BMJ Open

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Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2014-005867
Article Type:	Research
Date Submitted by the Author:	06-Jun-2014
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Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Paediatrics
Keywords:	Child & adolescent psychiatry < PSYCHIATRY, Suicide & self-harm < PSYCHIATRY, PREVENTIVE MEDICINE, Substance misuse < PSYCHIATRY

Prospective investigation of risk factors for suicidal thoughts in adolescence – the Young-HUNT study.

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Word count: 5989

None of the authors declare any conflict of interest

ABSTRACT

Background: Suicidal thoughts and suicidal behaviour emerge and increase during adolescence. A wide range of mental and physical health indicators, behaviours and lifestyle characteristics are reported to influence the development of suicidal thoughts in adolescence, yet the epidemiological evidence is inconclusive.

Objectives: To examine the associations between health- and lifestyle factors recorded in the participants' early teens, and development of suicidal thoughts during adolescence.

Participants: Population based cohort study of 2 399 secondary school students who attended the Young-Hunt 1 study in 1995-1997 (13-15 years old) were included in a follow-up study 4 years later (17-19 years old).

Settings: All student in the two relevant year-classes in Nord-Trøndelag County were invited, 80% attended both waves.

Outcome measure: Suicidal thoughts reported in late adolescence.

Results: 408 (17%, 95%Confidence Interval 15.5-18.5) of the adolescents reported suicidal thoughts at follow up, 158 (14.2%, CI 13.6-16.4) boys and 250 (19.5%, CI 18.8-22.0) girls. Baseline anxiety and depressive symptoms (adjusted Odds Ratio 1.9, CI 1.4-2.6), conduct problems (aOR 1.8, CI 1.3-2.6), overweight (aOR 1.9 CI 1.4-2.4), and muscular pain and tension (aOR 1.8, CI 1.4-2.4), were all associated with reporting suicidal thoughts at follow up.

Conclusion: One in six adolescents in high school experienced suicidal thoughts, girls predominating. Suicidal thoughts in late teens were most strongly associated with symptoms of anxiety/depression, conduct problems, pain/tension problems and overweight reported when participants were 13-15 years old. Specific preventive efforts in these groups might be indicated. Future research with suicide/suicidal

attempts as endpoints would give us further important information both for health service and prevention.

Strengths and limits of this study.

- Whole county cohort study with follow up after 4 years
- Exposure variables: behaviour/health traits, outcome: suicidal thoughts
- Suicidal thought were prevalent in late adolescence, boys 14.2%, girls 19.5%
- Suicidal thought were associated with anxiety/depression, conduct problem, pain/tension and overweight in early adolescence

INTRODUCTION

Suicidal thoughts and suicidal behaviours develop during adolescence and peak late in adolescence and early adulthood [1]. Recent research indicates that suicidal thoughts and attempts are parts of a continuum and share a common risk profile [2;3]. It is well known that anxiety and depression contribute to raised suicide risk [4-6], yet some prospective studies have also linked anxiety and depression to increased incidence of suicidal thoughts [3;7]. In addition, externalizing disorders like AD/HD and Conduct Disorders have been associated with suicidal attempts, and to a lesser extent suicidal thoughts [8;9]. Further, empirical support has been gained for the influence of childhood adversities, as low social support, sexual abuse, domestic violence and maternal depression, on the development of suicidal thoughts during adolescence [7;10;11]. The findings from studies on weight problems, both under- and overweight, and suicidal thoughts are contradictory, but overweight is often reported

as a risk factor among adults [12-14]. Even though adult alcohol problems contributes to a ten-fold increase in suicide related mortality [15], the relationship between alcohol use and suicidal thoughts in adolescence is sparsely studied the last decade [16;17]. Further, sleep disturbance [18], pain, especially headache [19;20], smoking and reduced physical activity [21;22] all have been reported to have a positive association with suicidal ideation.

Complex and partly paradoxical finding on gender differences complicate the understanding of adolescence suicidal ideation and behaviour. While girls report suicidal thoughts more often than boys during adolescence [23;24], completed suicide in adolescence and young adulthood is 3 to 4 times more common in males than females in the Western World [23;25;26]. The frequency of girls with suicidal thoughts peaks about 16 years of age, while it continues to increase beyond the age of 19 in boys [27]. Intriguingly, in adults overweight may be protective of suicide among males and a risk factor among females in the general population [13;28].

However, few large scale prospective studies have examined a wide range of risk- and protective factors for suicidal thoughts among adolescent boys and girls.

The aim of this exploratory population study was to prospectively investigate the association of different risk factors in early adolescence with the development of suicidal thoughts until late adolescence. Based on the previous literature we hypothesized that girls, individuals with high levels of anxiety and depression, inattentiveness, conduct problems, and alcohol-intoxications at baseline would be at increased risk of suicidal thoughts at follow-up.

METHOD

Study design, setting and participants

Young-HUNT 1, the first adolescent wave of the HUNT study (Nord-Trøndelag Health Study) (http://www.ntnu.no/hunt/english)[29], took place between 1995 and 1997. All teenagers (13-19 years) attending secondary and high schools in the county were invited to participate, and 90% attended. In Young-HUNT 2, (2000-2001) students in the last two years of high school or vocational training (age 17- 19) were invited; of these 2 399 (80%) attended both Young-HUNT 1 and 2. The mean follow-up time was 3.9 years.

Both at baseline and follow-up, the participants completed a self-report questionnaire in class and underwent a physical examination; including height and weight.

All 2 399 students who took part in both Young-HUNT 1 and 2 were included in the present study, but analyses of associations with weight are based on the 2 271 participants who took part in the clinical examination.

Measures

The Young-HUNT questionnaire includes a broad spectrum of health related variables relevant for this study (http://www.ntnu.edu/hunt/data/que). Some categorical variables were already dichotomized, other variables were based on instruments with multiple sub-questions and alternative answers. Variables transformation were based on factor analysis, described in former studies [30;31].

Outcome measure at follow-up

Suicidal thoughts

At follow up the students were asked: “Have you had thoughts about taking your own life?”. Positive responses were labelled as suicidal thoughts.

Exposure variables at baseline

Anxiety and depressive symptoms

From the Symptom Check List 90 R [32], an abbreviated and previously validated five item scale, SCL-5 [33;34], was integrated in the questionnaire.

According to former studies [35] and to our factor analysis, we included all five items in our variable.

Attention and conduct problems

A 14-item school-adjustment questionnaire was included in Young-HUNT, described in previous studies [30;36], was utilised to define attention- and conduct variables. A factor analysis identified two separate factors; attention problems and conduct problems. The summarized scores of all items in each category were dichotomised into low or high scores; defining scores above the 70 percentile for the study population as high.

Pain and tension symptoms

The following 4 items constituted the pain/tension variable: headache, neck pain, muscle and joint pain and palpitations the last 12 months. The values were dichotomized according to the 70th percentile, defining students with score above as high [31].

Alcohol use

Baseline alcohol status was defined using number of reported alcohol intoxications. The students answered the question: “Have you ever been drunk”. The variable were dichotomized to “never” or “ever” called “early alcohol intoxication”.

Smoking

Baseline smoking was assessed using the question: “Do you smoke?”. Current smoking was defined as “yes” to smoking daily or occasionally.

Sleep disturbance

Baseline sleep disturbance was defined as difficulties initiating sleep (DIS); “In the last month, have you had difficulty falling asleep?”. “Almost every night” and “often” were classified as insomnia in accordance with former research [37].

Physical activity

Level of physical activity at baseline was estimated using the question: “With exception of school activity, how many days a week do you practice sports or exercise to the point where you breathe heavily and/or sweat?”. “Four days a week or more” was classified as being regular physically active [38].

Height and weight

Height and weight were measured by especially trained nurses to the nearest centimetre, respectively nearest half kilogram with light clothes, without shoes, jacket or outdoor garments. Body mass index [39] was calculated as body weight (kg) divided by the square value of height (m). Using the age- and gender-specific BMI-cut-offs

for children and adolescents recommended by the International Obesity Task Force underweight was defined corresponding to BMI 18.5 kg per metre squared in adults [40]. Overweight was defined using age- and gender-specific BMI-cut-offs corresponding to BMI interval between 25 and 30 in adults and obese were defined with cut offs corresponding to BMI 30 and beyond in adults.

Statistics

PASW Statistics 18 was used for data analysis. Frequencies are given as percentages and 95% Confidence Intervals for proportions were included for comparison. Logistic regression was the main statistical analysis in the study, presenting result as odds ratios (OR) with 95% Confidence interval (CI).

In the main analysis, univariable logistic regression analyses were first used to examine the crude associations between the health and behavioural exposures with suicidal ideation at follow up. Results were stratified on gender, adjustment only made for age (Table 2). Then all the variables were entered in the same models stratified by gender (Table 3), thus adjusting for each other in addition to age. The fully adjusted models in this study include only participants that both completed all the variables used from the questionnaire and had participated in the clinical examination, giving a total number of completers of 1 911 in these models.

According to results from former studies with the Young –HUNT dataset [31;41;42], several clinically relevant statistical interactions were tested for. Interactions where shown between gender and overweight (p=0.01), possible interactions also between gender and anxiety/depressive symptoms (p=0.09), pain and tension (p=0.10) and

early alcohol debut (p=0.09) (Table 2). Accordingly all analyses were stratified by gender. Further, there were possible interactions shown between early alcohol intoxication and anxiety/depressive symptoms (p= 0.07) or physical activity (p=0.05) analysing for suicidal thoughts. To control for these potential interactions, analysis stratified on the presence of early alcohol intoxication were conducted, but only gave modest effect on the ORs and are not shown here.

RESULTS

Altogether 2 399 students (80 % of the eligible) completed the questionnaire in both waves of the study, 1 115 boys (46.5%) and 1 284 girls. 2 271 students answered the question on suicidal thoughts at follow-up; 408 students (17%) reported having had suicidal thoughts, the prevalence was 14.2% (CI 13.6-16.4) in boys and 19.5% (CI 18.8-22.0) in girls.

