76	1.53*	1.22-1.92	1.47**	1.16-1.87	1.51**	1.18-1.93
Very thin	3.15*	1.83-5.42	3.14*	1.83-5.41	3.82*	2.06-7.08	3.39*	1.75-6.53	2.99**	1.51-5.92
Intention to lose weight										
Yes	2.04*	1.54-2.71	2.04*	1.54-2.71	2.24*	1.61-3.11	1.53**	1.06-2.21	1.47**	1.01-2.15
No, but I need to lose weight	2.01*	1.6-2.52	2.01*	1.60-2.53	2.23*	1.69-2.95	1.88*	1.39-2.55	1.83*	1.34-2.52

Reference category in the dependent variable: No SI. Reference categories in the predictors: Disordered eating: Below cut-off for each trait. Body size perception: Like others, Intention to lose weight: No. Adjustment for SES from a subsample of 6852 participants. Primary level education used as reference category. *P-value<0.001, ** P-value<0.05

1

Table 4. Odds ratios for suicidal ideation(SI) given disordered eating, Body size perception or intention to lose weight in girls:

	Non adjusted		Adj. for age		Adj. for age/BMI		Adj. for age/BMI/SCL-5		Adj. for age/BMI/SCL-5/SES	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Disordered eating										
Poor appetite/Undereating	2.62*	2.03-3.38	2.63*	2.04-3.39	2.83*	2.17-3.70	1.78*	1.33-2.39	1.75*	1.30-2.37
Uncontrolled appetite/Overeating	1.94*	1.58-2.37	1.93*	1.58-2.37	2.05*	1.65-2.55	1.56*	1.23-1.98	1.58*	1.23-2.02
Body size perception										
Very fat	5.54*	3.75-8.18	5.48*	3.71-8.09	5.88*	3.67-9.45	3.96*	2.34-6.69	4.04*	2.35-6.92
Quite fat	2.09*	1.77-2.47	2.10*	1.77-2.48	2.24*	1.84-2.73	1.82*	1.47-2.26	1.85*	1.49-2.30
Quite thin	1.26	0.98-1.60	1.25	0.98-1.60	1.25	0.95-1.64	1.34	0.10-1.79	1.35	1.00-1.82
Very thin	2.09	0.92-4.72	2.04	0.9-4.61	2.53**	1.07-6.01	2.8**	1.13-6.94	2.45	0.95-6.30
Intention to lose weight										
Yes	2.76*	2.31-3.31	2.79*	2.33-3.34	2.97*	2.42-3.65	2.16*	1.73-2.70	2.17*	1.72-2.72
No, but I need to lose weight	1.92*	1.59-2.30	1.92*	1.59-2.31	1.99*	1.61-2.46	1.63*	1.30-2.04	1.61*	1.27-2.02

1 Reference category in the dependent variable: No SI. Reference categories in the predictors: Disordered eating: Below cut-off for each trait. Body size

2 perception: Like others (normal), Intention to lose weight: No. Adjustment for SES from a subsample of 6852 participants. Primary level education used as

3 reference category. *P-value<0.001, ** P-value<0.05

1 **Discussion**

2 **Principal findings of this study**

3 Our findings point at a considerable collective increase in the odds for SI amongst adolescents

4 with traits of DEs and body size or weight concerns in an intricate interplay with one another

5 as well as with other factors such as BMI and mental distress. Adolescent boys showed a

6 vulnerability for having SI and require special attention in risk assessment and treatment

7 approaches.

8 **Comparison with previous studies**

9 There is a high comorbidity between DE and mental distress in the form of anxiety or

10 depressive disorders [32], both closely linked to SI and attempted suicide [6]. DEs or

11 subjective perception of body shape or weight are not routinely included in clinical suicide

12 risk assessments which might lead to underestimation of vulnerability to future SI or suicidal

13 attempts.

14 Although our findings were of similar caliber and direction in both sexes, we observed some

15 sex differences concerning BMI and mental distress. Sex differences in clinical manifestation

16 of EDs [33] have been reported. Our observations were in line with previously found sex

17 differences in BSP in relation to actual BMI [34, 35], with girls showing a tendency to

18 overestimate and boys consistently underestimating their body size. In keeping with previous

19 reports[33] [36] [37]. Our male participants showed less inclination to lose weigh independent

20 of their actual BMI. Part of the sex differences in manifestations of EDs has been previously

21 attributed to higher BMI [38]. We could not find evidence in support of BMI having a similar

22 explanatory role for higher OR for SI amongst our male participants; however, our findings

23 were in line with previous reports of existing but somewhat overlooked higher vulnerability to

24 mental distress amongst adult male sufferers of DEs [39]. What constitutes this higher

1   vulnerability in boys should be further studied. Considering the increase in the incidence rates

2   of EDs amongst men, screening and treating men with EDs is becoming more and more a

3   priority [40].

4

5   In line with previous reports [22], we found that DEs were far more prevalent than clinically

6   diagnosed EDs, suggesting that in identification of vulnerable individuals and groups, more

7   weight should be given to the presence of DE symptoms and traits rather than solely to

8   presence or absence of EDs. A sizeable proportion of high-risk individuals do not meet

9   stringent diagnostic criteria for EDs and hence might slip through the safety net before a

10 suitable care approach can be warranted.

11

12 **Strengths and limitations**

13 Strengths of this study include the large sample size derived from a total Norwegian adolescent

14 population with low migration. Further, anthropometric measurements were carried out by trained

15 nurses. To date, most studies on EDs have relied upon clinical data or patient registries of adult

16 populations [41] which leaves out the adolescents in the general population in the time period

17 when psychological distress and disorders often manifest. With the median age of onset for

18 developing EDs reported as low as 12-13 years old [42], the importance of studying younger

19 affected individuals could not be more emphasized. Studies on male ED sufferers are fewer and

20 far in between, with adolescent male participants usually lumped into adult populations [33].

21 Using adolescent male population has made our findings more generalizable to this age group.

22

23 Conclusions should be drawn in the light of certain limitations in the current study. The use of

24 shortened and self-reported measures of DE (EAT-7) or mental distress (SCL-5), and not

16 | P a g e

1 standardized psychiatric interviews, has in effect rendered our findings less generalizable to

2 clinical populations. SI was assessed by a single item question that was not anchored to a point in

3 time; however, we have assumed no temporal relationship and do not interpret our results as

4 causal but rather associative, hence, the importance of conducting longitudinal studies on

5 causality.

Conclusions

7 An individually tailored approach to suicide risk assessment and management seems to be

8 more appropriate in subpopulations of adolescents with DEs and its related traits. Our findings

9 on difference between female and male adolescents may have potential implications in the

10 way clinicians address SI in different genders. Focus on addressing individuals' attitudes

11 towards their own body shape and size rather than maintaining a healthy BMI seems to be a

12 focal area in designing treatment plans to reduce burden of suicidal ideation or attempts.

13 Timely identification of associated factors for SI in high-risk but non-clinical populations is

14 important in designing strategic and preventive measures that intend to cut human and

15 economic costs of suicidal ideation and attempts. Future research in clinical populations

16 seems warranted.

Acknowledgement

18 The material described in this paper is original research and has not been previously published

19 or submitted for publication elsewhere.

Author statement

21 FSS has conceived the idea, performed the analyses and drafted the manuscript. FSS, TLH,

22 NM, ERS, OB and KK have contributed to interpretation of results and critical revision of

23 manuscript. Authors FSS, TLH, NM, ERS, OB and KK have read and approved of the final

24 version of manuscript before its submission. Authors FSS, TLH, NM, ERS, OB and KK can

1 be held accountable for all aspects of the work. Authors FSS, TLH, NM, ERS, OB and KK

2 declare no conflict of interest or any competing financial interests.

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21

Supplementary table 1. Body size perception, intention to lose weight and weight categories in boys and girls, pooled data:

	Boys(n=3192)				Girls(n=3275)			
	Obese (%)	Overweight (%)	Normal (%)	Underweight (%)	Obese (%)	Overweight (%)	Normal (%)	Underweight (%)
Body size perception								
Very fat	19(12.10)	9(0.38)	8(1.55)	0	39(27.70)	35(6.38)	17(0.70)	1(0.64)
Quite fat	1(0.64)	177(7.40)	243(47.19)	112(86.82)	93(65.96)	340(61.93)	478(19.68)	1(0.64)
Like others	24(15.29)	1578(66.00)	261(50.68)	17(13.18)	9(6.38)	172(31.33)	1624(66.86)	41(26.28)
Quite thin	92(58.60)	599(25.05)	2(0.39)	0	0	1(0.18)	300(12.35)	100(64.10)
Very thin	21(13.38)	28(1.17)	1(0.19)	0	0	1(0.18)	10(0.41)	13(8.33)
Total	**157**	**2391**	**515**	**129**	**141**	**549**	**2429**	**156**
	Boys(n=3191)				Girls(n=3260)			
	Obese (%)	Overweight (%)	Normal (%)	Underweight (%)	Obese (%)	Overweight (%)	Normal (%)	Underweight (%)
Intention to lose weight								
Yes	45(29.80)	101(23.77)	81(3.40)	0	59(42.14)	203(37.39)	455(18.79)	5(3.23)
No, but I need to lose weight	83(54.97)	157(36.94)	132(5.53)	3(2.19)	76(54.29)	232(42.73)	455(18.79)	4(2.58)
No, I am comfortable with my weight	23(15.23)	258(60.71)	2174(91.12)	134(97.81)	5(3.57)	108(19.89)	1512(62.43)	146(94.19)
Total	**151**	**425**	**2386**	**137**	**140**	**543**	**2422**	**155**

Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

Supplementary table 2. Distribution of body size perception in each BMI category in boys and girls; Young HUNT1(YH1) and Young HUNT3(YH3):

	YH1 boys(n=1834)				YH1 girls(n=1845)			
	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)
Body size perception								
Very fat	11(2)	8(3.29)	2(0.14)	0	23(35.93)	19(7.28)	9(0.63)	1(1)
Quite fat	40(72.73)	139(57.20)	113(7.81)	1(1.12)	38(59.38)	182(69.73)	311(21.9)	1(1)
Like others	4(7.27)	94(38.68)	967(66.83)	19(21.35)	3(4.69)	59(22.61)	948(66.76)	26(26)
Quite thin	0	2(0.82)	354(24.46)	59(66.29)	0	1(0.38)	146(10.28)	66(66)
Very thin	0	0	11(0.76)	10(11.24)	0	0	6(0.42)	6(6)
Total	**55**	**243**	**1447**	**89**	**64**	**261**	**1420**	**100**
	YH3 boys(n=1358)				YH3 girls(n=1430)			
	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(
Body size perception								
Very fat	8(8.60)	1(0.37)	6(0.64)	0	16(20.78)	16(5.56)	8(0.79)	0
Quite fat	72(77.42)	104(38.10)	64(6.79)	0	55(71.43)	158(54.86)	167(16.55)	0
Like others	13(13.98)	167(61.17)	611(64.79)	5(10.20)	6(7.79)	113(39.24)	676(67.00)	15(26.79)
Quite thin	0	0	245(25.98)	33(67.35)	0	0	154(15.26)	34(60.71)
Very thin	0	1(0.37)	17(1.80)	11(22.45)	0	1()	4(0.40)	7(12.5)
Total	**93**	**273**	**943**	**49**	**77**	**288**	**1009**	**56**

Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

Disordered eating

The EAT (Eating Attitude Test) is a standardized self-report questionnaire that has been used to identify individuals at risk of developing EDs [1] in both clinical and non-clinical adolescent populations and can discriminate eating disordered patients and controls[2]. Since EAT was considered too long to be included in the Young-HUNT Study, a shortened version, EAT-7, was used to identify disordered eating. For psychometric properties of EAT-7 [3]. Psychometric properties of the EAT-7 have been previously validated in two cohorts, YH1 [4] and 'Young in Norway' [5], and a two-factor solution of the EAT-7: EAT-A or "poor appetite/undereating" and EAT-B or "uncontrolled appetite/overeating", is reported to be robust for age and gender [4].

The EAT-A comprises the questions: 1) It can be difficult to stop eating when I first begin to eat, 2) I spend too much time thinking about food, 3) I feel that food controls my life, and 4) When I eat, I cut food in small pieces. EAT-B consists of questions: 1) When I eat a meal, I spend longer time than others, 2) Others think that I am too thin and 3) I feel that others pressure me to eat. Participants answered questions on a Likert scale with response options: "never/seldom" (coded as 0), "often" (coded as 1) and "always" (coded as 2). Scores on each question item were added up to determine sum-scores on EAT-A and EAT-B subscales separately. A maximum score for the EAT-A and EAT-B were therefore 8 and 6, respectively. Previously reported cut-off points [4] were then used to categorize participants into groups of cases with elevated EAT-A (score ≥ 3) or EAT-B (score ≥ 2). Cases were compared to adolescents scoring below these cut offs. Adolescents who scored above the cut-off on both the EAT-A and EAT-B (92 persons in total) were included in the analyses since associations between each EAT-7 subscale and SI were not deemed mutually exclusive. Cronbach's alphas were 0.57, 0.42 and 0.54 for EAT-A, EAT-B and EAT-7, respectively.

Principal Component Analysis for optimal cut-off points for EAT-A and EAT-B has been in agreement with previous reports and the cut-off points were also validated against the EAT-12 [4].

Mental distress

The Five-item Hopkins Symptom Checklist (SCL-5) [6], a valid and reliable measure of mental distress [7] was used to measure mental distress. SCL-5 is a shorter version of SCL-25 that constitutes 10 questions on anxiety and 15 questions on depression [8]. Self-rated measures of anxiety and depression on SCL-25 have a reported concordance rate of 86.7% with clinical assessment by a physician [8]. Stepwise regression has been used to identify question items that had maximum correlation with the scores on anxiety, depression and global scores on SCL-25 [7] [9]. Five of these question items constitute SCL-5, with an estimated correlation of 0.92 with SCL-25, an alpha reliability at 0.85 [9] and estimated sensitivity and specificity of 82% and 96 %, respectively [6].

On SCL-5, participants rated the presence or absence of the following five symptoms on a four-point Likert scale ranging from 1) "not bothered" to 4) "very much bothered" in response to the following question: "During the last 14 days", have you: 1) "Been constantly afraid and anxious", 2) "Felt tense or uneasy", 3) "Felt hopelessness when you think of the future", 4) "Felt dejected or sad" or 5) "Worried too much about various things". Only participants who had answered four or more questions were included. Sum scores were calculated by adding up scores on each question item. The sum score was then divided by the number of items answered. Based on previously reported cut-off points, SCL-5 scores of ≥2 were categorized as having "high" degree of mental distress (anxiety or depression), whereas SCL-5 scores < 2 were considered as "low" levels of mental distress [6].

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5-7
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8, Appendix
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	7-8, Appendix
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	9-10
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	9-10
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-10

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-14
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-14
Discussion			
Key results	18	Summarise key results with reference to study objectives	15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16-17
Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

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Suicidal ideation in relation to disordered eating, body size and weight perception: a cross-sectional study of a Norwegian adolescent population - The HUNT Study

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9   3   **The HUNT Study**
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29

1   **Abstract**

2   **Objective:** We conducted a population-based study on a sample of more than 7,000

3   adolescents where we examined the associations between suicidal ideation (SI) and disordered

4   eating (DE) and its related traits. **Design:** Cross-sectional. **Settings:** Data were derived from

5   two Norwegian population-based cohorts, the Young-HUNT1 (1995-97) and Young-HUNT3

6   (2006-08) from the county of Nord-Trøndelag, Norway. **Participants:** A total of 7,268

7   adolescents (15-19 years) who had completed self-reported questionnaires including items on

8   SI, DE, body size and weight perception were included. **Primary outcome measures:** Odds

9   ratios for SI given DE, body size or weight perception. Analyses were performed in

10   multivariate logistic regression models. **Results:** The prevalence of SI was 23.1% in total

11   population. Both girls and boys who reported DE, evaluated their body size as <u>not</u> "about the

12   same as others" or were "unhappy about their weight" had between two to five-fold increase

13   in odds for SI; these incremental risks were observed independent of sex, age, BMI and

14   socioeconomic status. We observed higher odds for SI amongst boys. **Conclusions:** Our

15   findings suggest a clear association between SI and DE and its associated traits, in both

16   genders but specially in males. Special attention should be paid on early detection of DE traits

17   amongst adolescents.

18   **Keywords:** Adolescents, Body size perception, Intention to lose weight, Eating disorder

19   (ED), EAT-12, HUNT, Suicidal ideation.

20

Strength and limitations of this study:

22   • We have identified detectable yet somewhat overlooked factors that may assist in

23   addressing suicidal ideation in adolescents.

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2
3   1   • Our results are of general relevance since our observations were made in a large,
4
5
6   2   population-based adolescent dataset that included both males and females.
7
8   3   • We address a vulnerable period with a potential for timely individual and societal
9
10   4   interventions.
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13   5   • A limitation of this study was the use of a single item question on suicidal ideation.
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18
19   7   **Introduction**
20
21
22   8   Suicide presides above all other causes of death in individuals aged 15-39 years [1]. The
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24   9   World Health Organization (WHO) has urged countries to invest in comprehensive suicide
25
26 10 prevention strategies [2] that identify and address the factors underlying suicidal ideation,
27
28
29 11 suicidal attempt and suicide. Suicidal ideation varies in form and degree of severity, from
30
31 12 fleeting thoughts to detailed planning. A meta-analysis of 172 longitudinal studies [3] has
32
33 13 shown that in adults, SI strongly correlates with suicidal attempt and death by suicide that
34
35 14 remains robust even after adjusting for severity of depression and stress-events [4].
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37
38 15 In adolescents, suicidal ideation is associated with an array of psychiatric disorders, most
39
40 16 significantly mood disorders and eating disorders (EDs) [5] but also anxiety [5] [6], weight
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42
43 17 and shape concerns [7], lack of regard for one's own body [8], higher body mass index (BMI)
44
45 18 [9, 10], and binge/purge symptoms [11, 12]. The suicide risk seems to be higher if eating
46
47
48 19 disorders and other psychological problems coexist [8]. Predictive ability of suicide risk
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50 20 factors has not changed much in the past 50 years, partly due to methodological problems and
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52 21 lack of research on a wider list of factors that can explain suicidal ideation or behavior in a
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54 22 way previously identified risk factors have not [13, 14].
55
56
57 23 Studying factors associating suicide in populations with traits of eating disorder poses certain
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59 24 difficulties. Since no more than one in four individuals with EDs come to the attention of
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3 | P a g e

1   clinicians[15], results derived from clinical data are less generalizable. Moreover, studies on

2   the associations between SI and EDs have been limited to clinical data on EDs with primarily

3   female participants[16, 17] whilst for instance in Australia, one in four and in UK, one in

4   three preadolescents who attend special ED clinics are male[18, 19]. In fact contrary to what

5   was initially believed, prevalence of certain ED diagnoses is higher amongst male population

6   than their female counterparts[20] [21]. Sex differences in the clinical representation of the

7   various specific EDs are also detected [17]. Current diagnostic criteria are mainly derived

8   from female populations and fail to identify a sizable number of male sufferers who do not fit

9   in the female ED profile. The importance of research in male populations with EDs cannot be

10   emphasized more.

11   Another potential problem area in conducting research in populations with EDs is the

12   heterogeneity within and across specific ED diagnoses. EDs, as classified by American

13   Psychiatric Association are 'Disorders of feeding and eating' [22] and range from clinical

14   forms that meet stringent diagnostic criteria of Anorexia Nervosa to forms that fluctuate in

15   form and severity over the years and may not necessarily fall into diagnostic categories [22].

16   In both clinical and research settings, using current diagnostic criteria will inevitably lead to

17   missing a population who presents fewer numbers of ED symptoms that may nevertheless

18   cause discomfort or a degree of dysfunction. This particular group is referred to as one

19   presenting symptoms of disordered eating (DE), a clinically less pronounced form of

20   'disorders of feeding and eating' [23], that seems to occur more frequently than EDs amongst

21   adolescents[24-26] specially in those with higher BMI [27]. New and large cross-gender

22   population-based research is essential in reliably understanding SI and its associated factors

23   amongst adolescents with DE traits [28].

1   With the age for SI onset reported to be as young as 10 years [29], the importance of research

2   at young adolescence period when prevalence of both SI and Eating Disorders (EDs)

3   increases [1] [30] [31] [32] cannot be overemphasized.

4   Accordingly, the purpose of the current investigation was to study DE traits in relation to SI in

5   a large sample of more than 7,000 Norwegian adolescents, including large numbers of male

6   participants. Prevalence of SI, DE traits and their characteristics were studied. Having found

7   supporting evidence in literature on adults[33, 34], authors examined 1- whether DE traits

8   such as DEs or weigh and shape concerns are associated with SI amongst adolescents and 2-

9   whether such potential associations could be accounted for by other factors such as

10 individuals' level of mental distress, BMI or socioeconomic status. The authors hypothesized

11 that SI is associated with DEs and its related traits such as body size or weight perception that

12 are independent of BMI, mental distress and socioeconomic status.

13

Materials and methods

Study design and population

16 Research subjects participated in the Young-HUNT (YH) Study, which is the adolescent arm

17 (13–19 years) of the Nord-Trøndelag Health Study (https://www.ntnu.edu/hunt). The HUNT

18 Study was primarily designed to investigate major public health issues in residents of the

19 county of Nord-Trøndelag, Norway. The YH Study comprises two cross-sectional surveys so

20 far: YH1 (1995–97) and YH3 (2006–08). These surveys were carried out at schools (response

21 rates between 83% and 90%). Data on DE traits, weight and shape concerns, mental distress,

22 socioeconomic status and SI were collected through self-reported questionnaires. Clinical

23 measurements were undertaken by specially trained nurses. The Young-HUNT database

1 includes anonymized data on 17,820 participants. Cohort profiles of both the adult HUNT

2 Study and the Young-HUNT Study have been previously described [35, 36].

3 Data from the YH1 and YH3 were combined and used for the present analyses. Only

4 participants 15 years of age or older were asked about SI and were therefore eligible for our

5 study. The total of 7,268 participants, (4,057 individuals from YH1 and 3,211 from YH3) that

6 had both questionnaire and clinical examination data were included in our study. Age and

7 gender distribution in the Young-HUNT1 (mean age: 17.62, female: 52.1%) and Young-

8 HUNT3 (mean age 17.63, female: 49.0%) were similar.

9

10 **Measurements**

11 **Suicidal ideation**

12 SI was measured by a single question asking participants: "Have you ever had thoughts of

13 taking your own life?" to which they could answer "Yes" or "No".

14

15 **Disordered eating (DE)**

16 EAT-7, a shortened version of The EAT (Eating Attitude Test) was used to identify

17 participants with DE (see Appendix). Individuals who were identified as having DE were then

18 grouped into two groups: EAT-A or "poor appetite/undereating" and EAT-B or "uncontrolled

19 appetite/overeating". Association analyses were performed on sex stratified groups with EAT-

20 A or EAT-B compared to those without DE (reference group). For more detail on EAT-7 and

21 its psychometric properties please see Appendix.

1   It is important to note that terms EDs and DEs are not used interchangeably in the current

2   study. ED has been the preferred term whenever authors referred to previous research

3   conducted in populations with defined EDs.

4

5   **Body size perception**

6   Body size perception (BSP) was measured by asking: "Do you consider yourself to be: "very

7   fat", "quite fat", "about the same as others", "quite thin" or "very thin". Participants who

8   perceived their body size as "about the same as others" have been used as reference group.

9

10 **Intention to lose weight**

11 Intention to lose weight was assessed by the following question: "Are you trying to lose

12 weight?" to which participants could answer: 1) "No, I am comfortable with my weight", 2)

13 "No, but I need to lose weight" or 3) "Yes". Participants who were comfortable with their

14 weight (alternative 1) were used as reference group.