At baseline symptoms of anxiety and depression were more frequent among girls (21.0%, CI 18.8-23.2), than boys (11.5%, CI 9.6-13.4) (Table 1), as was daily or occasional smoking: girls (12.1%, CI 10.3-13.9), boys (7.8%, CI 6.2-9.4). Conduct problems were more frequent among boys (16.2 %, CI 14.4-18.4), than girls (5.3%, CI 4.1-6.5) and more boys were physically active (35.6%, CI 32.8-38.4), compared to girls (23.4%, CI 21.1-25.7).

Table 1 inserted here

In the univariable age adjusted models (Table 2), anxiety and depressive symptoms, attention- and conduct problems, insomnia, pain/tension problems and smoking at baseline more than doubled the odds for suicidal thoughts at follow-up in both genders. Alcohol intoxication and overweight at baseline had moderate effects (50-70% increase) in both genders (Table 2). Underweight did not show an influence on suicidal ideation in this study. Physical activity 4-7 days a week had a protective effect (OR: 0.7, CI 0.5-0.9), whereas smoking at baseline increased odds for suicidal thoughts 4 years later (OR 2.1, CI 1.5-2.8).

Table 2 inserted here

In the fully adjusted model stratified by gender, anxiety and depressive symptoms (aOR 1.9, CI 1.4-2.6), together with pain and tension problems (aOR 1.8, CI 1.4-2.4) still seemed strongly associated with later suicidal ideation, especially among boys. Conduct problems also remained robustly associated to suicidal thoughts (aOR 1.8, CI 1.3-2.6) after adjustment. The association with overweight was strengthened (aOR 1.9, CI 1.4-2.7), with a robust relationship demonstrated also even among boys (aOR 2.0, CI 1.1-3.4). Obesity, was strongly associated with suicidal thoughts only among girls (aOR 3.1, CI 1.2-7.7) Further, smoking was associated with suicidal thoughts, specifically among girls (aOR 1.9, CI 1.2-3.1). The effect of early alcohol intoxications on crude OR for suicidal thoughts tends to weaken by correction for other important variables, especially smoking. Even used as a continuous variable, or split in three, adjustments remove the association observed in the bivariate models (Table 3). Attention problems, insomnia and early alcohol intoxications did not show statistically significant associations with suicidal thought in the fully integrated model.

Table 3 inserted here

The protective effect of physical activity was evident among boys (aOR 0.6 CI 0.4-0.9) but not among girls (aOR 0.7 CI 0.5-1.1). Further stratified analyses showed that the a protective association was evident in the group not reporting early alcohol intoxication(s) (OR 0.6, CI 0.4-0.8), compared to the group with early intoxication (OR 1.0, CI 0.6-1.6)

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DISCUSSION

Anxiety and depressive symptoms, together with pain and muscular tension, were associated with a 2-3 fold increased risk for development of suicidal thoughts during adolescence; and more so in boys than girls Attention problems also had a similar effect, which we suspect might be mediated through other health problems, like depression, visualized by reduced OR after adjustment in our analysis.

. In accordance with previous suicide-research [43;44], we found that conduct problems robustly increased the odds for suicidal thoughts in both genders.. Conduct problems emerge early in child development, and include some degree of impulsivity, frustration, poor academic achievement, social marginalization and often low self-esteem [45], all previously linked to suicidal behaviours and suicide [46]. Co-morbidity in conduct problems is common, especially with attention problems [47;48]. Both the features specific for (e.g. social reaction on rule braking behaviour) and common within attention- and conduct problems (as impulsivity), can be basis for development

of suicidality. The link might also be mediated through development of depressive symptoms around puberty. However, conduct problems seems robustly associated with suicidal thoughts even after correcting for depression and other possible confounders.

The gender distinction where boys seemed more vulnerable to anxiety and depressive symptoms, is in accordance with a previous study on adolescents with major depressive disorder [24]. The gender differences in findings may be related to the fact that depressive states are less frequent among boys, or might be reported by boys with more serious problems, thus representing a more extreme sample. The dissimilarity may also be due to different underlying causes, and the stigma of anxiety and depression may be more socially excluding among boys than girls [24]. Muscular pain and tension as a risk factor was formerly [19] thought to be mediated through mental health problems. Our findings were, however, robust to adjustment, including anxiety and depression, and merits further study.

In relation to weight/BMI, the literature indicates that the epidemiology and mechanisms of suicide ideation and suicide attempts differ from those leading to a completed suicide [12]. Consistently, population based studies of adults, have demonstrated a negative association of BMI with risk of completed suicide. In contrast, and in line with our findings among girls, several studies have demonstrated an increased risk of suicidal ideation and suicide attempts in the obese [13;49]. Overweight might be less socially accepted in girls compared to boys, and body image perspective more dominant. At baseline girls are physically more mature than boys, and this difference might influence our results.

Alcohol use disorders are frequently recorded in studies of completed suicide [50], yet our findings show a marginal association of early alcohol intoxications and development of suicidal thoughts. Alcohol intoxications at baseline might not have been the best measure to link early alcohol use to later suicidal ideation. Binge drinking is a common social activity among Norwegian teenager, and might involve both protective and risk-inducing factors. Alcohol intoxication might be more important in actually carrying out an impulsive attempt rather than generating suicidal thoughts. In addition early alcohol involvement can act as a modifier on other risk factors. Additional analysis in our study confirmed that early alcohol intoxication nearly doubled the effect anxiety/depressive symptoms had on suicidal ideation.

Smoking increased odds for suicidal thoughts in our study, but was heavily correlated with early alcohol intoxication. Of the 244 adolescents reporting smoking at baseline 199 (82%) also reported early alcohol intoxications. Both alcohol use and smoking can be perceived as experimental and deviant behaviour among persons under 16. They tend to identify the same group of adolescents, sharing many risk factors, including conduct problems.

Among Norwegian adolescence, physical activity seemed moderately protective against suicidal ideation, but the effect was most evident among boys and among students without alcohol experience in secondary school. Moderating effects of gender and alcohol use on health behaviour are also reported in some newer studies [51-53].

Strengths and limitations

The Young-HUNT Study is a total population study with a high response rate and few drop-outs even at follow up. The questionnaire included a broad collection of health and lifestyle background variables, some pre-validated, and some tested in former research from Young-HUNT [54]. The study thus was representative for the population in Nord-Trøndelag, and Norway, at that time, but more important, it represents a baseline for general studies of later health effects in many years to come. The study was designed for prospective investigations, with approximately 4 years follow up time. Even if 4 years seems little in prospective studies, these years represents a great leap in adolescent development.

However, some limitations have to be pointed out. The Regional Committee for Medial and Research Ethics were concerned that even asking a question about suicidal thoughts might initiate suicidal thinking and did not allow the question in secondary school at the time. Exclusion of adolescence with suicidal thought at baseline was thus not possible, so the study is based on lifetime suicidal thoughts reported at follow up. Other studies have confirmed that suicidal thought are developing between the age of 13 and 18 [55], supporting our assumption of suicidal thought mostly emerging during follow up time.

According to existing literature and our factor analysis it is not possible to divide anxiety from depression in SCL-5. Evidence from adult population supports that mixed anxiety and depression is strongly associated with suicide [56;57].

Conclusion and implications

Suicidal thoughts are frequent among high school students in Norway. In this study, anxiety/depression, conduct problems , overweight, together with pain and tension at the age of 13-15 years, were strongly associated with developing suicidal thoughts during late adolescence. The importance of externalizing behaviour seems under-communicated in the actual debate about risk factors and prevention of suicidal behaviours [58].

The role of early alcohol intoxication remained inconclusive, while physical activity might protect from suicidal thoughts among boys.

To study the pathway from suicidal thoughts to completed suicide, large scale population based studies with specified baseline measures on suicidal behaviours, should be linked with hospital- and mortality registries

Table1. Baseline prevalence of health and behavioural problems, and lifestyle. Total N=2 399, N completers suicidal thoughts=2 271, N physical examination =2 210

	Total		Boys		Girls	
	N	%	N	%	N	%
Mental health variables						
Anxiety/depressive symptoms	397	16.5	128	11.5	269	21.0
Attention problems	448	18.7	188	16.9	260	20.2
Conduct problems	249	10.4	181	16.2	68	5.3
Insomnia (DIS)	185	7.7	67	6.0	118	9.2
Physical health variables						
Pain and tension problems	453	18.9	148	13.3	305	23.8
Underweight (Total N=2210)	149	6.2	60	5.4	89	6.9
Overweight (Total N=2210)	303	12.6	138	12.4	165	12.9
Obesity (Total N=2210)	64	2.7	35	3.1	29	2.3
Lifestyle factors						
Early alcohol intoxication(s)	624	26.0	267	23.9	357	27.8
Physical activity (4 days/week or more)	697	29.1	397	35.6	300	23.4
Daily or occasional smoking	248	10.3	87	7.8	161	12.1

* Over- and underweight are defined by international (IOTF) criteria based on BMI cut-off in each year- and gender-cohort

Table 2. Logistic regression models; single input* age adjusted associations and fully adjusted model of health and behavioural problems, and lifestyle at baseline 1995-97 with suicidal ideation at follow-up in 2000-01. N=2 271 (completers of suicidal thoughts question).**