15

16 **Mental distress**

17 The Five-item Hopkins Symptom Checklist (SCL-5) [37], a valid and reliable measure of

18 mental distress [38] was used to identify participants with a high degree of mental distress

19 (see Appendix). Based on previously reported cut-off points, participants were grouped into

20 those with "high" degree of mental distress (anxiety or depression) as opposed to those with

21 "low" levels of mental distress who were used as reference group.

22

Anthropometric measures

Standardized measurements of height and weight were carried out by trained nurses where participants wore light clothing and no shoes. Weight was measured to the nearest half kilo and height to the nearest cm. BMI was calculated as weight (kg)/height^2 (m^2). Based on standard definitions outlined by Cole and colleagues where age and gender are taken into consideration whilst interpreting BMI [39, 40], participants were grouped into four categories: obese, overweight, normal weight and underweight.

Socioeconomic status

Occupation, financial wealth or deprivation have previously been used as measures of socioeconomic status (SES), but education level has been reported as the best measurement to identify health inequalities [41]. In our study, maternal education level is used as a proxy for SES.

Every Norwegian citizen has a unique personal 11-digit identification number, which was used to identify participants' mothers from the Norwegian Family Register. The data on education was then obtained from the Statistics Norway database (SSB) on 6,852 mothers. The educational levels were coded according to the Norwegian Standard Classification of Education (NUS) into three: primary (0-10 years school attendance, reference category), secondary (11-14 years of school attendance) and tertiary (> 14 years of school attendance) [42].

Statistical analysis

1   Multivariable logistic regression models were employed in sex stratified samples to

2   investigate the associations between DE, BSP and intention to lose weight and SI in separate

3   models for each exposure factors. Models were adjusted for age, BMI, mental distress and

4   SES. Results are reported as Odds Ratios (OR) with 95% confidence intervals. Overall

5   missingness was < 5% and considered missing at random (MAR). We performed a complete

6   case analysis. Models were fitted in IBM SPSS Statistics 25.

7   Based on previous reports on validity and reliability of single-item question on SI [43],the

8   authors concluded that statistical errors are less likely to have influenced the results in a

9   meaningful way, firstly due to fairly large effect sizes observed and reduction in the chances

10 for a Type II error and secondly due to a relatively large sample size that reduces the

11 possibility of a Type I error. Collinearity between exposure variable was examined in linear

12 regression model. The authors found no evidence of multicollinearity as assessed by tolerance

13 values greater than 0.1. Inspection of correlation coefficient showed no evidence support of

14 correlations (all values were under 0.7).

15

16 Independent-samples t-tests and Chi-square tests of independence (both significant at the 0.05

17 level) were performed to determine whether participants from YH1 and YH3 differed in ways

18 that would affect the validity of our results derived from pooled data. Participants were

19 compared on all exposure variables. Wherever no statistically significant differences were

20 observed, the association analyses were done on pooled data from YH1 and YH3 cohorts.

21 Otherwise, association analyses were done separately in YH1 and YH3 as well as on the

22 pooled data. Comparing the results from these separate analyses detected no meaningful

23 difference. Results are therefore reported for pooled data only.

24

1   **Ethics statement**

2   Our study was conducted in accordance to the Helsinki Declaration and was approved by the

3   Regional and National Committees for Medical and Health Research Ethics (2009/740-2) as

4   well as by the Norwegian Data Inspectorate. In Norway, the legal age for consent is 16 years.

5   Written consents were obtained from participants older than 16, and from their parents or

6   legal guardians for younger participants.

7

8   **Patient and Public Involvement statement**

9   Patients and the public were not involved in the design and conception of the study.

10   Recruitment phase was entry level for the public. There are no plans to disseminate the results

11   to patients.

12

13   **Results**

14   **Population characteristics**

15   Overall prevalence of SI in our study population was 23.0 %. Prevalence of SI was similar

16   between YH1 and YH3 (Table 1). The prevalence of SI amongst adolescents in the poor

17   appetite/undereating group was 44.1% and 35.0% amongst those in the uncontrolled

18   appetite/overeating group, as opposed to 20.5% in participants without DE.

Table 1. Sample characteristics (n=7 628†; 3659 girls, 3609 boys, mean age=17.63 years):

| | Total | Boys | Girls |
	N (%)	N (%)	N (%)
Suicidal ideation			
Young-HUNT1	939(23.1)	417(20.1)	522(26.3)
Young-HUNT3	742(23.1)	311(20.2)	431(25.3)
Weight categories (BMI)‡			

Obese	296(4.5)	143(4.3)	153(4.7)
Overweight	1072(16.4)	552(16.8)	520(16.1)
Normal weight	4855(74.5)	2443(74.1)	2412(74.8)
Underweight	296(4.5)	157(4.8)	139(4.3)
Body size perception			
Very fat	154(2.1)	41(1.1)	113(3.1)
Quite fat	1639(22.7)	606(17.0)	1033(28.4)
About the same as others	4119(57.2)	2097(58.7)	2022(55.7)
Quite thin	1210(16.8)	771(21.4)	439(12.1)
Very thin	84(1.2)	58(1.6)	26(0.7)
Intention to lose weight			
Yes	1085(15.1)	256(7.2)	829(22.9)
No, but I need to lose weight	1282(17.8)	428(12.0)	854(23.6)
No, I am comfortable with my weight	4827(67.1)	2890(80.9)	1937(53.5)
Disordered eating			
Poor appetite/undereating	338(4.7)	74(2.1)	264(7.3)
Uncontrolled appetite/overeating	843(11.8)	363(10.2)	480(13.3)
Anxiety/depression	1484(20.9)	439(12.5)	1045(29.2)

†Subgroups may not sum to total number due to missing values.

‡Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

1

2 Uncontrolled appetite/overeating was more prevalent (11.8%) than poor appetite/undereating

3 (4.7%) with girls more affected than boys in both groups (Table 1). The prevalence of poor

4 appetite/undereating was similar in YH1 and YH3 (4.5% and 5.0% respectively) whilst the

5 prevalence of uncontrolled appetite/overeating decreased from YH1 to YH3 (13.7% to 9.4%).

6 Compared to those without DEs, more participants with DE perceived themselves as <u>not</u>

7 "about the same as others" (Table 2). In the total sample, 57.2% perceived their body size as

8 <u>not</u> "about the same as others", whereas more girls compared to boys perceived themselves as

9 "fat" or "very fat" whilst more boys, perceived themselves as "thin" or "very thin" (Table 1).

10 Irrespective of BMI, a general trend of underestimation of body size in boys and

11 overestimation in girls was found (Supplementary table 1).

Table 2. Intention to lose weight and body size perception in individuals with DE in pooled data:

	Uncontrolled appetite/ overeating group	Poor appetite/ undereating group

	Total N (%)	Boys N (%)	Girls N (%)	Total N (%)	Boys N (%)	Girls N (%)
Intention to lose weight						
Yes	128(15.3)	20(5.6)	108(22.7)	166(49.7)	13(18.1)	153(58.4)
No, but I need to lose weight	89(10.7)	17(4.7)	72(15.2)	71(21.3)	13(18.1)	58(22.1)
No, I am happy with my weight	617(74.0)	322(89.7)	295(62.1)	97(29.0)	46(63.8)	51(19.5)
Body size perception						
Very fat	15(1.8)	4(1.1)	11(2.3)	27(8.1)	7(9.9)	20(7.6)
Quite fat	118(14.0)	25(6.9)	93(19.4)	146(43.6)	19(26.8)	127(48.1)
About the same as others	356(42.3)	133(36.7)	223(46.5)	124(37.0)	27(38.0)	97(36.7)
Quite thin	298(35.4)	163(45.0)	135(28.1)	33(9.9)	16(22.5)	17(6.4)
Very thin	55(6.5)	37(10.2)	18(3.8)	5(1.5)	2(2.8)	3(1.1)

1

2 Majority of participants (67.1%) were comfortable with their weight (Table 1). Compared to

3 boys and irrespective of their actual BMI, more girls were unhappy with their weight

4 (Supplementary table 2). Such gender differences became even more pronounced in

5 participants with DE (Table 2).

6 Girls and boys differed very little in terms of BMI distribution in the total sample (Table 1).

7 Compared to the YH1 sample, BMI distribution shifted towards obese and overweight in

8 YH3, with a greater shift towards obese and overweight in boys (Supplementary table 1).

9 Overall, 20.9% of the participants reported having higher levels of mental distress as defined

10 by SCL-5 (Table 1). Independent of presence or absence of DE, girls showed significantly

11 higher prevalence of mental distress than the boys (Data not shown).

12

13 **Association between suicidal ideation and disordered eating**

14 Compared with those without DE and in both genders, the odds for SI were more than

15 doubled in the poor appetite/undereating group, and almost doubled in the uncontrolled

16 appetite/overeating group. Adjustment for age made negligible changes in the OR for SI;

17 however, adjustments for BMI further increased the odds in both sexes without losing

18 statistical significance (Table 3 and Table 4). With further adjustments for mental distress, the

1   odds for SI remained statistically significant in both sexes in the respective DE subgroups

2   although the effect sizes decreased. After adjustment made for age, BMI and mental distress,

3   boys had higher odds for SI compared to girls in both DE groups (Table 3 and Table 4).

4

5   **Association between suicidal ideation and body size perception**

6   In both sexes, perceiving body size as <u>not</u> "about the same as others" ("very fat", "quite fat",

7   "quite thin" or "very thin") was associated with higher odds for SI. For instance, boys who

8   perceived their body size as "very fat" showed an odds ratio of 4.45 (2.38-8.31) compared to

9   boys who perceived their body size as "about the same as others". The same comparison in

10   girls yielded an odd ratio for SI of 5.54 (3.75-8.18). Similar observations were made in boys

11   or girls who perceived their body size as "quite fat". Higher odds for SI in groups with body

12   size perception as "quite thin" or "very thin" were only statistically significant in boys (see

13   Table 3 and Table 4). All results were robust to adjustment for age, BMI and SCL-5. In both

14   sexes, odds ratios for SI were higher the farther BSP deviated from the population norm

15   ("about the same as others"), in either direction. With some small exceptions, adjustment for

16   mental distress reduced the odds for SI across all BSP groups in both girls and boys (Tables 3

17   and 4). Compared to boys, girls who considered their body size as "very fat" showed slightly

18   higher odds of SI after adjustments for age and BMI. Potential moderator effect of sex was

19   examined in a two-way ANCOVA model in the full dataset with interaction terms. We found

20   no statistical evidence that sex had significant moderator effect on the association between

21   BSP "very fat" and SI (p-value: 0.118).

22

23   **Association between suicidal ideation and intention to lose weight**

1   In the crude analyses, "intention to lose weight", even without actively engaging in weight

2   reduction measures, more than doubled the odds for SI in both genders (Tables 3 and 4).

3   Compared to those who "did not try to lose weight", the odds ratio for SI in those who

4   intended to lose weight was doubled in boys and nearly tripled in girls. These findings were

5   robust to adjustments made for age, BMI and mental distress (Table 3 and Table 4).

6

7   **Testing for possible confounding effect of socioeconomic status (SES)**

8   A subsample of 6,852 participants with available information on highest maternal education

9   level was used to investigate possible confounding effect of SES on the associations between

10   SI and DE, BSP or intention to lose weight. Adjusting for SES made very slight change to our

11   findings (Table 3 and Table 4).