	Total				*Boys*				*Girls*			
	OR*	CI	aOR**	CI	OR*	CI	aOR**	CI	OR*	CI	aOR**	CI
Mental health issues												
Anxiety/depressive symptoms	2.7	2.1-3.4	1.9	1.4-2.6	3.5	2.3-5.4	2.8	1.7-4.8	2.3	1.7-3.1	1.5	1.0-2.2
Attention problems	2.1	1.7-2.7	1.3	1.0-1.7	2.2	1.5-3.3	1.3	0.8-2.1	2.0	1.5-2.7	1.2	0.8-1.8
Conduct problems	2.3	1.7-3.1	1.8	1.3-2.6	2.5	1.7-3.7	1.9	1.2-3.1	3.0	1.8-5.1	1.8	1.0-3.4
Insomnia (DIS)	2.3	1.7-3.2	1.4	0.9-2.1	2.1	1.2-3.8	1.1	0.5-2.3	2.3	1.6-3.5	1.5	1.0-2.6
Physical health issues												
Pain and tension problems	2.7	2.1-3.4	1.8	1.4-2.4	3.1	2.1-4.8	2.0	1.2-3.3	2.3	1.7-3.2	1.7	1.2-2.5
Underweight (Total N=2 210)	1.3	0.8-2.0	1.5	0.9-2.5	1.4	0.7-2.8	1.8	0.8-4.1	1.2	0.7-2.2	1.4	0.7-2.5
Overweight (Total N=2 210)	1.7	1.3-2.3	1.9	1.4-2.7	1.6	1.0-2.6	2.0	1.1-3.4	1.7	1.2-2.6	1.8	1.2-2.8
Obesity (Total N=2 210)	1.9	1.0-3.4	1.5	0.8-3.1	0.7	0.2-2.3	0.6	0.1-2.5	3.7	1.7-8.0	3.1	1.2-7.7
Lifestyle factors												
Early alcohol intoxication(s)	1.7	1.3-2.2	1.2	0.8-1.6	2.1	1.4-3.2	1.5	0.9-2.4	1.5	1.1-2.1	1.0	0.6-1.5
Physical activity	0.7	0.5-0.9	0.7	0.5-0.9	0.7	0.5-0.9	0.6	0.4-0.9	0.8	0.6-1.1	0.7	0.5-1.1
Daily or occasional smoking	2.1	1.5-2.8	1.5	1.0-2.3	2.1	1.2-3.5	1.0	0.5-2.0	2.0	1.3-2.9	1.9	1.2-3.1

OR* Odds ratio adjusted for age

aOR** Odds Ratio adjusted for age, anxiety/depressive symptoms, attention problems, conduct problems, insomnia, pain/tension problems, physical activity, alcohol intoxications and smoking.

Table 3. Binary logistic regression; associations of frequencies of alcohol intoxications at baseline 1995-97 with suicidal ideation at follow-up in 2000-01. OR from single input age adjusted models, and adjusted OR (aOR) from fully adjusted models

	Total				Boys				Girls			
	OR*	95%CI	aOR**	95%CI	OR*	95%CI	aOR**	95%CI	OR*	95%CI	aOR**	95%CI
No early alc. intox	1		1		1		1		1		1	
1-3 alc. intox	1.5	1.1-2.0	1.1	0.8-1.6	1.7	1.1-2.8	1.3	0.8-2.3	1.3	0.9-1.9	0.9	0.6-1.5
>4 alc. intox	1.9	1.3-2.7	1.3	0.8-2.1	2.5	1.4-4.4	1.8	0.9-2.6	1.5	1.0-2.5	1.1	0.6-2.0

OR* Odds ratio adjusted for age

aOR** Odds Ratio adjusted for age, anxiety/depressive symptoms, attention problems, conduct problems, insomnia, pain/tension problems, physical activity and smoking.

Contributorship statement

Arve Strandheim: primary author, formed the idea and method, analysed and wrote the draft, coordinated and finished the manuscript.

Ottar Bjerkeset: contributed in developing the idea, background and writing of the manuscript.

David Gunnell: developing the idea with the corresponding author, supervision in choice of methods and background literature in addition to forming the writing of the article.

Sigrid Bjørnelv: developed the methods of age- and sex stratified weight variable, wrote most of the eating part of the article and commented generally in the development of the article.

Turid Lingaas Holmen PI of the Young HUNT study, method supervisor, but also generally taking part in forming the text.

Niels Bentzen Supervisor of the whole project. He was involved in development of ideas, writing and the general progress in the work with the article.

Competing Interest

None of the authors declare any competing interests

Funding

This article was funded as a part of a PhD project by a grant from the Liaison Committee between the Central Norwegian Health Authority and the Norwegian University of Science and Technology. In addition North-Trøndelag County has contributed to the project. The funding providers played no role in study design, analysis, interpretation, writing or submission of this article.

Data sharing

Technical appendix, statistical details and dataset are accessible from the corresponding author. Extra data can be made available by e-mailing Young-HUNT PI, Professor Turid Lingaas Holmen, turid.lingaas.holmen@ntnu.no

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Acknowledgments:

The Nord-Trøndelag Health Study (The HUNT Study) is collaboration between HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology NTNU), Nord-Trøndelag County Council, Central Norway Health Authority, and the Norwegian Institute of Public Health.

STROBE Statement—checklist of items that should be included in reports of observational studies
My responses are marked by X= checked (AS)

	Item No	Recommendation
Title and abstract	1	(*a*) X Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) X Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	X Explain the scientific background and rationale for the investigation being reported
Objectives	3	X State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	X Present key elements of study design early in the paper
Setting	5	X Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) X *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		(*b*)
Variables	7	X Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	*X* 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
Bias	9	X Describe any efforts to address potential sources of bias
Study size	10	X Explain how the study size was arrived at
Quantitative variables	11	X Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) X Describe all statistical methods, including those used to control for confounding
		(*b*) X Describe any methods used to examine subgroups and interactions
		(*c*) X Explain how missing data were addressed

Continued on next page

Results		
Participants	13*	(a) X 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
Descriptive data	14*	(a) X Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) X Indicate number of participants with missing data for each variable of interest
		(c) X *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*X Cohort study*—Report numbers of outcome events or summary measures over time
Main results	16	(*a*) X 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
		(*b*) X Report category boundaries when continuous variables were categorized
		(*c*)
Other analyses	17	X Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	X Summarise key results with reference to study objectives
Limitations	19	X Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	X Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	X Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	X 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

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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 www.strobe-statement.org.

BMJ Open

Risk factors for suicidal thoughts in adolescence – a prospective cohort study -The Young-HUNT study.

Journal:	*BMJ Open*
Manuscript ID:	bmjopen-2014-005867.R1
Article Type:	Research
Date Submitted by the Author:	24-Jul-2014
Complete List of Authors:	Strandheim, Arve; Norwegian University of Science and Technology (NTNU), HUNT researc centr; Sykehuset Levanger, Child and adolescent psychiatry Bjerkeset, Ottar; Høgskolen i Nord-Trøndelag, helsefag Gunnell, DJ; University of Bristol, Social Medicine Bjørnelv, Sigrid; NTNU, INM Holmen, Turid; Norwegian University of Science and Technology, HUNT research Center, Department of Public Health and General Practice Bentzen, Niels; NTNU, ISM
Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Paediatrics
Keywords:	Child & adolescent psychiatry < PSYCHIATRY, Suicide & self-harm < PSYCHIATRY, PREVENTIVE MEDICINE, Substance misuse < PSYCHIATRY

Risk factors for suicidal thoughts in adolescence – a prospective cohort study - The Young-HUNT study.

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Word count: 5833

None of the authors declare any conflict of interest

ABSTRACT

Objectives: Examining the associations between health- and lifestyle factors recorded in the participants' early teens, and development of suicidal thoughts recorded 4 years later

Design: Population based prospective cohort study.

Settings: All students in the two relevant year classes in Nord-Trøndelag County were invited, 80% attended both waves of data collection.

Participants: 2 399 secondary school students who participated in the Young-Hunt 1 study in 1995-1997 (13-15 years old) were included in a follow-up study 4 years later (17-19 years old).

Primary outcome measure: Suicidal thoughts reported at age 17-19 years.

Results: 408 (17%, 95%Confidence Interval (CI) 15.5-18.5) of the adolescents reported suicidal thoughts at follow up, 158 (14.2%, CI 13.6-16.4) boys and 250 (19.5%, CI 18.8-22.0) girls. Baseline anxiety and depressive symptoms (adjusted Odds Ratio (aOR) 1.9, CI 1.4-2.6), conduct problems (aOR 1.8, CI 1.3-2.6), overweight (aOR 1.9 CI 1.4-2.4), and muscular pain and tension (aOR 1.8, CI 1.4-2.4), were all associated with reporting suicidal thoughts at follow up.

Conclusion: One in six young adults experienced suicidal thoughts, girls predominating. Suicidal thoughts were most strongly associated with symptoms of anxiety/depression, conduct problems, pain/tension and overweight reported when participants were 13-15 years old. Specific preventive efforts in these groups might be indicated. Future research should investigate whether similar associations are seen with suicide/suicidal attempts as endpoints.

Strengths and limitations of this study.

- Whole county cohort study with follow up after 4 years
- Exposure variables: behaviour/health traits, outcome: suicidal thoughts
- Suicidal thought were prevalent in late adolescence, boys 14.2%, girls 19.5%
- Suicidal thought were associated with anxiety/depression, conduct problem, pain/tension and overweight in early adolescence

INTRODUCTION

Suicidal thoughts and suicidal behaviours develop during adolescence and peak late in adolescence and early adulthood [1]. Recent findings from population based studies indicate that suicidal thoughts and attempts are parts of a continuum and share a common risk profile [2;3]. It is well known from general population studies that anxiety and depression contribute to raised suicide risk [4;4-6], yet some prospective studies have also linked anxiety and depression to increased incidence of suicidal thoughts [3;7-9]. In adolescence, externalizing disorders like ADHD and Conduct Disorders have been associated with suicidal attempts, and to a lesser extent suicidal thoughts [10;11]. Further, there is empirical support that childhood adversities, such as low social support, sexual abuse, domestic violence and maternal depression, influence the development of suicidal thoughts during adolescence [4;7;12;13]. The findings from studies on weight problems, both under- and overweight, and suicidal thoughts are contradictory, but overweight is often reported as a risk factor among adults [14-16]. Even though adult alcohol problems contributes to a ten-fold increase in suicide related mortality [17], the relationship between alcohol use and suicidal thoughts in adolescence is sparsely studied the last decade [18;19]. Further, sleep disturbance [20], pain, especially headache [21;22], smoking and reduced physical activity [23-25] all have been reported to have a positive association with suicidal ideation in the adolescent general population.

Complex and partly paradoxical finding on gender differences complicate the understanding of adolescence suicidal ideation and behaviour. While girls report suicidal thoughts more often than boys during adolescence [26;27], completed suicide in adolescence and young adulthood is 3 to 4 times more common in males than

females in the Western World [26;28;29]. The prevalence of suicidal thoughts among girls peaks about 16 years of age, while it continues to increase beyond the age of 19 in boys [30]. Intriguingly, in adults overweight may be protective of suicide among males and a risk factor among females in the general population [15;31].

However, few large scale prospective studies have examined a wide range of risk- and protective factors for suicidal thoughts among adolescent boys and girls.

The aim of this exploratory population study was to investigate the association of different risk factors in early adolescence with the development of suicidal thoughts 4 years later.. Based on existing literature we hypothesized that girls, individuals with high levels of anxiety and depression, inattentiveness, conduct problems, and alcohol-intoxications at baseline would be at increased risk of suicidal thoughts at follow-up.

METHOD

Study design, setting and participants

Young-HUNT 1, the first wave of the adolescent part of the HUNT study (Nord-Trøndelag Health Study) (http://www.ntnu.no/hunt/english)[32], took place between 1995 and 1997. All teenagers (13-19 years) attending secondary and high schools in the county were invited to participate and 90% attended. In Young-HUNT 2, (2000-2001) students in the last two years of high school or vocational training (age 17- 19) were invited; of these 2 399 (80%) attended both Young-HUNT 1 and 2. The mean follow-up time was 3.9 years.

Both at baseline and follow-up, the participants completed a self-report questionnaire in class and underwent a physical examination; including height and weight.

All 2 399 students who took part in both Young-HUNT 1 and 2 were included in the present study, but analyses of associations with weight are based on the 2 271 participants who took part in the clinical examination.

Ethics

All the potential participants and their parents received a written statement about the study one month prior to the collection of the data, making a discussion possible before signing the consent. Voluntary participation was stressed both to the adolescents and their parents.

Measures

The Young-HUNT questionnaire includes a broad spectrum of health related variables relevant for this study (http://www.ntnu.edu/hunt/data/que). Some categorical variables were already dichotomized, other variables (as anxiety and depressive symptoms, attention- and conduct problems, pain and tension symptoms) were based on instruments with multiple sub-questions and alternative answers.; categorisation of responses to these questions was based on factor analysis, described in earlierr studies [33;34].

Outcome measure at follow-up

Suicidal thoughts

At follow up the students were asked: “Have you had thoughts about taking your own life?” (yes/no). Positive responses were labelled as suicidal thoughts.

Exposure variables at baseline

Anxiety and depressive symptoms

Derived from the Symptom Check List 90 R [35], an abbreviated and previously validated five item scale, SCL-5 [36;37], was integrated in the questionnaire. According to previous studies [38] and to our factor analysis, we included all five items in our variable.

Attention- and conduct problems

A 14-item school-adjustment questionnaire was included in Young-HUNT, described in previous studies [33;39], was utilised to define attention- and conduct variables. A factor analysis identified two separate factors; attention problems and conduct

problems. Conduct problems include disagreement with teacher, such as quarrels and scolding, as well as involvement in fights at school; attention problems include both inattention and hyperkinetic symptoms. The summarized scores of all items in each category were dichotomised into low or high scores; defining scores above the 70 percentile for the study population as high.

Pain and tension symptoms

The following 4 items constituted the pain/tension variable: headache, neck pain, muscle and joint pain and palpitations the last 12 months. The values were dichotomized according to the 70th percentile, defining students with score above as high [34].

Alcohol use

Baseline alcohol status was defined using number of reported alcohol intoxications. The students answered the question: “Have you ever been drunk”. The variable were dichotomized to “never” or “ever”, and named “early alcohol intoxication”. For further differentiation early alcohol intoxications were divided in three; none, 1-3, 4 and more (table 3).

Smoking

Smoking at baseline was assessed using the question: “Do you smoke?” (yes/no). Current smoking was defined as “yes” to smoking daily or occasionally.

Sleep disturbance

Baseline sleep disturbance was defined as difficulties initiating sleep (DIS); “In the last month, have you had difficulty falling asleep?”. “Almost every night” and “often” were classified as insomnia in accordance with former research [40].

Physical activity

Level of physical activity at baseline was estimated using the question: “With exception of school activity, how many days a week do you practice sports or exercise to the point where you breathe heavily and/or sweat?”. “Four days a week or more” was classified as being regular physically active [41].

Height and weight

Height and weight were measured by especially trained nurses to the nearest centimetre, respectively nearest half kilogram with light clothes, without shoes, jacket or outdoor garments. Body mass index [42] was calculated as body weight (kg) divided by the square value of height (m). Using the age- and gender-specific BMI-cut-offs for children and adolescents recommended by the International Obesity Task Force underweight was defined corresponding to BMI 18.5 kg per metre squared or less in adults [43]. Overweight was defined using age- and gender-specific BMI-cut-offs corresponding to BMI interval between 25 and 30 in adults and obese were defined with cut offs corresponding to BMI 30 and beyond in adults.

Statistics

PASW Statistics 18 was used for data analysis. Frequencies are given as percentages and 95% Confidence Intervals for proportions were included for

comparison. Logistic regression was the main statistical analysis in the study, presenting result as odds ratios (OR) with 95% Confidence interval (CI).

In the main analysis, univariable logistic regression analyses were first used to examine the crude associations between the health and behavioural exposures with suicidal ideation at follow up. Results were stratified on gender, adjustment only made for age. Then all the variables were entered in the same models stratified by gender (Table 2), thus adjusting for each other in addition to age. The fully adjusted models in this study include only participants that both completed all the variables used from the questionnaire and had participated in the clinical examination, giving a total number of completers of 1 911 in these models.

According to results from former studies using the Young –HUNT dataset [34;;45], several clinically relevant statistical interactions were tested for. In the present study interactions were shown between gender and overweight (p=0.01), possible interactions also between gender and anxiety/depressive symptoms (p=0.09), pain and tension (p=0.10) and early alcohol intoxication (p=0.09). Accordingly, all analyses were stratified by gender (Table 2). Further, there were possible interactions shown between early alcohol intoxication and anxiety/depressive symptoms (p= 0.07) or physical activity (p=0.05) analysing for suicidal thoughts. To control for these potential interactions, analysis stratified on the presence of early alcohol intoxication were conducted, but only gave modest effect on the ORs and are not shown here.

RESULTS

Altogether 2 399 students (80 % of the eligible) completed the questionnaire in both waves of the study, 1 115 boys (46.5%) and 1 284 girls. 2 271 students answered the question on suicidal thoughts at follow-up; 408 students (17%) reported having had suicidal thoughts, and the prevalence was 14.2% (CI 13.6-16.4) in boys and 19.5% (CI 18.8-22.0) in girls.

At baseline symptoms of anxiety and depression were more frequent among girls (21.0%, CI 18.8-23.2), than boys (11.5%, CI 9.6-13.4) (Table 1), as was daily or occasional smoking: girls (12.1%, CI 10.3-13.9), boys (7.8%, CI 6.2-9.4). Conduct problems were more frequent among boys (16.2 %, CI 14.4-18.4), than girls (5.3%, CI 4.1-6.5) and more boys were physically active (35.6%, CI 32.8-38.4), compared to girls (23.4%, CI 21.1-25.7).

Table 1 inserted here

In the univariable age adjusted models (Table 2), anxiety and depressive symptoms, attention- and conduct problems, insomnia, pain/tension problems and smoking at baseline more than doubled the odds for suicidal thoughts at follow-up in both genders. Alcohol intoxication and overweight at baseline had moderate effects on suicidal thoughts (50-70% increase) in both genders (Table 2), whereas underweight did not show an influence on suicidal ideation in this study. Physical activity 4-7 days a week had a protective effect (OR: 0.7, CI 0.5-0.9), whereas smoking at baseline increased odds for suicidal thoughts 4 years later (OR 2.1, CI 1.5-2.8).

Table 2 inserted here

In the fully adjusted model stratified by gender, anxiety and depressive symptoms (aOR 1.9, CI 1.4-2.6), together with pain and tension problems (aOR 1.8, CI 1.4-2.4) still seemed strongly associated with later suicidal ideation, especially among boys. Conduct problems also remained robustly associated to suicidal thoughts (aOR 1.8, CI 1.3-2.6) after adjustment. The association with overweight was strengthened (aOR 1.9, CI 1.4-2.7), with a robust relationship demonstrated also even among boys (aOR 2.0, CI 1.1-3.4). I contrast; obesity was strongly associated with suicidal thoughts only among girls (aOR 3.1, CI 1.2-7.7). Further, smoking was associated with suicidal thoughts, specifically among girls (aOR 1.9, CI 1.2-3.1).

The effect of early alcohol intoxications on crude OR for suicidal thoughts weakened in models controlling for other variables; controlling for smoking in particular attenuated the strength of the associations. Such effects were also seen when the association with alcohol was investigated across 3 levels of increasing exposure (Table 3). Attention problems, insomnia and early alcohol intoxications did not show statistically significant associations with suicidal thought in the fully integrated model.

Table 3 inserted here

The protective effect of physical activity was evident among boys (aOR 0.6 CI 0.4-0.9) but not significantly among girls (aOR 0.7 CI 0.5-1.1). Further stratified analyses showed that the protective association was evident in the group not reporting early alcohol intoxication(s) (OR 0.6, CI 0.4-0.8), compared to the group with early intoxication (OR 1.0, CI 0.6-1.6).

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DISCUSSION

Anxiety and depressive symptoms, together with pain and muscular tension, were associated with nearly doubled increased risk for development of suicidal thoughts during adolescence; and more so in boys than girls. Attention problems also had a similar unadjusted effect, which we suspect might be mediated through other health problems, like depression, visualized by reduced OR after adjustment in our analysis. In accordance with previous suicide-research [46;47], we found that conduct problems robustly increased the odds for suicidal thoughts in both genders. Conduct problems as well as conduct disorder emerge early in child development, and include some degree of impulsivity, frustration, poor academic achievement, social marginalization and often low self-esteem [48], all previously linked to suicidal behaviours and suicide[49]. Using diagnostic categories, co-morbidity in conduct disorder is common, especially with attention and hyperactivity disorders [50;51]. Features that are specific for (e.g. social reaction on rule breaking behaviour), and features that commonly occur within attention- and conduct problems (as impulsivity), can be basis for development of suicidality. The link might also be mediated through development of depressive symptoms around puberty. However, our broad category of conduct problems seems robustly associated with suicidal thoughts even after controlling for depression and other possible confounders.