12

Table 3. Odds ratios for suicidal ideation (SI) given disordered eating, body size perception or intention to lose weight in boys:

	Non-adjusted		Adj. for age		Adj. for age/BMI		Adj. for age/BMI/SCL-5		Adj. for age/BMI/SCL-5/SES	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Disordered eating										
Poor appetite/Undereating	**2.47***	1.53-3.98	**2.47***	1.53-3.97	**2.87***	1.75-4.71	**2.10****	1.19-3.73	**2.28****	1.26-4.11
Uncontrolled appetite/Overeating	**1.95***	1.53-2.47	**1.95***	1.53-2.47	**2.09***	1.61-2.71	**1.77***	1.34-2.35	**1.81***	1.35-2.42
Body size perception										
Very fat	**4.45***	2.38-8.31	**4.44***	2.38-8.30	**5.68***	2.78-11.61	**4.20***	1.96-9.02	**4.43***	2.02-9.71
Quite fat	**1.93***	1.56-2.39	**1.93***	1.56-2.39	**2.13***	1.63-2.78	**1.74***	1.31-2.32	**1.64****	1.22-2.21
Quite thin	**1.44****	1.17-1.76	**1.44****	1.17-1.76	**1.53***	1.22-1.92	**1.47****	1.16-1.87	**1.51****	1.18-1.93
Very thin	**3.15***	1.83-5.42	**3.14***	1.83-5.41	**3.82***	2.06-7.08	**3.39***	1.75-6.53	**2.99****	1.51-5.92
Intention to lose weight										
Yes	**2.04***	1.54-2.71	**2.04***	1.54-2.71	**2.24***	1.61-3.11	**1.53****	1.06-2.21	**1.47****	1.01-2.15
No, but I need to lose weight	**2.01***	1.6-2.52	**2.01***	1.60-2.53	**2.23***	1.69-2.95	**1.88***	1.39-2.55	**1.83***	1.34-2.52

Reference category in the dependent variable: No SI. Reference categories in the predictors: Disordered eating: Below cut-off for each trait. Body size perception: About the same as others, Intention to lose weight: No. Adjustment for SES from a subsample of 6852 participants. Primary level education used as reference category. *P-value<0.001, ** P-value<0.05

1

Table 4. Odds ratios for suicidal ideation (SI) given disordered eating, Body size perception or intention to lose weight in girls:

	Non-adjusted		Adj. for age		Adj. for age/BMI		Adj. for age/BMI/SCL-5		Adj. for age/BMI/SCL-5/SES	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Disordered eating										
Poor appetite/Undereating	2.62*	2.03-3.38	2.63*	2.04-3.39	2.83*	2.17-3.70	1.78*	1.33-2.39	1.75*	1.30-2.37
Uncontrolled appetite/Overeating	1.94*	1.58-2.37	1.93*	1.58-2.37	2.05*	1.65-2.55	1.56*	1.23-1.98	1.58*	1.23-2.02
Body size perception										
Very fat	5.54*	3.75-8.18	5.48*	3.71-8.09	5.88*	3.67-9.45	3.96*	2.34-6.69	4.04*	2.35-6.92
Quite fat	2.09*	1.77-2.47	2.10*	1.77-2.48	2.24*	1.84-2.73	1.82*	1.47-2.26	1.85*	1.49-2.30
Quite thin	1.26	0.98-1.60	1.25	0.98-1.60	1.25	0.95-1.64	1.34	0.10-1.79	1.35	1.00-1.82
Very thin	2.09	0.92-4.72	2.04	0.9-4.61	2.53**	1.07-6.01	2.8**	1.13-6.94	2.45	0.95-6.30
Intention to lose weight										
Yes	2.76*	2.31-3.31	2.79*	2.33-3.34	2.97*	2.42-3.65	2.16*	1.73-2.70	2.17*	1.72-2.72
No, but I need to lose weight	1.92*	1.59-2.30	1.92*	1.59-2.31	1.99*	1.61-2.46	1.63*	1.30-2.04	1.61*	1.27-2.02

1 Reference category in the dependent variable: No SI. Reference categories in the predictors: Disordered eating: Below cut-off for each trait. Body size
2 perception: About the same as others (normal), Intention to lose weight: No. Adjustment for SES from a subsample of 6852 participants. Primary level
3 education used as reference category. *P-value<0.001, ** P-value<0.05

1 **Discussion**

2 **Principal findings of this study**

3 Our findings point at a considerable collective increase in the odds for SI amongst adolescents

4 with traits of DEs, body size or weight concerns as well as with other factors such as BMI and

5 mental distress. Adolescent boys with DE traits showed a vulnerability for having SI and

6 require special attention in suicide risk assessment and treatment approaches.

7 **Comparison with previous studies**

8 In line with previous reports [27], we found that DEs were far more prevalent than clinically

9 diagnosed EDs, suggesting that in identification of vulnerable individuals and groups, more

10 weight should be given to the presence of DE symptoms and traits rather than solely to

11 presence or absence of a clinical diagnoses (EDs). A sizeable proportion of high-risk

12 individuals do not meet stringent diagnostic criteria for EDs and hence might slip through the

13 safety net before a suitable care approach can be warranted.

14 There is a high comorbidity between DE and mental distress in the form of anxiety or

15 depressive disorders [44], both closely linked to SI and attempted suicide [6]. DEs or

16 subjective perception of body shape or weight are not routinely included in clinical suicide

17 risk assessments which might lead to underestimation of vulnerability to future SI or suicidal

18 attempts.

19 Although our findings were of similar caliber and direction in both sexes, we observed some

20 sex differences concerning BMI and mental distress. Our observations were in line with

21 previously found sex differences in 1- clinical manifestations of EDs [45] or 2- BSP in

22 relation to actual BMI [46, 47], with girls showing a tendency to overestimate and boys

23 consistently underestimating their body size. In keeping with previous reports[45] [48] [49],

1   our male participants showed less inclination to lose weight independent of their actual BMI.

2   Part of the sex differences in manifestations of EDs has been previously attributed to higher

3   BMI [50, 51]. We could not find evidence in support of BMI having a similar explanatory role

4   for higher OR for SI amongst our male participants with DE traits, possibly partly due to

5   differences in what these young individuals set themselves upon to achieve by dietary

6   restraints or other means to lose weight, with female population more concerned about their

7   weight[52] whilst male population shows more concern for looking masculine and lean[53],

8   which in effect renders BMI less indicative of presence or severity of DEs amongst males.

9   Our findings were in line with previous reports of existing but somewhat overlooked higher

10 vulnerability to mental distress amongst adult male sufferers of DEs [54] that, as previously

11 outlined in great details is reflective of higher prevalence of a wider array of comorbid

12 psychiatric disorders [17] that can potentiate an existing association between DE traits and SI.

13 Furthermore, male populations seem to be more reluctant in seeking help for their symptoms

14 [17] which can further potentiate existing associations between DE traits and SI by the factor

15 of severity of unidentified and hence unaddressed DE traits or other comorbid psychiatric

16 disorders. What constitutes this gender difference requires further research. Considering the

17 increase in the incidence rates of EDs amongst men who also seem to present different set of

18 symptoms of EDs, screening and treating men with EDs is becoming more and more a priority

19 [55]. Current reliance on a diagnostic framework based on thinness[17] fails in identification

20 of muscularity-oriented pathology of EDs in male population, in clinical or research settings.

21 Some discrepancy between participants' actual BMI and body size perception was observed

22 (see Supplementary table 1) where individuals inaccurately perceived their own body size by

23 means of under- or overestimation. The direction of BSP inaccuracy, as under- or

24 overestimation of BSP, in conjunction with gender specific societal body ideals might have

25 some real implications in the degree with which BSP inaccuracy might further associate with

1 mental distress and SI. But one can argue that inaccurate BSP might not necessarily lead to

2 higher mental distress, for instance if the direction of BSP inaccuracy qualifies individuals to

3 a more favorable position in relation to what society regards as normal or ideal. BSP

4 inaccuracy by underestimation might cause less mental distress in female individuals who are

5 obese or overweight but perceive their body size as normal or underweight, in effect

6 rebranding own's body size perception in a more approved fashion (following agreed societal

7 norms). Possible associations between BSP, BSP accuracy, BMI and intention to lose weight

8 require full exploration that is beyond the scope of current study but is being investigated in a

9 parallel study conducted (by the authors) on determinants of dieting in a Norwegian

10 community sample (The HUNT Study).

11

12 **Strengths and limitations**

13 Strengths of this study include the large sample size derived from a total Norwegian adolescent

14 population with a homogenous ethnic background. Further, anthropometric measurements were

15 carried out by trained nurses. To date, most studies on EDs have relied upon clinical data or

16 patient registries of adult populations [56] which leaves out the adolescents in the general

17 population in the time period when psychological distress and disorders often manifest. With the

18 median age of onset for developing EDs reported as low as 12-13 years old [57], the importance

19 of studying younger affected individuals could not be more emphasized. Studies on male ED

20 sufferers are fewer and far in between, with adolescent male participants usually lumped into adult

21 populations [45]. Our results are of general relevance since our observations were made in a large,

22 population-based adolescent dataset that included both males and females.

23 Conclusions should be drawn in the light of certain limitations in the current study. The use of

24 shortened and self-reported measures of DE (EAT-7) or mental distress (SCL-5), and not

25 standardized psychiatric interviews, has in effect rendered our findings less generalizable to

1   clinical populations. SI was assessed by a single item question. Due to temporal bias in a cross-

2   sectional design, we are not able to assess potential causal relationships between DE traits and

3   SI. We do not interpret our results as causal but rather associative, hence, the importance of

4   conducting future longitudinal studies on causality in larger populations. One interesting line of

5   enquiry is to look at various DE traits clustered in smaller groups based on participants' BMI or

6   body size perception, which was not possible to perform in the current study given small number

7   of participants in each cluster. Conducting a follow-up study on a larger dataset from the HUNT

8   Study including adolescents from the most recent data collection, HUNT4 Survey (2017-19), may

9   reach a higher statistical power and hence more conclusive results. Using single-item question on

10 SI in future studies provides an opportunity of validation and to confirm the results obtained here

11 and is hence encouraged by the authors; however, to overcome miscalculation or misinterpretation

12 errors, adding follow up questions will supplement information derived from a single-item

13 question on SI.

Conclusions

14

15 An individually tailored approach to suicide risk assessment and management seems to be

16 more appropriate in subpopulations of adolescents with DEs and its related traits. Our findings

17 on difference between female and male adolescents may have potential implications in the

18 way clinicians address SI across genders. Shifting focus from maintaining a healthy BMI to

19 addressing individuals' attitudes towards their own body shape and size is important in

20 designing treatment plans that reduce burden of suicidal ideation or attempts. Timely

21 identification of associated factors for SI in high-risk but non-clinical populations is important

22 in designing strategic and preventive measures that intend to cut human and economic costs of

23 suicidal ideation and attempts. Future longitudinal research in both clinical and community

24 populations, preferably with data on onset, frequency and severity of SI in comparison to that

1   of DEs traits could help in overcoming current methodological and interpretational difficulties

2   in drawing more conclusive results on temporal relationship between these factors.

3

4   **Acknowledgement**

7

8   **Author statement**

15 **Funding**

22 **Data availability statement**

1 Due to restrictions imposed by the HUNT Research Centre (in accordance with Norwegian

2 Data Inspectorate), data cannot be made publicly available. Data are currently stored in the

3 HUNT databank, and there are restrictions in place for the handling of HUNT data files. Data

4 used from the HUNT Study in research projects will be made available on request to the

5 HUNT Data Access Committee (hunt@medicine.ntnu.no). The HUNT data access

6 information (available here: http://www.ntnu.edu/hunt/data) describes in detail the policy

7 regarding data availability.