The observation that boys seemed more vulnerable to anxiety and depressive symptoms, is in accordance with a previous study on adolescents with major depressive disorder [27]. The gender differences in findings may be related to the fact that depressive states are less frequent among boys, or might be reported by boys

with more serious problems, thus representing a more extreme sample. The dissimilarity may also be due to different underlying causes, and the stigma of anxiety and depression may be more socially excluding among boys than girls [27]. Muscular pain and tension were formerly [21] thought to be mediated through mental health problems. Our findings were, however, robust to adjustment, including anxiety and depression, and merits further study.

In relation to weight/BMI, the literature indicates that the epidemiology and mechanisms of suicide ideation and suicide attempts differ from those leading to a completed suicide [14]. Consistently, population based studies of adults have demonstrated a negative association of BMI with risk of completed suicide. In contrast, and in line with our findings among girls, several studies have demonstrated an increased risk of suicidal ideation and suicide attempts in the obese [15;52]. Overweight might be less socially accepted in girls compared to boys, and body image perspective more dominant. Due to an earlier onset of puberty, girls were physically more mature than boys at baseline, and this difference might have influenced our results.

Alcohol use disorders are frequently recorded in studies of completed suicide [53], yet our findings show a marginal association of early alcohol intoxications and development of suicidal thoughts. Alcohol intoxications at baseline might not represent an ideal measure to link early alcohol use to later suicidal ideation. Binge drinking is a common social activity among Norwegian teenagers, and might involve both protective and risk-inducing factors. For instance, adolescents not drinking at all might be more lonely and isolated. Alcohol intoxication might initialize an impulsive

attempt rather than generating suicidal thoughts. In addition early alcohol involvement can act as a modifier on other risk factors. Additional analysis in our study confirmed that early alcohol intoxication nearly doubled the effect anxiety/depressive symptoms had on suicidal ideation.

Smoking increased odds for suicidal thoughts in our study, but was heavily correlated with early alcohol intoxication. Of the 244 adolescents reporting smoking at baseline 199 (82%) also reported early alcohol intoxications. Both alcohol use and smoking can be perceived as experimental and deviant behaviour among persons under 16. They tend to identify the same group of adolescents, sharing many risk factors, including conduct problems.

Among Norwegian adolescence, physical activity seemed moderately protective against suicidal ideation, but the effect was most evident among boys and among students without alcohol experience in secondary school. Moderating effects of gender and alcohol use on health behaviour are also reported in some newer studies [54-56].

Strengths and limitations

The Young-HUNT Study is a total population study with a high response rate and few drop-outs even at follow up. The study thus was representative for the population in Nord-Trøndelag, and Norway, at that time, but more important, it represents a baseline for general studies of later health effects in many years to come. The study was designed for prospective investigations, with approximately 4 years follow up time. Even if 4 years seems little in prospective studies, these years represents a

great leap in adolescent development. The questionnaire included a broad collection of health and lifestyle background variables, some pre-validated, and some tested in former research from Young-HUNT [57]. None of the variables used have diagnostic precision, but represents broader problem groups in a majority of otherwise healthy adolescents.

However, some limitations have to be pointed out. The Regional Committee for Medial and Research Ethics were concerned that even asking a question about suicidal thoughts might initiate suicidal thinking and did not allow the question in secondary school at the time. Exclusion of adolescence with suicidal thought at baseline was thus not possible, so the study is based on lifetime suicidal thoughts reported at follow up. Other studies have confirmed that suicidal thought are developing between the age of 13 and 18 [58], supporting our assumption of suicidal thought mostly emerging during follow up time. Questions about self-harm was also excluded.

In third year of high school some students were attending vocational training, and were not at school when the study was conducted. They were tried invited by post, but response rate were low (34%). This represents a possible social bias, but former studies have compared the baseline responses of the missing at follow up, without finding any disturbing skewness [32]

The fully adjusted models require answers in all variables, and is no way to be totally sure that the 1911 informants in the adjusted analysis are representative for the whole cohort, but the similarity in results in crude ORs and adjusted ORs are reassuring.

According to existing literature and our factor analysis, it is not possible to separate anxiety from depression in SCL-5. The measure used in this study therefore represents the symptom load of mixed anxiety and depression. Evidence from adult population supports that mixed anxiety and depression, rather than single conditions, is strongly associated with suicide [59;60].

Conclusion and implications

Suicidal thoughts are frequent among high school students in Norway. In this study, anxiety/depression, conduct problems , overweight, together with pain and tension at the age of 13-15 years, were strongly associated with developing suicidal thoughts during late adolescence. The importance of externalizing behaviour seems under-communicated in the actual debate about risk factors and prevention of suicidal behaviours [61].

The role of early alcohol intoxication remained inconclusive, while physical activity might protect from suicidal thoughts among boys.

To study the pathway from suicidal thoughts to completed suicide, large scale population based studies with specified baseline measures on suicidal behaviours, should be linked with hospital- and mortality registries.

Table 1. Baseline prevalence of health and behavioural problems, and lifestyle. Total N=2 399, N completers suicidal thoughts=2 271, N physical examination =2 210

	Total		Boys		Girls	
	N	%	N	%	N	%
Mental health variables						
Anxiety/depressive symptoms	397	16.5	128	11.5	269	21.0
Attention problems	448	18.7	188	16.9	260	20.2
Conduct problems	249	10.4	181	16.2	68	5.3
Insomnia (DIS)	185	7.7	67	6.0	118	9.2
Physical health variables						
Pain and tension problems	453	18.9	148	13.3	305	23.8
Underweight* (Total N=2210)	149	6.2	60	5.4	89	6.9
Overweight* (Total N=2210)	303	12.6	138	12.4	165	12.9
Obesity (Total N=2210)	64	2.7	35	3.1	29	2.3
Lifestyle factors						
Early alcohol intoxication(s)	624	26.0	267	23.9	357	27.8
Physical activity (4 days/week or more)	697	29.1	397	35.6	300	23.4
Daily or occasional smoking	248	10.3	87	7.8	161	12.1

* Over- and underweight are defined by international (IOTF) criteria based on BMI cut-off in each year- and gender-cohort

Table 2. Logistic regression models; single input* age adjusted associations and fully adjusted model of health and behavioural problems, and lifestyle at baseline 1995-97 with suicidal ideation at follow-up in 2000-01. N=2 271 (completers of suicidal thoughts question).**

	Total				*Boys*				*Girls*			
	OR*	CI	aOR**	CI	OR*	CI	aOR**	CI	OR*	CI	aOR**	CI
Mental health issues												
Anxiety/depressive symptoms	2.7	2.1-3.4	1.9	1.4-2.6	3.5	2.3-5.4	2.8	1.7-4.8	2.3	1.7-3.1	1.5	1.0-2.2
Attention problems	2.1	1.7-2.7	1.3	1.0-1.7	2.2	1.5-3.3	1.3	0.8-2.1	2.0	1.5-2.7	1.2	0.8-1.8
Conduct problems	2.3	1.7-3.1	1.8	1.3-2.6	2.5	1.7-3.7	1.9	1.2-3.1	3.0	1.8-5.1	1.8	1.0-3.4
Insomnia (DIS)	2.3	1.7-3.2	1.4	0.9-2.1	2.1	1.2-3.8	1.1	0.5-2.3	2.3	1.6-3.5	1.5	1.0-2.6
Physical health issues												
Pain and tension problems	2.7	2.1-3.4	1.8	1.4-2.4	3.1	2.1-4.8	2.0	1.2-3.3	2.3	1.7-3.2	1.7	1.2-2.5
Underweight (Total N=2 210)	1.3	0.8-2.0	1.5	0.9-2.5	1.4	0.7-2.8	1.8	0.8-4.1	1.2	0.7-2.2	1.4	0.7-2.5
Overweight (Total N=2 210)	1.7	1.3-2.3	1.9	1.4-2.7	1.6	1.0-2.6	2.0	1.1-3.4	1.7	1.2-2.6	1.8	1.2-2.8
Obesity (Total N=2 210)	1.9	1.0-3.4	1.5	0.8-3.1	0.7	0.2-2.3	0.6	0.1-2.5	3.7	1.7-8.0	3.1	1.2-7.7
Lifestyle factors												
Early alcohol intoxication(s)	1.7	1.3-2.2	1.2	0.8-1.6	2.1	1.4-3.2	1.5	0.9-2.4	1.5	1.1-2.1	1.0	0.6-1.5
Physical activity	0.7	0.5-0.9	0.7	0.5-0.9	0.7	0.5-0.9	0.6	0.4-0.9	0.8	0.6-1.1	0.7	0.5-1.1
Daily or occasional smoking	2.1	1.5-2.8	1.5	1.0-2.3	2.1	1.2-3.5	1.0	0.5-2.0	2.0	1.3-2.9	1.9	1.2-3.1

OR* Odds ratio adjusted for age

aOR** Odds Ratio adjusted for age, anxiety/depressive symptoms, attention problems, conduct problems, insomnia, pain/tension problems, physical activity, alcohol intoxications and smoking.

Table 3. Logistic regression; associations of frequencies of alcohol intoxications at baseline 1995-97 with suicidal ideation at follow-up in 2000-01. OR from single input age adjusted models, and adjusted OR (aOR) from fully adjusted models

	Total				Boys				Girls			
	OR*	95%CI	aOR**	95%CI	OR*	95%CI	aOR**	95%CI	OR*	95%CI	aOR**	95%CI
No early alc. intox	1		1		1		1		1		1	
1-3 alc. intox	1.5	1.1-2.0	1.1	0.8-1.6	1.7	1.1-2.8	1.3	0.8-2.3	1.3	0.9-1.9	0.9	0.6-1.5
>4 alc. intox	1.9	1.3-2.7	1.3	0.8-2.1	2.5	1.4-4.4	1.8	0.9-2.6	1.5	1.0-2.5	1.1	0.6-2.0

OR* Odds ratio adjusted for age

aOR** Odds Ratio adjusted for age, anxiety/depressive symptoms, attention problems, conduct problems, insomnia, pain/tension problems, physical activity and smoking.

Acknowledgments:

The Nord-Trøndelag Health Study (The HUNT Study) is collaboration between HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology NTNU), Nord-Trøndelag County Council, Central Norway Health Authority, and the Norwegian Institute of Public Health.

Funding

This article was funded as a part of a PhD project by a grant from the Liaison Committee between the Central Norwegian Health Authority and the Norwegian University of Science and Technology. In addition North-Trøndelag County has contributed to the project. The funding providers played no role in study design, analysis, interpretation, writing or submission of this article.

Contributorship statement

Arve Strandheim: primary author, formed the idea and method, analysed and wrote the draft, coordinated and finished the manuscript.

Ottar Bjerkeset: contributed in developing the idea, background and writing of the manuscript.

David Gunnell: developing the idea with the corresponding author, supervision in choice of methods and background literature in addition to forming the writing of the article.

Sigrid Bjørnelv: developed the methods of age- and sex stratified weight variable, wrote most of the eating part of the article and commented generally in the development of the article.

Turid Lingaas Holmen PI of the Young HUNT study, method supervisor, but also generally taking part in forming the text.

Niels Bentzen Supervisor of the whole project. He was involved in development of ideas, writing and the general progress in the work with the article.

Competing Interest

None of the authors declare any competing interests

Data sharing

Technical appendix, statistical details and dataset are accessible from the corresponding author. Extra data can be made available by e-mailing Young-HUNT PI, Professor Turid Lingaas Holmen, turid.lingaas.holmen@ntnu.no

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Risk factors for suicidal thoughts in adolescence – a prospective cohort study - The Young-HUNT study.

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Word count: 5989

None of the authors declare any conflict of interest

ABSTRACT

Background: Suicidal thoughts and suicidal behaviour emerge and increase during adolescence. A wide range of mental and physical health indicators, behaviours and lifestyle characteristics ~~are reported to~~ influence the development of suicidal thoughts in adolescence, yet the epidemiological evidence is inconclusive.

Objectives: ~~To e~~Examininge the associations between health- and lifestyle factors recorded in the participants' early teens, and development of suicidal thoughts recorded 4 years later~~.~~

Participants: Population based cohort study of 2 399 secondary school students who ~~attended~~ participated in the Young-Hunt 1 study in 1995-1997 (13-15 years old) were included in a follow-up study 4 years later (17-19 years old).

Settings: All students in the two relevant year ~~-~~classes in Nord-Trøndelag County were invited, 80% attended both waves of data collection.

Outcome measure: Suicidal thoughts reported ~~in late adolescence~~at age 17-19 years.

Results: 408 (17%, 95%Confidence Interval (CI) 15.5-18.5) of the adolescents reported suicidal thoughts at follow up, 158 (14.2%, CI 13.6-16.4) boys and 250 (19.5%, CI 18.8-22.0) girls. Baseline anxiety and depressive symptoms (adjusted Odds Ratio (aOR) 1.9, CI 1.4-2.6), conduct problems (aOR 1.8, CI 1.3-2.6), overweight (aOR 1.9 CI 1.4-2.4), and muscular pain and tension (aOR 1.8, CI 1.4-2.4), were all associated with reporting suicidal thoughts at follow up.

Conclusion: One in six ~~adolescents in high school~~young adults experienced suicidal thoughts, girls predominating. Suicidal thoughts ~~in late teens~~ were most strongly associated with symptoms of anxiety/depression, conduct problems, pain/tension ~~problems~~ and overweight reported when participants were 13-15 years old. Specific preventive efforts in these groups might be indicated. Future research should investigate whether similar associations are seen with suicide/suicidal attempts as endpoints ~~would give us further important information both for health service and prevention~~.

Strengths and limitations of this study.

- Whole county cohort study with follow up after 4 years
- Exposure variables: behaviour/health traits, outcome: suicidal thoughts
- Suicidal thought were prevalent in late adolescence, boys 14.2%, girls 19.5%
- Suicidal thought were associated with anxiety/depression, conduct problem, pain/tension and overweight in early adolescence

INTRODUCTION

Suicidal thoughts and suicidal behaviours develop during adolescence and peak late in adolescence and early adulthood [1]. Recent findings from ~~research in total~~ populations~~s~~ based studies~~,~~ indicate~~s~~ that suicidal thoughts and attempts are parts of a continuum and share a common risk profile [2;3]. It is well known from general population studies that anxiety and depression contribute to raised suicide risk [4;4-6~~4-6~~], yet some prospective studies have also linked anxiety and depression to increased

incidence of suicidal thoughts [3;7-9~~3;7~~]. In ~~addition~~adolescence, externalizing disorders like AD~~/~~HD and Conduct Disorders have been associated with suicidal attempts, and to a lesser extent suicidal thoughts [10;11~~8;9~~]. Further, there is empirical support that ~~has been gained for the influence of~~ childhood adversities, such as low social support, sexual abuse, domestic violence and maternal depression, influence ~~on~~ the development of suicidal thoughts during adolescence [4;7;12;13~~7;10;11~~]. The findings from studies on weight problems, both under- and overweight, and suicidal thoughts are contradictory, but overweight is often reported as a risk factor among adults [14-16~~12-14~~]. Even though adult alcohol problems contributes to a ten-fold increase in suicide related mortality [17~~15~~], the relationship between alcohol use and suicidal thoughts in adolescence is sparsely studied the last decade [18;19~~16;17~~]. Further, sleep disturbance [20~~18~~], pain, especially headache [21;22~~19;20~~], smoking and reduced physical activity [23-25~~21;22~~] all have been reported to have a positive association with suicidal ideation in the adolescent general population.

Complex and partly paradoxical finding on gender differences complicate the understanding of adolescence suicidal ideation and behaviour. While girls report suicidal thoughts more often than boys during adolescence [26;27~~23;24~~], completed suicide in adolescence and young adulthood is 3 to 4 times more common in males than females in the Western World [26;28;29~~23;25;26~~]. The prevalence of suicidal thoughts ~~frequency of~~among girls ~~with suicidal thoughts~~ peaks about 16 years of age, while it continues to increase beyond the age of 19 in boys [30~~27~~]. Intriguingly, in adults overweight may be protective of suicide among males and a risk factor among females in the general population [15;31~~13;28~~].

However, few large scale prospective studies have examined a wide range of risk- and protective factors for suicidal thoughts among adolescent boys and girls.

The aim of this exploratory population study was to ~~prospectively~~ investigate the association of different risk factors in early adolescence with the development of suicidal thoughts ~~until late adolescence~~4 years later.. Based on existing ~~the previous~~ literature we hypothesized that girls, individuals with high levels of anxiety and depression, inattentiveness, conduct problems, and alcohol-intoxications at baseline would be at increased risk of suicidal thoughts at follow-up.

METHOD

Study design, setting and participants

Young-HUNT 1, the first ~~adolescent~~ wave of the adolescent part of the HUNT study (Nord-Trøndelag Health Study) (http://www.ntnu.no/hunt/english)[~~29~~32], took place between 1995 and 1997. All teenagers (13-19 years) attending secondary and high schools in the county were invited to participate, and 90% attended. In Young-HUNT 2, (2000-2001) students in the last two years of high school or vocational training (age 17- 19) were invited; of these 2 399 (80%) attended both Young-HUNT 1 and 2. The mean follow-up time was 3.9 years.

Both at baseline and follow-up, the participants completed a self-report questionnaire in class and underwent a physical examination; including height and weight.

All 2 399 students who took part in both Young-HUNT 1 and 2 were included in the present study, but analyses of associations with weight are based on the 2 271 participants who took part in the clinical examination.

Ethics

All the potential participants and their parents received a written statement about the study one month prior to the collection of the data, making a discussion possible before signing the consent. Voluntary participation was stressed both to the adolescents and their parents.

Measures

The Young-HUNT questionnaire includes a broad spectrum of health related variables relevant for this study (http://www.ntnu.edu/hunt/data/que). Some categorical variables were already dichotomized, other variables (as anxiety and depressive symptoms, attention- and conduct problems, pain and tension symptoms) were based on instruments with multiple sub-questions and alternative answers.; ~~Variables~~ categorisation of responses to these questions ~~transformation were~~was based on factor analysis, described in earlier~~former~~ studies [33;34~~30;31~~].

Outcome measure at follow-up

Suicidal thoughts

At follow up the students were asked: “Have you had thoughts about taking your own life?” (yes/no). Positive responses were labelled as suicidal thoughts.

Exposure variables at baseline

Anxiety and depressive symptoms

Derived f~~F~~rom the Symptom Check List 90 R [35~~32~~], an abbreviated and previously validated five item scale, SCL-5 [36;37~~33;34~~], was integrated in the questionnaire. According to ~~former~~ previous studies [38~~35~~] and to our factor analysis, we included all five items in our variable.

Attention- and conduct problems

A 14-item school-adjustment questionnaire was included in Young-HUNT, described in previous studies [33;39~~30;36~~], was utilised to define attention- and conduct variables. A factor analysis identified two separate factors; attention problems and conduct

problems. Conduct problems include disagreement with teacher, such as quarrels and scolding, as well as involvement in fights at school; attention problems include both inattention and hyperkinetic symptoms. The summarized scores of all items in each category were dichotomised into low or high scores; defining scores above the 70 percentile for the study population as high.

Pain and tension symptoms

The following 4 items constituted the pain/tension variable: headache, neck pain, muscle and joint pain and palpitations the last 12 months. The values were dichotomized according to the 70th percentile, defining students with score above as high [34~~31~~].

Alcohol use

Baseline alcohol status was defined using number of reported alcohol intoxications. The students answered the question: “Have you ever been drunk”. The variable were dichotomized to “never” or “ever”, and named ~~called~~ “early alcohol intoxication”. For further differentiation early alcohol intoxications were divided in three; none, 1-3, 4 and more (table 3).

Smoking

~~Baseline S~~smoking at baseline was assessed using the question: “Do you smoke?” (yes/no). Current smoking was defined as “yes” to smoking daily or occasionally.

Sleep disturbance

Baseline sleep disturbance was defined as difficulties initiating sleep (DIS); “In the last month, have you had difficulty falling asleep?”. “Almost every night” and “often” were classified as insomnia in accordance with former research [40~~37~~].

Physical activity

Level of physical activity at baseline was estimated using the question: “With exception of school activity, how many days a week do you practice sports or exercise to the point where you breathe heavily and/or sweat?”. “Four days a week or more” was classified as being regular physically active [41~~38~~].