8

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Supplementary table 1. Distribution of body size perception in each BMI category in boys and girls; Young HUNT1(YH1) and Young HUNT3(YH3):

	YH1 boys(n=1834)				YH1 girls(n=1845)			
	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)
Body size perception								
Very fat	11(2)	8(3.29)	2(0.14)	0	23(35.93)	19(7.28)	9(0.63)	1(1)
Quite fat	40(72.73)	139(57.20)	113(7.81)	1(1.12)	38(59.38)	182(69.73)	311(21.9)	1(1)
Like others	4(7.27)	94(38.68)	967(66.83)	19(21.35)	3(4.69)	59(22.61)	948(66.76)	26(26)
Quite thin	0	2(0.82)	354(24.46)	59(66.29)	0	1(0.38)	146(10.28)	66(66)
Very thin	0	0	11(0.76)	10(11.24)	0	0	6(0.42)	6(6)
Total	**55**	**243**	**1447**	**89**	**64**	**261**	**1420**	**100**
	YH3 boys(n=1358)				YH3 girls(n=1430)			
	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(
Body size perception								
Very fat	8(8.60)	1(0.37)	6(0.64)	0	16(20.78)	16(5.56)	8(0.79)	0
Quite fat	72(77.42)	104(38.10)	64(6.79)	0	55(71.43)	158(54.86)	167(16.55)	0
Like others	13(13.98)	167(61.17)	611(64.79)	5(10.20)	6(7.79)	113(39.24)	676(67.00)	15(26.79)
Quite thin	0	0	245(25.98)	33(67.35)	0	0	154(15.26)	34(60.71)
Very thin	0	1(0.37)	17(1.80)	11(22.45)	0	1()	4(0.40)	7(12.5)
Total	**93**	**273**	**943**	**49**	**77**	**288**	**1009**	**56**

Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

Supplementary table 2. Intention to lose weight and weight categories in boys and girls, pooled data:

	Boys(n=3191)				Girls(n=3260)			
	Obese(%)	Overweight(%)	Normal(%)	Underweight(%)	Obese(%)	Overweight(%)	Normal(%)	Underweigh
Intention to lose weight								
Yes	45(29.80)	101(23.77)	81(3.40)	0	59(42.14)	203(37.39)	455(18.79)	5(3.23)
No, but I need to lose weight	83(54.97)	157(36.94)	132(5.53)	3(2.19)	76(54.29)	232(42.73)	455(18.79)	4(2.58)
No, I am comfortable with my weight	23(15.23)	258(60.71)	2174(91.12)	134(97.81)	5(3.57)	108(19.89)	1512(62.43)	146(94.1
Total	**151**	**425**	**2386**	**137**	**140**	**543**	**2422**	**155**

Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

Disordered eating

The EAT (Eating Attitude Test) is a standardized self-report questionnaire that has been used to identify individuals at risk of developing EDs [1] in both clinical and non-clinical adolescent populations and can discriminate eating disordered patients and controls[2]. Since EAT was considered too long to be included in the Young-HUNT Study, a shortened version, EAT-7, was used to identify disordered eating. For psychometric properties of EAT-7 [3]. Psychometric properties of the EAT-7 have been previously validated in two cohorts, YH1 [4] and 'Young in Norway' [5], and a two-factor solution of the EAT-7: EAT-A or "poor appetite/undereating" and EAT-B or "uncontrolled appetite/overeating", is reported to be robust for age and gender [4].

The EAT-A comprises the questions: 1) It can be difficult to stop eating when I first begin to eat, 2) I spend too much time thinking about food, 3) I feel that food controls my life, and 4) When I eat, I cut food in small pieces. EAT-B consists of questions: 1) When I eat a meal, I spend longer time than others, 2) Others think that I am too thin and 3) I feel that others pressure me to eat. Participants answered questions on a Likert scale with response options: "never/seldom" (coded as 0), "often" (coded as 1) and "always" (coded as 2). Scores on each question item were added up to determine sum-scores on EAT-A and EAT-B subscales separately. A maximum score for the EAT-A and EAT-B were therefore 8 and 6, respectively. Previously reported cut-off points [4] were then used to categorize participants into groups of cases with elevated EAT-A (score ≥ 3) or EAT-B (score ≥ 2). Cases were compared to adolescents scoring below these cut offs. Adolescents who scored above the cut-off on both the EAT-A and EAT-B (92 persons in total) were included in the analyses since associations between each EAT-7 subscale and SI were not deemed mutually exclusive. Cronbach's alphas were 0.57, 0.42 and 0.54 for EAT-A, EAT-B and EAT-7, respectively.

Principal Component Analysis for optimal cut-off points for EAT-A and EAT-B has been in agreement with previous reports and the cut-off points were also validated against the EAT-12 [4].

Mental distress

The Five-item Hopkins Symptom Checklist (SCL-5) [6], a valid and reliable measure of mental distress [7] was used to measure mental distress. SCL-5 is a shorter version of SCL-25 that constitutes 10 questions on anxiety and 15 questions on depression [8]. Self-rated measures of anxiety and depression on SCL-25 have a reported concordance rate of 86.7% with clinical assessment by a physician [8]. Stepwise regression has been used to identify question items that had maximum correlation with the scores on anxiety, depression and global scores on SCL-25 [7] [9]. Five of these question items constitute SCL-5, with an estimated correlation of 0.92 with SCL-25, an alpha reliability at 0.85 [9] and estimated sensitivity and specificity of 82% and 96 %, respectively [6].

On SCL-5, participants rated the presence or absence of the following five symptoms on a four-point Likert scale ranging from 1) "not bothered" to 4) "very much bothered" in response to the following question: "During the last 14 days", have you: 1) "Been constantly afraid and anxious", 2) "Felt tense or uneasy", 3) "Felt hopelessness when you think of the future", 4) "Felt dejected or sad" or 5) "Worried too much about various things". Only participants who had answered four or more questions were included. Sum scores were calculated by adding up scores on each question item. The sum score was then divided by the number of items answered. Based on previously reported cut-off points, SCL-5 scores of ≥2 were categorized as having "high" degree of mental distress (anxiety or depression), whereas SCL-5 scores < 2 were considered as "low" levels of mental distress [6].

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STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up	4
		(*b*) For matched studies, give matching criteria and number of exposed and unexposed	
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5-7
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8, Appendix
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	7-8, Appendix
		(*b*) Describe any methods used to examine subgroups and interactions	
		(*c*) Explain how missing data were addressed	
		(*d*) If applicable, explain how loss to follow-up was addressed	
		(*e*) Describe any sensitivity analyses	
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	9-10
		(b) Give reasons for non-participation at each stage	
		(c) Consider use of a flow diagram	
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	9-10
		(b) Indicate number of participants with missing data for each variable of interest	
		(c) Summarise follow-up time (eg, average and total amount)	
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-10

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-14
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-14

Discussion			
Key results	18	Summarise key results with reference to study objectives	15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16-17

Other information			
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	18

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.

BMJ Open

Suicidal ideation in relation to disordered eating, body size and weight perception: a cross-sectional study of a Norwegian adolescent population - The HUNT Study

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1 **Abstract**

2 **Objective:** We conducted a population-based study on a sample of more than 7,000

3 adolescents where we examined the associations between suicidal ideation (SI) and disordered

4 eating (DE) and its related traits. **Design:** Cross-sectional. **Settings:** Data were derived from

5 two Norwegian population-based cohorts, the Young-HUNT1 (1995-97) and Young-HUNT3

6 (2006-08) from the county of Nord-Trøndelag, Norway. **Participants:** A total of 7,268

7 adolescents (15-19 years) who had completed self-reported questionnaires including items on

8 SI, DE, body size and weight perception were included. **Primary outcome measures:** Odds

9 ratios for SI given DE, body size or weight perception. Analyses were performed in

10 multivariate logistic regression models. **Results:** The prevalence of SI was 23.1% in total

11 population. Both girls and boys who reported DE, evaluated their body size as <u>not</u> "about the

12 same as others" or were "unhappy about their weight" had between two to five-fold increase

13 in odds for SI; these incremental risks were observed independent of sex, age, BMI and

14 socioeconomic status. We observed higher odds for SI amongst boys. **Conclusions:** Our

15 findings suggest a clear association between SI and DE and its associated traits, in both

16 genders but especially in males. Special attention should be paid on early detection of DE

17 traits amongst adolescents.

18 **Keywords:** Adolescents, Body size perception, Intention to lose weight, Eating disorder

19 (ED), EAT-12, HUNT, Suicidal ideation.

20

Strength and limitations of this study:

22 • We have identified detectable yet somewhat overlooked factors that may assist in

23 addressing suicidal ideation in adolescents.

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1 • Our results are of general relevance since our observations were made in a large,

2 population-based adolescent dataset that included both males and females.

3 • We address a vulnerable period with a potential for timely individual and societal

4 interventions.

5 • A limitation of this study was the use of a single item question on suicidal ideation.

6

Introduction

8 Suicide presides above all other causes of death in individuals aged 15-39 years [1]. The

9 World Health Organization (WHO) has urged countries to invest in comprehensive suicide

10 prevention strategies [2] that identify and address the factors underlying suicidal ideation,

11 suicidal attempt and suicide. Suicidal ideation varies in form and degree of severity, from

12 fleeting thoughts to detailed planning. A meta-analysis of 172 longitudinal studies [3] has

13 shown that in adults, SI strongly correlates with suicidal attempt and death by suicide that

14 remains robust even after adjusting for severity of depression and stress-events [4].

15 In adolescents, suicidal ideation is associated with an array of psychiatric disorders, most

16 significantly mood disorders and eating disorders (EDs) [5] but also anxiety [5] [6], weight

17 and shape concerns [7], lack of regard for one's own body [8], higher body mass index (BMI)

18 [9, 10], and binge/purge symptoms [11, 12]. The suicide risk seems to be higher if eating

19 disorders and other psychological problems coexist [8]. Predictive ability of suicide risk

20 factors has not changed much in the past 50 years, partly due to methodological problems and

21 lack of research on a wider list of factors that can explain suicidal ideation or behavior in a

22 way previously identified risk factors have not [13, 14].

23 Studying factors associating suicide in populations with traits of eating disorder poses certain

24 difficulties. Since no more than one in four individuals with EDs come to the attention of

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1   clinicians[15], results derived from clinical data are less generalizable. Moreover, studies on

2   the associations between SI and EDs have been limited to clinical data on EDs with primarily

3   female participants[16, 17] whilst for instance in Australia, one in four and in UK, one in

4   three preadolescents who attend special ED clinics are male[18, 19]. In fact contrary to what

5   was initially believed, prevalence of certain ED diagnoses is higher amongst male population

6   than their female counterparts[20] [21]. Sex differences in the clinical representation of the

7   various specific EDs are also detected [17]. Current diagnostic criteria are mainly derived

8   from female populations and fail to identify a sizable number of male sufferers who do not fit

9   in the female ED profile. The importance of research in male populations with EDs cannot be

10   emphasized more.

11   Another potential problem area in conducting research in populations with EDs is the

12   heterogeneity within and across specific ED diagnoses. EDs, as classified by American

13   Psychiatric Association are 'Disorders of feeding and eating' [22] and range from clinical

14   forms that meet stringent diagnostic criteria of Anorexia Nervosa to forms that fluctuate in

15   form and severity over the years and may not necessarily fall into diagnostic categories [22].

16   In both clinical and research settings, using current diagnostic criteria will inevitably lead to

17   missing a population who presents fewer numbers of ED symptoms that may nevertheless

18   cause discomfort or a degree of dysfunction. This particular group is referred to as one

19   presenting symptoms of disordered eating (DE), a clinically less pronounced form of

20   'disorders of feeding and eating' [23], that seems to occur more frequently than EDs amongst

21   adolescents[24-26] specially in those with higher BMI [27]. New and large cross-gender

22   population-based research is essential in reliably understanding SI and its associated factors

23   amongst adolescents with DE traits [28].

1　With the age for SI onset reported to be as young as 10 years [29], the importance of research

2　at young adolescence period when prevalence of both SI and Eating Disorders (EDs)

3　increases [1] [30] [31] [32] cannot be overemphasized.

4　Accordingly, the purpose of the current investigation was to study DE traits in relation to SI in

5　a large sample of more than 7,000 Norwegian adolescents, including large numbers of male

6　participants. Prevalence of SI, DE traits and their characteristics were studied. Having found

7　supporting evidence in literature on adults[33, 34], authors first examined whether DE or its

8　related traits, such as weight and shape concerns, are associated with SI amongst adolescents

9　and secondly whether such potential associations could be accounted for by other factors such

10　as individuals' level of mental distress, BMI or socioeconomic status. The authors

11　hypothesized that SI is associated with DE and its related traits such as body size or weight

12　perception that are independent of BMI, mental distress and socioeconomic status.