Height and weight

Height and weight were measured by especially trained nurses to the nearest centimetre, respectively nearest half kilogram with light clothes, without shoes, jacket or outdoor garments. Body mass index [42~~39~~] was calculated as body weight (kg) divided by the square value of height (m). Using the age- and gender-specific BMI-cut-offs for children and adolescents recommended by the International Obesity Task Force underweight was defined corresponding to BMI 18.5 kg per metre squared or less in adults [43~~40~~]. Overweight was defined using age- and gender-specific BMI-cut-offs corresponding to BMI interval between 25 and 30 in adults and obese were defined with cut offs corresponding to BMI 30 and beyond in adults.

Statistics

PASW Statistics 18 was used for data analysis. Frequencies are given as percentages and 95% Confidence Intervals for proportions were included for

comparison. Logistic regression was the main statistical analysis in the study, presenting result as odds ratios (OR) with 95% Confidence interval (CI).

In the main analysis, univariable logistic regression analyses were first used to examine the crude associations between the health and behavioural exposures with suicidal ideation at follow up. Results were stratified on gender, adjustment only made for age ~~(Table 2)~~. Then all the variables were entered in the same models stratified by gender (Table 2), thus adjusting for each other in addition to age. The fully adjusted models in this study include only participants that both completed all the variables used from the questionnaire and had participated in the clinical examination, giving a total number of completers of 1 911 in these models.

According to results from former studies using ~~with~~ the Young –HUNT dataset [34;;45][31;41;42], several clinically relevant statistical interactions were tested for. In the present study ~~i~~interactions w~~h~~ere shown between gender and overweight (p=0.01), possible interactions also between gender and anxiety/depressive symptoms (p=0.09), pain and tension (p=0.10) and early alcohol ~~debut (~~intoxication (p=0.09) ~~(Table 2)~~. Accordingly, all analyses were stratified by gender (Table 2). Further, there were possible interactions shown between early alcohol intoxication and anxiety/depressive symptoms (p= 0.07) or physical activity (p=0.05) analysing for suicidal thoughts. To control for these potential interactions, analysis stratified on the presence of early alcohol intoxication were conducted, but only gave modest effect on the ORs and are not shown here.

RESULTS

Altogether 2 399 students (80 % of the eligible) completed the questionnaire in both waves of the study, 1 115 boys (46.5%) and 1 284 girls. 2 271 students answered the question on suicidal thoughts at follow-up; 408 students (17%) reported having had suicidal thoughts, and the prevalence was 14.2% (CI 13.6-16.4) in boys and 19.5% (CI 18.8-22.0) in girls.

At baseline symptoms of anxiety and depression were more frequent among girls (21.0%, CI 18.8-23.2), than boys (11.5%, CI 9.6-13.4) (Table 1), as was daily or occasional smoking: girls (12.1%, CI 10.3-13.9), boys (7.8%, CI 6.2-9.4). Conduct problems were more frequent among boys (16.2 %, CI 14.4-18.4), than girls (5.3%, CI 4.1-6.5) and more boys were physically active (35.6%, CI 32.8-38.4), compared to girls (23.4%, CI 21.1-25.7).

Table 1 inserted here

In the univariable age adjusted models (Table 2), anxiety and depressive symptoms, attention- and conduct problems, insomnia, pain/tension problems and smoking at baseline more than doubled the odds for suicidal thoughts at follow-up in both genders. Alcohol intoxication and overweight at baseline had moderate effects on suicidal thoughts (50-70% increase) in both genders (Table 2), whereas underweight did not show an influence on suicidal ideation in this study. Physical activity 4-7 days a week had a protective effect (OR: 0.7, CI 0.5-0.9), whereas smoking at baseline increased odds for suicidal thoughts 4 years later (OR 2.1, CI 1.5-2.8).

Table 2 inserted here

In the fully adjusted model stratified by gender, anxiety and depressive symptoms (aOR 1.9, CI 1.4-2.6), together with pain and tension problems (aOR 1.8, CI 1.4-2.4) still seemed strongly associated with later suicidal ideation, especially among boys. Conduct problems also remained robustly associated to suicidal thoughts (aOR 1.8, CI 1.3-2.6) after adjustment. The association with overweight was strengthened (aOR 1.9, CI 1.4-2.7), with a robust relationship demonstrated also even among boys (aOR 2.0, CI 1.1-3.4). I contrast; obesity was strongly associated with suicidal thoughts only among girls (aOR 3.1, CI 1.2-7.7). Further, smoking was associated with suicidal thoughts, specifically among girls (aOR 1.9, CI 1.2-3.1).

The effect of early alcohol intoxications on crude OR for suicidal thoughts ~~tends to~~ weakened ~~by correction~~in models controlling for ~~for~~ other ~~important~~ variables; ~~especially~~controlling for smoking in particular attenuated the strength of the associations ~~smoking~~. Such effects were also seen when the association with alcohol was investigated across 3 levels of increasing exposure ~~Even used as a continuous variable, or split in three, adjustments remove the association observed in the bivariate models~~ (Table 3). Attention problems, insomnia and early alcohol intoxications did not show statistically significant associations with suicidal thought in the fully integrated model.

Table 3 inserted here

The protective effect of physical activity was evident among boys (aOR 0.6 CI 0.4-0.9) but not significantly among girls (aOR 0.7 CI 0.5-1.1). Further stratified analyses showed that the protective association was evident in the group not reporting early alcohol intoxication(s) (OR 0.6, CI 0.4-0.8), compared to the group with early intoxication (OR 1.0, CI 0.6-1.6).

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DISCUSSION

Anxiety and depressive symptoms, together with pain and muscular tension, were associated with nearly ~~a~~ ~~2-3 fold~~ doubled increased risk for development of suicidal thoughts during adolescence; and more so in boys than girls. Attention problems also had a similar unadjusted effect, which we suspect might be mediated through other health problems, like depression, visualized by reduced OR after adjustment in our analysis.

~~.~~ In accordance with previous suicide-research [46;47~~43;44~~], we found that conduct problems robustly increased the odds for suicidal thoughts in both genders~~.~~. Conduct problems as well as conduct disorder emerge early in child development, and include some degree of impulsivity, frustration, poor academic achievement, social marginalization and often low self-esteem [48~~45~~], all previously linked to suicidal behaviours and suicide [49~~46~~]. ~~C~~Using diagnostic categories, co-morbidity in conduct ~~problems~~ disorder is common, especially with attention and hyperactivity disorders ~~problems~~ [50;51~~47;48~~]. ~~Both the~~F ~~f~~eatures that are specific for (e.g. social reaction on rule breaking behaviour), and features that commonly occur within attention- and conduct problems (as impulsivity), can be basis for development of suicidality. The link might also be mediated through development of depressive symptoms around puberty. However, our broad category of conduct problems seems robustly associated with

suicidal thoughts even after ~~correcting~~controlling for depression and other possible confounders.

The observation that boys seemed more vulnerable to anxiety and depressive symptoms, is in accordance with a previous study on adolescents with major depressive disorder [27~~24~~]. The gender differences in findings may be related to the fact that depressive states are less frequent among boys, or might be reported by boys with more serious problems, thus representing a more extreme sample. The dissimilarity may also be due to different underlying causes, and the stigma of anxiety and depression may be more socially excluding among boys than girls [27~~24~~]. Muscular pain and tension were formerly [21~~19~~] thought to be mediated through mental health problems. Our findings were, however, robust to adjustment, including anxiety and depression, and merits further study.

In relation to weight/BMI, the literature indicates that the epidemiology and mechanisms of suicide ideation and suicide attempts differ from those leading to a completed suicide [14~~12~~]. Consistently, population based studies of adults~~,~~ have demonstrated a negative association of BMI with risk of completed suicide. In contrast, and in line with our findings among girls, several studies have demonstrated an increased risk of suicidal ideation and suicide attempts in the obese [15;52~~13;49~~]. Overweight might be less socially accepted in girls compared to boys, and body image perspective more dominant. Due to an earlier onset of puberty, girls were physically more mature than boys at baseline, and this difference might have influenced our results.

Alcohol use disorders are frequently recorded in studies of completed suicide [53~~50~~], yet our findings show a marginal association of early alcohol intoxications and development of suicidal thoughts. Alcohol intoxications at baseline might not represent an ideal measure to link early alcohol use to later suicidal ideation. Binge drinking is a common social activity among Norwegian teenagers, and might involve both protective and risk-inducing factors. For instance, adolescents not drinking at all might be more lonely and isolated. Alcohol intoxication might initialize an impulsive attempt rather than generating suicidal thoughts. In addition early alcohol involvement can act as a modifier on other risk factors. Additional analysis in our study confirmed that early alcohol intoxication nearly doubled the effect anxiety/depressive symptoms had on suicidal ideation.

Smoking increased odds for suicidal thoughts in our study, but was heavily correlated with early alcohol intoxication. Of the 244 adolescents reporting smoking at baseline 199 (82%) also reported early alcohol intoxications. Both alcohol use and smoking can be perceived as experimental and deviant behaviour among persons under 16. They tend to identify the same group of adolescents, sharing many risk factors, including conduct problems.

Among Norwegian adolescence, physical activity seemed moderately protective against suicidal ideation, but the effect was most evident among boys and among students without alcohol experience in secondary school. Moderating effects of gender and alcohol use on health behaviour are also reported in some newer studies [54-56~~51-53~~].

Strengths and limitations

The Young-HUNT Study is a total population study with a high response rate and few drop-outs even at follow up. The study thus was representative for the population in Nord-Trøndelag, and Norway, -at that time, but more important, it represents a baseline for general studies of later health effects in many years to come. The study was designed for prospective investigations, with approximately 4 years follow up time. Even if 4 years seems little in prospective studies, these years represents a great leap in adolescent development. The questionnaire included a broad collection of health and lifestyle background variables, some pre-validated, and some tested in former research from Young-HUNT [57]. None of the variables used have diagnostic precision, but represents broader problem groups in a majority of otherwise healthy adolescents.

However, some limitations have to be pointed out. The Regional Committee for Medial and Research Ethics were concerned that even asking a question about suicidal thoughts might initiate suicidal thinking and did not allow the question in secondary school at the time. Exclusion of adolescence with suicidal thought at baseline was thus not possible, so the study is based on lifetime suicidal thoughts reported at follow up. Other studies have confirmed that suicidal thought are developing between the age of 13 and 18 [58,55], supporting our assumption of suicidal thought mostly emerging during follow up time. Questions about self-harm was also excluded.

In third year of high school some students were attending vocational training, and were not at school when the study was conducted. They were tried invited by post, but response rate were low (34%). This represents a possible social bias, but former

studies have compared the baseline responses of the missing at follow up, without finding any disturbing skewness [32]

The fully adjusted models require answers in all variables, and is no way to be totally sure that the 1911 informants in the adjusted analysis are representative for the whole cohort, but the similarity in results in crude ORs and adjusted ORs are reassuring.

According to existing literature and our factor analysis, it is not possible to separate anxiety from depression in SCL-5. The measure used in this study therefore represents the symptom load of mixed anxiety and depression. Evidence from adult population supports that mixed anxiety and depression, rather than single conditions, is strongly associated with suicide [59;60~~56;57~~].

Conclusion and implications

Suicidal thoughts are frequent among high school students in Norway. In this study, anxiety/depression, conduct problems , overweight, together with pain and tension at the age of 13-15 years, were strongly associated with developing suicidal thoughts during late adolescence. The importance of externalizing behaviour seems under-communicated in the actual debate about risk factors and prevention of suicidal behaviours [61~~58~~].

The role of early alcohol intoxication remained inconclusive, while physical activity might protect from suicidal thoughts among boys.

To study the pathway from suicidal thoughts to completed suicide, large scale population based studies with specified baseline measures on suicidal behaviours, should be linked with hospital- and mortality registries.

Table1. Baseline prevalence of health and behavioural problems, and lifestyle. Total N=2 399, N completers suicidal thoughts=2 271, N physical examination =2 210

	Total		Boys		Girls	
	N	%	N	%	N	%
Mental health variables						
Anxiety/depressive symptoms	397	16.5	128	11.5	269	21.0
Attention problems	448	18.7	188	16.9	260	20.2
Conduct problems	249	10.4	181	16.2	68	5.3
Insomnia (DIS)	185	7.7	67	6.0	118	9.2
Physical health variables						
Pain and tension problems	453	18.9	148	13.3	305	23.8
Underweight* (Total N=2210)	149	6.2	60	5.4	89	6.9
Overweight* (Total N=2210)	303	12.6	138	12.4	165	12.9
Obesity (Total N=2210)	64	2.7	35	3.1	29	2.3
Lifestyle factors						
Early alcohol intoxication(s)	624	26.0	267	23.9	357	27.8
Physical activity (4 days/week or more)	697	29.1	397	35.6	300	23.4
Daily or occasional smoking	248	10.3	87	7.8	161	12.1

* Over- and underweight are defined by international (IOTF) criteria based on BMI cut-off in each year- and gender-cohort

Table 2. Logistic regression models; single input* age adjusted associations and fully adjusted model of health and behavioural problems, and lifestyle at baseline 1995-97 with suicidal ideation at follow-up in 2000-01. N=2 271 (completers of suicidal thoughts question).**

	Total				*Boys*				*Girls*			
	OR*	CI	aOR**	CI	OR*	CI	aOR**	CI	OR*	CI	aOR**	CI
Mental health issues												
Anxiety/depressive symptoms	2.7	2.1-3.4	1.9	1.4-2.6	3.5	2.3-5.4	2.8	1.7-4.8	2.3	1.7-3.1	1.5	1.0-2.2
Attention problems	2.1	1.7-2.7	1.3	1.0-1.7	2.2	1.5-3.3	1.3	0.8-2.1	2.0	1.5-2.7	1.2	0.8-1.8
Conduct problems	2.3	1.7-3.1	1.8	1.3-2.6	2.5	1.7-3.7	1.9	1.2-3.1	3.0	1.8-5.1	1.8	1.0-3.4
Insomnia (DIS)	2.3	1.7-3.2	1.4	0.9-2.1	2.1	1.2-3.8	1.1	0.5-2.3	2.3	1.6-3.5	1.5	1.0-2.6
Physical health issues												
Pain and tension problems	2.7	2.1-3.4	1.8	1.4-2.4	3.1	2.1-4.8	2.0	1.2-3.3	2.3	1.7-3.2	1.7	1.2-2.5
Underweight (Total N=2 210)	1.3	0.8-2.0	1.5	0.9-2.5	1.4	0.7-2.8	1.8	0.8-4.1	1.2	0.7-2.2	1.4	0.7-2.5
Overweight (Total N=2 210)	1.7	1.3-2.3	1.9	1.4-2.7	1.6	1.0-2.6	2.0	1.1-3.4	1.7	1.2-2.6	1.8	1.2-2.8
Obesity (Total N=2 210)	1.9	1.0-3.4	1.5	0.8-3.1	0.7	0.2-2.3	0.6	0.1-2.5	3.7	1.7-8.0	3.1	1.2-7.7
Lifestyle factors												
Early alcohol intoxication(s)	1.7	1.3-2.2	1.2	0.8-1.6	2.1	1.4-3.2	1.5	0.9-2.4	1.5	1.1-2.1	1.0	0.6-1.5
Physical activity	0.7	0.5-0.9	0.7	0.5-0.9	0.7	0.5-0.9	0.6	0.4-0.9	0.8	0.6-1.1	0.7	0.5-1.1
Daily or occasional smoking	2.1	1.5-2.8	1.5	1.0-2.3	2.1	1.2-3.5	1.0	0.5-2.0	2.0	1.3-2.9	1.9	1.2-3.1

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OR* Odds ratio adjusted for age

aOR** Odds Ratio adjusted for age, anxiety/depressive symptoms, attention problems, conduct problems, insomnia, pain/tension problems, physical activity, alcohol intoxications and smoking.

Table 3. Logistic regression; associations of frequencies of alcohol intoxications at baseline 1995-97 with suicidal ideation at follow-up in 2000-01. OR from single input age adjusted models, and adjusted OR (aOR) from fully adjusted models

	Total				Boys				Girls			
	OR*	95%CI	aOR**	95%CI	OR*	95%CI	aOR**	95%CI	OR*	95%CI	aOR**	95%CI
No early alc. intox	1		1		1		1		1		1	
1-3 alc. intox	1.5	1.1-2.0	1.1	0.8-1.6	1.7	1.1-2.8	1.3	0.8-2.3	1.3	0.9-1.9	0.9	0.6-1.5
>4 alc. intox	1.9	1.3-2.7	1.3	0.8-2.1	2.5	1.4-4.4	1.8	0.9-2.6	1.5	1.0-2.5	1.1	0.6-2.0

OR* Odds ratio adjusted for age

aOR** Odds Ratio adjusted for age, anxiety/depressive symptoms, attention problems, conduct problems, insomnia, pain/tension problems, physical activity and smoking.

Contributorship statement

Arve Strandheim: primary author, formed the idea and method, analysed and wrote the draft, coordinated and finished the manuscript.

Ottar Bjerkeset: contributed in developing the idea, background and writing of the manuscript.

David Gunnell: developing the idea with the corresponding author, supervision in choice of methods and background literature in addition to forming the writing of the article.

Sigrid Bjørnelv: developed the methods of age- and sex stratified weight variable, wrote most of the eating part of the article and commented generally in the development of the article.

Turid Lingaas Holmen PI of the Young HUNT study, method supervisor, but also generally taking part in forming the text.

Niels Bentzen Supervisor of the whole project. He was involved in development of ideas, writing and the general progress in the work with the article.

Competing Interest

None of the authors declare any competing interests

Funding

This article was funded as a part of a PhD project by a grant from the Liaison Committee between the Central Norwegian Health Authority and the Norwegian University of Science and Technology. In addition North-Trøndelag County has contributed to the project. The funding providers played no role in study design, analysis, interpretation, writing or submission of this article.

Data sharing

Technical appendix, statistical details and dataset are accessible from the corresponding author. Extra data can be made available by e-mailing Young-HUNT PI, Professor Turid Lingaas Holmen, turid.lingaas.holmen@ntnu.no

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Acknowledgments:

The Nord-Trøndelag Health Study (The HUNT Study) is collaboration between HUNT Research Centre (Faculty of Medicine, Norwegian University of Science and Technology NTNU), Nord-Trøndelag County Council, Central Norway Health Authority, and the Norwegian Institute of Public Health.

STROBE Statement—checklist of items that should be included in reports of observational studies
My responses are marked by X= checked (AS)

	Item No	Recommendation
Title and abstract	1	(*a*) X Indicate the study's design with a commonly used term in the title or the abstract
		(*b*) X Provide in the abstract an informative and balanced summary of what was done and what was found
Introduction		
Background/rationale	2	X Explain the scientific background and rationale for the investigation being reported
Objectives	3	X State specific objectives, including any prespecified hypotheses
Methods		
Study design	4	X Present key elements of study design early in the paper
Setting	5	X Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection
Participants	6	(*a*) X *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up
		(*b*)
Variables	7	X Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable
Data sources/ measurement	8*	*X* 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
Bias	9	X Describe any efforts to address potential sources of bias
Study size	10	X Explain how the study size was arrived at
Quantitative variables	11	X Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why
Statistical methods	12	(*a*) X Describe all statistical methods, including those used to control for confounding
		(*b*) X Describe any methods used to examine subgroups and interactions
		(*c*) X Explain how missing data were addressed

Continued on next page

Results		
Participants	13*	(a) X 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
Descriptive data	14*	(a) X Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders
		(b) X Indicate number of participants with missing data for each variable of interest
		(c) X *Cohort study*—Summarise follow-up time (eg, average and total amount)
Outcome data	15*	*X Cohort study*—Report numbers of outcome events or summary measures over time
Main results	16	(*a*) X 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
		(*b*) X Report category boundaries when continuous variables were categorized
		(*c*)
Other analyses	17	X Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses
Discussion		
Key results	18	X Summarise key results with reference to study objectives
Limitations	19	X Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias
Interpretation	20	X Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence
Generalisability	21	X Discuss the generalisability (external validity) of the study results
Other information		
Funding	22	X 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

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

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 www.strobe-statement.org.