13

Materials and methods

Study design and population

16　Research subjects participated in the Young-HUNT (YH) Study, which is the adolescent arm

17　(13–19 years) of the Nord-Trøndelag Health Study (https://www.ntnu.edu/hunt). The HUNT

18　Study was primarily designed to investigate major public health issues in residents of the

19　county of Nord-Trøndelag, Norway. The YH Study comprises two cross-sectional surveys so

20　far: YH1 (1995–97) and YH3 (2006–08). These surveys were carried out at schools (response

21　rates between 83% and 90%). Data on DE traits, weight and shape concerns, mental distress,

22　socioeconomic status and SI were collected through self-reported questionnaires. Clinical

23　measurements were undertaken by specially trained nurses. The Young-HUNT database

1   includes anonymized data on 17,820 participants. Cohort profiles of both the adult HUNT

2   Study and the Young-HUNT Study have been previously described [35, 36].

3   Data from the YH1 and YH3 were combined and used for the present analyses. Only

4   participants 15 years of age or older were asked about SI and were therefore eligible for our

5   study. The total of 7,268 participants, (4,057 individuals from YH1 and 3,211 from YH3) that

6   had both questionnaire and clinical examination data were included in our study. Age and

7   gender distribution in the Young-HUNT1 (mean age: 17.62, female: 52.1%) and Young-

8   HUNT3 (mean age 17.63, female: 49.0%) were similar.

9

10   **Measurements**

11   **Suicidal ideation**

12   SI was measured by a single question asking participants: "Have you ever had thoughts of

13   taking your own life?" to which they could answer "Yes" or "No".

14

15   **Disordered eating (DE)**

16   EAT-7, a shortened version of The EAT (Eating Attitude Test) was used to identify

17   participants with DE (see Appendix). Individuals who were identified as having DE were then

18   grouped into two groups: EAT-A or "poor appetite/undereating" and EAT-B or "uncontrolled

19   appetite/overeating". Association analyses were performed on sex stratified groups with EAT-

20   A or EAT-B compared to those without DE (reference group). For more detail on EAT-7 and

21   its psychometric properties please see Appendix.

1   It is important to note that terms EDs and DE are not used interchangeably in the current

2   study. ED has been the preferred term whenever authors referred to previous research

3   conducted in populations with defined EDs.

4

5   **Body size perception**

6   Body size perception (BSP) was measured by asking: "Do you consider yourself to be: "very

7   fat", "quite fat", "about the same as others", "quite thin" or "very thin". Participants who

8   perceived their body size as "about the same as others" have been used as reference group.

9

10   **Intention to lose weight**

11   Intention to lose weight was assessed by the following question: "Are you trying to lose

12   weight?" to which participants could answer: 1) "No, I am comfortable with my weight", 2)

13   "No, but I need to lose weight" or 3) "Yes". Participants who were comfortable with their

14   weight (alternative 1) were used as reference group.

15

16   **Mental distress**

17   The Five-item Hopkins Symptom Checklist (SCL-5) [37], a valid and reliable measure of

18   mental distress [38] was used to identify participants with a high degree of mental distress

19   (see Appendix). Based on previously reported cut-off points, participants were grouped into

20   those with "high" degree of mental distress (anxiety or depression) as opposed to those with

21   "low" levels of mental distress who were used as reference group.

22

1 **Anthropometric measures**

2 Standardized measurements of height and weight were carried out by trained nurses where

3 participants wore light clothing and no shoes. Weight was measured to the nearest half kilo

4 and height to the nearest cm. BMI was calculated as weight (kg)/height^2 (m^2). Based on

5 standard definitions outlined by Cole and colleagues where age and gender are taken into

6 consideration whilst interpreting BMI [39, 40], participants were grouped into four categories:

7 obese, overweight, normal weight and underweight.

8

9 **Socioeconomic status**

10 Occupation, financial wealth or deprivation have previously been used as measures of

11 socioeconomic status (SES), but education level has been reported as the best measurement to

12 identify health inequalities [41]. In our study, maternal education level is used as a proxy for

13 SES.

14 Every Norwegian citizen has a unique personal 11-digit identification number, which was

15 used to identify participants' mothers from the Norwegian Family Register. The data on

16 education was then obtained from the Statistics Norway database (SSB) on 6,852 mothers.

17 The educational levels were coded according to the Norwegian Standard Classification of

18 Education (NUS) into three: primary (0-10 years school attendance, reference category),

19 secondary (11-14 years of school attendance) and tertiary (> 14 years of school attendance)

20 [42].

21

22 **Statistical analysis**

1   Multivariable logistic regression models were employed in sex stratified samples to

2   investigate the associations between DE, BSP and intention to lose weight and SI in separate

3   models for each exposure factors. Models were adjusted for age, BMI, mental distress and

4   SES. Results are reported as Odds Ratios (OR) with 95% confidence intervals. Overall

5   missingness was < 5% and considered missing at random (MAR). We performed a complete

6   case analysis. Models were fitted in IBM SPSS Statistics 25.

7   Based on previous reports on validity and reliability of single-item question on SI [43],the

8   authors concluded that statistical errors are less likely to have influenced the results in a

9   meaningful way, firstly due to fairly large effect sizes observed and reduction in the chances

10 for a Type II error and secondly due to a relatively large sample size that reduces the

11 possibility of a Type I error. Collinearity between exposure variable was examined in linear

12 regression model. The authors found no evidence of multicollinearity as assessed by tolerance

13 values greater than 0.1. Inspection of correlation coefficient showed no evidence in support of

14 high correlations (all values were under 0.7).

15

16 Independent-samples t-tests and Chi-square tests of independence (both significant at the 0.05

17 level) were performed to determine whether participants from YH1 and YH3 differed in ways

18 that would affect the validity of our results derived from pooled data. Participants were

19 compared on all exposure variables. Wherever no statistically significant differences were

20 observed, the association analyses were done on pooled data from YH1 and YH3 cohorts.

21 Otherwise, association analyses were done separately in YH1 and YH3 as well as on the

22 pooled data. Comparing the results from these separate analyses detected no meaningful

23 difference. Results are therefore reported for pooled data only.

24

1 **Ethics statement**

2 Our study was conducted in accordance to the Helsinki Declaration and was approved by the

3 Regional and National Committees for Medical and Health Research Ethics (2009/740-2) as

4 well as by the Norwegian Data Inspectorate. In Norway, the legal age for consent is 16 years.

5 Written consents were obtained from participants older than 16, and from their parents or

6 legal guardians for younger participants.

7

8 **Patient and Public Involvement statement**

9 Patients and the public were not involved in the design and conception of the study.

10 Recruitment phase was entry level for the public. There are no plans to disseminate the results

11 to patients.

12

13 **Results**

14 **Population characteristics**

15 Overall prevalence of SI in our study population was 23.0 %. Prevalence of SI was similar

16 between YH1 and YH3 (Table 1). The prevalence of SI amongst adolescents in the poor

17 appetite/undereating group was 44.1% and 35.0% amongst those in the uncontrolled

18 appetite/overeating group, as opposed to 20.5% in participants without DE.

Table 1. Sample characteristics (n=7 628†; 3659 girls, 3609 boys, mean age=17.63 years):

	Total N (%)	Boys N (%)	Girls N (%)
Suicidal ideation			
Young-HUNT1	939(23.1)	417(20.1)	522(26.3)
Young-HUNT3	742(23.1)	311(20.2)	431(25.3)
Weight categories (BMI)‡			

Obese	296(4.5)	143(4.3)	153(4.7)
Overweight	1072(16.4)	552(16.8)	520(16.1)
Normal weight	4855(74.5)	2443(74.1)	2412(74.8)
Underweight	296(4.5)	157(4.8)	139(4.3)
Body size perception			
Very fat	154(2.1)	41(1.1)	113(3.1)
Quite fat	1639(22.7)	606(17.0)	1033(28.4)
About the same as others	4119(57.2)	2097(58.7)	2022(55.7)
Quite thin	1210(16.8)	771(21.4)	439(12.1)
Very thin	84(1.2)	58(1.6)	26(0.7)
Intention to lose weight			
Yes	1085(15.1)	256(7.2)	829(22.9)
No, but I need to lose weight	1282(17.8)	428(12.0)	854(23.6)
No, I am comfortable with my weight	4827(67.1)	2890(80.9)	1937(53.5)
Disordered eating			
Poor appetite/undereating	338(4.7)	74(2.1)	264(7.3)
Uncontrolled appetite/overeating	843(11.8)	363(10.2)	480(13.3)
Anxiety/depression	1484(20.9)	439(12.5)	1045(29.2)

†Subgroups may not sum to total number due to missing values.

‡Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

1

2   Uncontrolled appetite/overeating was more prevalent (11.8%) than poor appetite/undereating

3   (4.7%) with girls more affected than boys in both groups (Table 1). The prevalence of poor

4   appetite/undereating was similar in YH1 and YH3 (4.5% and 5.0% respectively) whilst the

5   prevalence of uncontrolled appetite/overeating decreased from YH1 to YH3 (13.7% to 9.4%).

6   Compared to those without DE, more participants with DE perceived themselves as <u>not</u>

7   "about the same as others" (Table 2). In the total sample, 57.2% perceived their body size as

8   <u>not</u> "about the same as others", whereas more girls compared to boys perceived themselves as

9   "fat" or "very fat" whilst more boys, perceived themselves as "thin" or "very thin" (Table 1).

10   Irrespective of BMI, a general trend of underestimation of body size in boys and

11   overestimation in girls was found (Supplementary table 1).

Table 2. Intention to lose weight and body size perception in individuals with DE in pooled data:

	Uncontrolled appetite/ overeating group	Poor appetite/ undereating group

11 | P a g e

	Total N (%)	Boys N (%)	Girls N (%)	Total N (%)	Boys N (%)	Girls N (%)
Intention to lose weight						
Yes	128(15.3)	20(5.6)	108(22.7)	166(49.7)	13(18.1)	153(58.4)
No, but I need to lose weight	89(10.7)	17(4.7)	72(15.2)	71(21.3)	13(18.1)	58(22.1)
No, I am happy with my weight	617(74.0)	322(89.7)	295(62.1)	97(29.0)	46(63.8)	51(19.5)
Body size perception						
Very fat	15(1.8)	4(1.1)	11(2.3)	27(8.1)	7(9.9)	20(7.6)
Quite fat	118(14.0)	25(6.9)	93(19.4)	146(43.6)	19(26.8)	127(48.1)
About the same as others	356(42.3)	133(36.7)	223(46.5)	124(37.0)	27(38.0)	97(36.7)
Quite thin	298(35.4)	163(45.0)	135(28.1)	33(9.9)	16(22.5)	17(6.4)
Very thin	55(6.5)	37(10.2)	18(3.8)	5(1.5)	2(2.8)	3(1.1)

1

2 Majority of participants (67.1%) were comfortable with their weight (Table 1). Compared to

3 boys and irrespective of their actual BMI, more girls were unhappy with their weight

4 (Supplementary table 2). Such gender differences became even more pronounced in

5 participants with DE (Table 2).

6 Girls and boys differed very little in terms of BMI distribution in the total sample (Table 1).

7 Compared to the YH1 sample, BMI distribution shifted towards obese and overweight in

8 YH3, with a greater shift towards obese and overweight in boys (Supplementary table 1).

9 Overall, 20.9% of the participants reported having higher levels of mental distress as defined

10 by SCL-5 (Table 1). Independent of presence or absence of DE, girls showed significantly

11 higher prevalence of mental distress than the boys (Data not shown).

12

13 **Association between suicidal ideation and disordered eating**

14 Compared with those without DE and in both genders, the odds for SI were more than

15 doubled in the poor appetite/undereating group, and almost doubled in the uncontrolled

16 appetite/overeating group. Adjustment for age made negligible changes in the OR for SI;

17 however, adjustments for BMI further increased the odds in both sexes without losing

18 statistical significance (Table 3 and Table 4). With further adjustments for mental distress, the

1 odds for SI remained statistically significant in both sexes in the respective DE subgroups

2 although the effect sizes decreased. After adjustment made for age, BMI and mental distress,

3 boys had higher odds for SI compared to girls in both DE groups (Table 3 and Table 4).

4

5 **Association between suicidal ideation and body size perception**

6 In both sexes, perceiving body size as <u>not</u> "about the same as others" ("very fat", "quite fat",

7 "quite thin" or "very thin") was associated with higher odds for SI. For instance, boys who

8 perceived their body size as "very fat" showed an odds ratio of 4.45 (2.38-8.31) compared to

9 boys who perceived their body size as "about the same as others". The same comparison in

10 girls yielded an odd ratio for SI of 5.54 (3.75-8.18). Similar observations were made in boys

11 or girls who perceived their body size as "quite fat". Higher odds for SI in groups with body

12 size perception as "quite thin" or "very thin" were only statistically significant in boys (see

13 Table 3 and Table 4). All results were robust to adjustment for age, BMI and SCL-5. In both

14 sexes, odds ratios for SI were higher the farther BSP deviated from the population norm

15 ("about the same as others"), in either direction. With some small exceptions, adjustment for

16 mental distress reduced the odds for SI across all BSP groups in both girls and boys (Tables 3

17 and 4). Compared to boys, girls who considered their body size as "very fat" showed slightly

18 higher odds of SI after adjustments for age and BMI. Potential moderator effect of sex was

19 examined in a two-way ANCOVA model in the full dataset with interaction terms. We found

20 no statistical evidence that sex had significant moderator effect on the association between

21 BSP "very fat" and SI (p-value: 0.118).

22

23 **Association between suicidal ideation and intention to lose weight**

1   In the crude analyses, "intention to lose weight", even without actively engaging in weight

2   reduction measures, more than doubled the odds for SI in both genders (Tables 3 and 4).

3   Compared to those who "did not try to lose weight", the odds ratio for SI in those who

4   intended to lose weight was doubled in boys and nearly tripled in girls. These findings were

5   robust to adjustments made for age, BMI and mental distress (Table 3 and Table 4).

6

7   **Testing for possible confounding effect of socioeconomic status (SES)**

8   A subsample of 6,852 participants with available information on highest maternal education

9   level was used to investigate possible confounding effect of SES on the associations between

10   SI and DE, BSP or intention to lose weight. Adjusting for SES made very slight change to our

11   findings (Table 3 and Table 4).

12

Table 3. Odds ratios for suicidal ideation (SI) given disordered eating, body size perception or intention to lose weight in boys:

	Non-adjusted		Adj. for age		Adj. for age/BMI		Adj. for age/BMI/SCL-5		Adj. for age/BMI/SCL-5/SES	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Disordered eating										
Poor appetite/Undereating	**2.47***	1.53-3.98	**2.47***	1.53-3.97	**2.87***	1.75-4.71	**2.10****	1.19-3.73	**2.28****	1.26-4.11
Uncontrolled appetite/Overeating	**1.95***	1.53-2.47	**1.95***	1.53-2.47	**2.09***	1.61-2.71	**1.77***	1.34-2.35	**1.81***	1.35-2.42
Body size perception										
Very fat	**4.45***	2.38-8.31	**4.44***	2.38-8.30	**5.68***	2.78-11.61	**4.20***	1.96-9.02	**4.43***	2.02-9.71
Quite fat	**1.93***	1.56-2.39	**1.93***	1.56-2.39	**2.13***	1.63-2.78	**1.74***	1.31-2.32	**1.64****	1.22-2.21
Quite thin	**1.44****	1.17-1.76	**1.44****	1.17-1.76	**1.53***	1.22-1.92	**1.47****	1.16-1.87	**1.51****	1.18-1.93
Very thin	**3.15***	1.83-5.42	**3.14***	1.83-5.41	**3.82***	2.06-7.08	**3.39***	1.75-6.53	**2.99****	1.51-5.92
Intention to lose weight										
Yes	**2.04***	1.54-2.71	**2.04***	1.54-2.71	**2.24***	1.61-3.11	**1.53****	1.06-2.21	**1.47****	1.01-2.15
No, but I need to lose weight	**2.01***	1.6-2.52	**2.01***	1.60-2.53	**2.23***	1.69-2.95	**1.88***	1.39-2.55	**1.83***	1.34-2.52

Reference category in the dependent variable: No SI. Reference categories in the predictors: Disordered eating: Below cut-off for each trait. Body size perception: About the same as others, Intention to lose weight: No. Adjustment for SES from a subsample of 6852 participants. Primary level education used as reference category. *P-value<0.001, ** P-value<0.05

1

Table 4. Odds ratios for suicidal ideation (SI) given disordered eating, Body size perception or intention to lose weight in girls:

	Non-adjusted		Adj. for age		Adj. for age/BMI		Adj. for age/BMI/SCL-5		Adj. for age/BMI/SCL-5/SES	
	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI	OR	95% CI
Disordered eating										
Poor appetite/Undereating	**2.62***	2.03-3.38	**2.63***	2.04-3.39	**2.83***	2.17-3.70	**1.78***	1.33-2.39	**1.75***	1.30-2.37
Uncontrolled appetite/Overeating	**1.94***	1.58-2.37	**1.93***	1.58-2.37	**2.05***	1.65-2.55	**1.56***	1.23-1.98	**1.58***	1.23-2.02
Body size perception										
Very fat	**5.54***	3.75-8.18	**5.48***	3.71-8.09	**5.88***	3.67-9.45	**3.96***	2.34-6.69	**4.04***	2.35-6.92
Quite fat	**2.09***	1.77-2.47	**2.10***	1.77-2.48	**2.24***	1.84-2.73	**1.82***	1.47-2.26	**1.85***	1.49-2.30
Quite thin	**1.26**	0.98-1.60	1.25	0.98-1.60	1.25	0.95-1.64	1.34	0.10-1.79	1.35	1.00-1.82
Very thin	**2.09**	0.92-4.72	2.04	0.9-4.61	**2.53****	1.07-6.01	**2.8****	1.13-6.94	2.45	0.95-6.30
Intention to lose weight										
Yes	**2.76***	2.31-3.31	**2.79***	2.33-3.34	**2.97***	2.42-3.65	**2.16***	1.73-2.70	**2.17***	1.72-2.72
No, but I need to lose weight	**1.92***	1.59-2.30	**1.92***	1.59-2.31	**1.99***	1.61-2.46	**1.63***	1.30-2.04	**1.61***	1.27-2.02

1 Reference category in the dependent variable: No SI. Reference categories in the predictors: Disordered eating: Below cut-off for each trait. Body size
2 perception: About the same as others (normal), Intention to lose weight: No. Adjustment for SES from a subsample of 6852 participants. Primary level
3 education used as reference category. *P-value<0.001, ** P-value<0.05

1 **Discussion**

2 **Principal findings of this study**

3 Our findings point at a considerable collective increase in the odds for SI amongst adolescents

4 with traits of DE, body size or weight concerns as well as with other factors such as BMI and

5 mental distress. Adolescent boys with DE traits showed a vulnerability for having SI and

6 require special attention in suicide risk assessment and treatment approaches.

7 **Comparison with previous studies**

8 In line with previous reports [27], we found that DE was far more prevalent than clinically

9 diagnosed EDs, suggesting that in identification of vulnerable individuals and groups, more

10 weight should be given to the presence of DE symptoms and traits rather than solely to

11 presence or absence of a clinical diagnoses (EDs). A sizeable proportion of high-risk

12 individuals do not meet stringent diagnostic criteria for EDs and hence might slip through the

13 safety net before a suitable care approach can be warranted.

14 There is a high comorbidity between DE and mental distress in the form of anxiety or

15 depressive disorders [44], both closely linked to SI and attempted suicide [6]. DE or

16 subjective perception of body shape or weight are not routinely included in clinical suicide

17 risk assessments which might lead to underestimation of vulnerability to future SI or suicidal

18 attempts.

19 Although our findings were of similar caliber and direction in both sexes, we observed some

20 sex differences concerning BMI and mental distress. Our observations were in line with

21 previously found sex differences in 1- clinical manifestations of EDs [45] or 2- BSP in

22 relation to actual BMI [46, 47], with girls showing a tendency to overestimate and boys

23 consistently underestimating their body size. In keeping with previous reports[45] [48] [49],

1   our male participants showed less inclination than the females to lose weight, independent of

2   their actual BMI. Unlike previous research that has accounted BMI for gender differences in

3   ED manifestations [50, 51], higher BMI could not explain higher OR for SI amongst our male

4   participants with DE traits, possibly because they were not as much concerned with their BMI

5   as they are with looking masculine and lean [52]. In contrast, their female counterparts seem

6   to be more concerned about their weight[53], which in effect renders BMI less indicative of

7   presence or severity of DE amongst males. Similar to previous reports [54], we found higher

8   vulnerability to mental distress amongst adult male sufferers of DE. This higher vulnerability

9   is possibly a reflection of higher prevalence of a wider array of comorbid psychiatric disorders

10 [17] amongst these male sufferers of DE. Presence of psychiatric comorbidities can potentiate

11 existing associations between DE and SI amongst males with DE. Furthermore, male

12 populations seem to be more reluctant in seeking help for their symptoms [17] which can

13 further exacerbate the associations between DE and SI as these individuals will not be

14 receiving help for either condition. Further research is required for understanding what

15 constitutes this gender difference. Considering the increase in the incidence rates of EDs

16 amongst men who also seem to present different set of symptoms of EDs, screening and

17 treating men with EDs is becoming more and more a priority [55]. Current reliance on a

18 diagnostic framework based on thinness[17] fails in identification of muscularity-oriented

19 pathology of EDs in male population, in clinical or research settings.

20 Some discrepancy between participants' actual BMI and body size perception was observed

21 (see Supplementary table 1) where individuals inaccurately perceived their own body size by

22 means of under- or overestimation. The direction of BSP inaccuracy, as under- or

23 overestimation of BSP, in conjunction with gender specific societal body ideals might have

24 some real implications in the degree with which BSP inaccuracy might further associate with

25 mental distress and SI. But one can argue that inaccurate BSP might not necessarily lead to

1 higher mental distress, for instance if the direction of BSP inaccuracy qualifies individuals to

2 a more favorable position in relation to what society regards as normal or ideal. BSP

3 inaccuracy by underestimation might cause less mental distress in female individuals who are

4 obese or overweight but perceive their body size as normal or underweight, in effect

5 rebranding own's body size perception in a more approved fashion (following agreed societal

6 norms). Possible associations between BSP, BSP accuracy, BMI and intention to lose weight

7 require full exploration that is beyond the scope of current study but is being investigated in a

8 parallel study conducted (by the authors) on determinants of dieting in a Norwegian

9 community sample (The HUNT Study).

10

11 **Strengths and limitations**

12 Strengths of this study include the large sample size derived from a total Norwegian adolescent

13 population with a homogenous ethnic background. Further, anthropometric measurements were

14 carried out by trained nurses. To date, most studies on EDs have relied upon clinical data or

15 patient registries of adult populations [56] which leaves out the adolescents in the general

16 population in the time period when psychological distress and disorders often manifest. With the

17 median age of onset for developing EDs reported as low as 12-13 years old [57], the importance

18 of studying younger affected individuals could not be more emphasized. Studies on male ED

19 sufferers are fewer and far in between, with adolescent male participants usually lumped into adult

20 populations [45]. Our results are of general relevance since our observations were made in a large,

21 population-based adolescent dataset that included both males and females.

22 Conclusions should be drawn in the light of certain limitations in the current study. The use of

23 shortened and self-reported measures of DE (EAT-7) or mental distress (SCL-5), and not

24 standardized psychiatric interviews, has in effect rendered our findings less generalizable to

25 clinical populations. SI was assessed by a single item question. Due to temporal bias in a cross-

1 sectional design, we are not able to assess potential causal relationships between DE traits and

2 SI. We do not interpret our results as causal but rather associative, hence, the importance of

3 conducting future longitudinal studies on causality in larger populations. One interesting line of

4 enquiry is to look at various DE traits clustered in smaller groups based on participants' BMI or

5 body size perception, which was not possible to perform in the current study given small number

6 of participants in each cluster. Conducting a follow-up study on a larger dataset from the HUNT

7 Study including adolescents from the most recent data collection, HUNT4 Survey (2017-19), may

8 reach a higher statistical power and hence more conclusive results. Using single-item question on

9 SI in future studies provides an opportunity of validation and to confirm the results obtained here

10 and is hence encouraged by the authors; however, to overcome miscalculation or misinterpretation

11 errors, adding follow up questions will supplement information derived from a single-item

12 question on SI. Time lapse since YH1 makes prevalence reports from that time less reflective

13 of the current situation; however, authors found no evidence that suggested pooling data from

14 YH1 and YH3 would render the study findings less valid. On the other hand, older cohorts

15 such YH1 are useful in retrospective research on potential time trends in DE manifestations or

16 their potential impact on prevalence of SI amongst adolescence. Furthermore, such

17 retrospective studies can provide inferential insight into, for example, how environmental

18 changes might have associated with time trends of DE traits amongst adolescents.

19 **Conclusions**

20 An individually tailored approach to suicide risk assessment and management seems to be

21 more appropriate in subpopulations of adolescents with DE and its related traits. Our findings

22 on difference between female and male adolescents may have potential implications in the

23 way clinicians address SI across genders. Shifting focus from maintaining a healthy BMI to

24 addressing individuals' attitudes towards their own body shape and size is important in

25 designing treatment plans that reduce burden of suicidal ideation or attempts. Timely

identification of associated factors for SI in high-risk but non-clinical populations is important

in designing strategic and preventive measures that intend to cut human and economic costs of

suicidal ideation and attempts. Future longitudinal research in both clinical and community

populations, preferably with data on onset, frequency and severity of SI in comparison to that

of DE traits could help in overcoming current methodological and interpretational difficulties

in drawing more conclusive results on temporal relationship between these factors.

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Author statement

FSS has conceived the idea, performed the analyses and drafted the manuscript. FSS, TLH,

NM, ERS, OB and KK have contributed to interpretation of results and critical revision of

manuscript. Authors FSS, TLH, NM, ERS, OB and KK have read and approved of the final

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Data availability statement

4 Due to restrictions imposed by the HUNT Research Centre (in accordance with Norwegian

5 Data Inspectorate), data cannot be made publicly available. Data are currently stored in the

6 HUNT databank, and there are restrictions in place for the handling of HUNT data files. Data

7 used from the HUNT Study in research projects will be made available on request to the

8 HUNT Data Access Committee (hunt@medicine.ntnu.no). The HUNT data access

9 information (available here: http://www.ntnu.edu/hunt/data) describes in detail the policy

10 regarding data availability.

11

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Supplementary table 1. Distribution of body size perception in each BMI category in boys and girls; Young HUNT1(YH1) and Young HUNT3(YH3):

	YH1 boys(n=1834)				YH1 girls(n=1845)			
	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)
Body size perception								
Very fat	11(2)	8(3.29)	2(0.14)	0	23(35.93)	19(7.28)	9(0.63)	1(1)
Quite fat	40(72.73)	139(57.20)	113(7.81)	1(1.12)	38(59.38)	182(69.73)	311(21.9)	1(1)
Like others	4(7.27)	94(38.68)	967(66.83)	19(21.35)	3(4.69)	59(22.61)	948(66.76)	26(26)
Quite thin	0	2(0.82)	354(24.46)	59(66.29)	0	1(0.38)	146(10.28)	66(66)
Very thin	0	0	11(0.76)	10(11.24)	0	0	6(0.42)	6(6)
Total	**55**	**243**	**1447**	**89**	**64**	**261**	**1420**	**100**
	YH3 boys(n=1358)				YH3 girls(n=1430)			
	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(%)	Obese(%)	Overweight(%)	Normal weight(%)	Underweight(
Body size perception								
Very fat	8(8.60)	1(0.37)	6(0.64)	0	16(20.78)	16(5.56)	8(0.79)	0
Quite fat	72(77.42)	104(38.10)	64(6.79)	0	55(71.43)	158(54.86)	167(16.55)	0
Like others	13(13.98)	167(61.17)	611(64.79)	5(10.20)	6(7.79)	113(39.24)	676(67.00)	15(26.79)
Quite thin	0	0	245(25.98)	33(67.35)	0	0	154(15.26)	34(60.71)
Very thin	0	1(0.37)	17(1.80)	11(22.45)	0	1()	4(0.40)	7(12.5)
Total	**93**	**273**	**943**	**49**	**77**	**288**	**1009**	**56**

Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

Supplementary table 2. Intention to lose weight and weight categories in boys and girls, pooled data:

	Boys(n=3191)				Girls(n=3260)			
	Obese(%)	Overweight(%)	Normal(%)	Underweight(%)	Obese(%)	Overweight(%)	Normal(%)	Underweigh
Intention to lose weight								
Yes	45(29.80)	101(23.77)	81(3.40)	0	59(42.14)	203(37.39)	455(18.79)	5(3.23)
No, but I need to lose weight	83(54.97)	157(36.94)	132(5.53)	3(2.19)	76(54.29)	232(42.73)	455(18.79)	4(2.58)
No, I am comfortable with my weight	23(15.23)	258(60.71)	2174(91.12)	134(97.81)	5(3.57)	108(19.89)	1512(62.43)	146(94.1
Total	**151**	**425**	**2386**	**137**	**140**	**543**	**2422**	**155**

Weight categories are calculated according to Cole et al. 2000 and Cole et al. 2007.

Disordered eating

The EAT (Eating Attitude Test) is a standardized self-report questionnaire that has been used to identify individuals at risk of developing EDs [1] in both clinical and non-clinical adolescent populations and can discriminate eating disordered patients and controls[2]. Since EAT was considered too long to be included in the Young-HUNT Study, a shortened version, EAT-7, was used to identify disordered eating. For psychometric properties of EAT-7 [3]. Psychometric properties of the EAT-7 have been previously validated in two cohorts, YH1 [4] and 'Young in Norway' [5], and a two-factor solution of the EAT-7: EAT-A or "poor appetite/undereating" and EAT-B or "uncontrolled appetite/overeating", is reported to be robust for age and gender [4].

The EAT-A comprises the questions: 1) It can be difficult to stop eating when I first begin to eat, 2) I spend too much time thinking about food, 3) I feel that food controls my life, and 4) When I eat, I cut food in small pieces. EAT-B consists of questions: 1) When I eat a meal, I spend longer time than others, 2) Others think that I am too thin and 3) I feel that others pressure me to eat. Participants answered questions on a Likert scale with response options: "never/seldom" (coded as 0), "often" (coded as 1) and "always" (coded as 2). Scores on each question item were added up to determine sum-scores on EAT-A and EAT-B subscales separately. A maximum score for the EAT-A and EAT-B were therefore 8 and 6, respectively. Previously reported cut-off points [4] were then used to categorize participants into groups of cases with elevated EAT-A (score ≥ 3) or EAT-B (score ≥ 2). Cases were compared to adolescents scoring below these cut offs. Adolescents who scored above the cut-off on both the EAT-A and EAT-B (92 persons in total) were included in the analyses since associations between each EAT-7 subscale and SI were not deemed mutually exclusive. Cronbach's alphas were 0.57, 0.42 and 0.54 for EAT-A, EAT-B and EAT-7, respectively.

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Principal Component Analysis for optimal cut-off points for EAT-A and EAT-B has been in agreement with previous reports and the cut-off points were also validated against the EAT-12 [4].

Mental distress

The Five-item Hopkins Symptom Checklist (SCL-5) [6], a valid and reliable measure of mental distress [7] was used to measure mental distress. SCL-5 is a shorter version of SCL-25 that constitutes 10 questions on anxiety and 15 questions on depression [8]. Self-rated measures of anxiety and depression on SCL-25 have a reported concordance rate of 86.7% with clinical assessment by a physician [8]. Stepwise regression has been used to identify question items that had maximum correlation with the scores on anxiety, depression and global scores on SCL-25 [7] [9]. Five of these question items constitute SCL-5, with an estimated correlation of 0.92 with SCL-25, an alpha reliability at 0.85 [9] and estimated sensitivity and specificity of 82% and 96 %, respectively [6].

On SCL-5, participants rated the presence or absence of the following five symptoms on a four-point Likert scale ranging from 1) "not bothered" to 4) "very much bothered" in response to the following question: "During the last 14 days", have you: 1) "Been constantly afraid and anxious", 2) "Felt tense or uneasy", 3) "Felt hopelessness when you think of the future", 4) "Felt dejected or sad" or 5) "Worried too much about various things". Only participants who had answered four or more questions were included. Sum scores were calculated by adding up scores on each question item. The sum score was then divided by the number of items answered. Based on previously reported cut-off points, SCL-5 scores of ≥2 were categorized as having "high" degree of mental distress (anxiety or depression), whereas SCL-5 scores < 2 were considered as "low" levels of mental distress [6].

References:

1. Garner, D.M. and P.E. Garfinkel, *The Eating Attitudes Test: an index of the symptoms of anorexia nervosa.* Psychol Med, 1979. **9**(2): p. 273-9.

2. Williamson DA, A.D., Gleaves DH, *Anorexia nervosa and bulimia nervosa: Structured interview methodologies and psychological assessment*. 1996, American Psychological Association: Washington, DC.

3. Sardahaee, F.S., et al., *Effects of single genetic variants and polygenic obesity risk scores on disordered eating in adolescents - The HUNT study.* Appetite, 2017. **118**: p. 8-16.

4. Bjomelv, S., A. Mykletun, and A.A. Dahl, *The influence of definitions on the prevalence of eating problems in an adolescent population.* Eat Weight Disord, 2002. **7**(4): p. 284-92.

5. Wichstrom, L., *Social, psychological and physical correlates of eating problems. A study of the general adolescent population in Norway.* Psychol Med, 1995. **25**(3): p. 567-79.

6. Strand, B.H., et al., *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**(2): p. 113-8.

7. Tambs, K. and T. Moum, *How well can a few questionnaire items indicate anxiety and depression?* Acta Psychiatr Scand, 1993. **87**(5): p. 364-7.

8. Hesbacher, P.T., et al., *Psychiatric illness in family practice.* J Clin Psychiatry, 1980. **41**(1): p. 6-10.

9. Tambs, K., *Selection of questions to short-form versions of original psychometric instruments in MoBa.* Norwegian journal of epidemiology(norsk epidemiologi), 2014(24): p. 195-201.

STROBE Statement—Checklist of items that should be included in reports of *cohort studies*

	Item No	Recommendation	Page No
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract (*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	1
Introduction			
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	3
Objectives	3	State specific objectives, including any prespecified hypotheses	4
Methods			
Study design	4	Present key elements of study design early in the paper	4
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	4
Participants	6	(*a*) Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up (*b*) For matched studies, give matching criteria and number of exposed and unexposed	4
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	5-7
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	5-7
Bias	9	Describe any efforts to address potential sources of bias	5-7
Study size	10	Explain how the study size was arrived at	4
Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	7-8, Appendix
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding (*b*) Describe any methods used to examine subgroups and interactions (*c*) Explain how missing data were addressed (*d*) If applicable, explain how loss to follow-up was addressed (*e*) Describe any sensitivity analyses	7-8, Appendix
Results			
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed (b) Give reasons for non-participation at each stage (c) Consider use of a flow diagram	9-10
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders (b) Indicate number of participants with missing data for each variable of interest (c) Summarise follow-up time (eg, average and total amount)	9-10
Outcome data	15*	Report numbers of outcome events or summary measures over time	9-10

Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	9-14
		(*b*) Report category boundaries when continuous variables were categorized	
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time period	
Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	9-14

Discussion

Key results	18	Summarise key results with reference to study objectives	15
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	16
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	16
Generalisability	21	Discuss the generalisability (external validity) of the study results	16-17

Other information

| Funding | 22 | Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based | 18 |

*Give information separately for exposed and unexposed groups.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at http://www.strobe-statement.org.