Social inequalities in body weight and dental caries experience among adolescents in Northern Norway: a cross-sectional study from the Tromsø Study Fit Futures cohort.

CURRENT STATUS: UNDER REVIEW

BMC Oral Health  ▶  BMC Series

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DOI: 10.21203/rs.2.18717/v1

SUBJECT AREAS  Dentistry  Epidemiology

KEYWORDS  general health condition, body mass index, oral health condition, dental caries experience, social inequalities, social determinants, adolescents, Norway
Abstract

Background Non-communicable general and oral health conditions share common social determinants. The aim of the present study was to investigate and compare social inequalities in body weight (as a general health condition) and dental caries experience (as an oral health condition) based on several social determinants in a sample of adolescents from Northern Norway.

Methods The present analysis included data from 477 girls and 508 boys from the population-based Tromsø study Fit Futures, which included first-year students attending upper secondary school in 2010-2011 from two municipalities in Norway (1038 participants in total, 93% participation rate). Multivariable binary logistic regression analysis stratified by sex was used to investigate the association between socioeconomic position (SEP) indicators (mother’s education, parents’ employment, and adolescent’s study program) and body weight (as a general health outcome), and dental caries experience (as an oral health outcome). Comparative models were adjusted for age, birth country, household composition (with or without adults), and a “composite health/health behavior” variable.

Results Girls enrolled in the sports and physical education program (versus the vocational program) had lower odds of being overweight/obese (OR 0.20, 95% CI 0.04-0.96) and of having high dental caries experience (OR 0.26, 95% CI 0.10-0.67). For boys, demographic characteristic, i.e. living in a household without adults was strongly associated with being overweight/obese (OR=2.78, 95% CI 1.23-6.29) and having high dental caries experience (OR=2.29, 95% CI 1.08-4.84).

Conclusions Social inequalities in body weight and dental caries experience might be expected only in adulthood, but our findings show that they were present as
early as adolescence in Northern Norway, and that they were based on different social determinants for girls and boys. Similar magnitudes of social inequalities in body weight and dental caries experience among girls were observed based on the SEP indicator study program, and, among boys, on the demographic characteristic household composition. This suggests that the relationship between body weight and dental caries experience is based on socioeconomic and demographic factors rather than directly on general-oral health. Our findings support the broader concept of social context as a common risk factor for general and oral health.

Background
The common risk/health factor approach (CRHFA) suggests that non-communicable general and oral health conditions share common risk factors, such as behavioral variables (e.g., diet, hygiene, physical activity, tobacco use, and alcohol use) and psychosocial factors (e.g., stress and perceived control) [1]. The CRHFA aims to reduce “risk factors” and promote “health factors” common to non-communicable general and oral health conditions. In this way, the CRHFA strives to simultaneously improve the general and oral health of the whole population and that of high-risk groups, thereby reducing social inequities [1]. The CRHFA was integrated into the conceptual model of social determinants. This framework, presented by the World Health Organization (WHO), shows that behavioral and psychosocial factors are only intermediate determinants of health, as these factors are shaped by one’s social environment and are correlated with socioeconomic position (SEP), which itself is influenced by the socioeconomic and political context in which one lives, including governance, macroeconomics, social and public policies, culture, and societal values [2, 3].
There are numerous studies investigating the links between non-communicable general and oral health conditions. The general health conditions overweight and obesity are considered global epidemics [4], and their prevalence among children and adolescents is increasing substantially [5]. In addition to amplifying multiple risk factors (e.g., metabolic syndrome, high blood pressure, deteriorated glucose tolerance) in childhood and adolescence, overweight and obesity are risk factors for cardiovascular diseases in adulthood, which are the leading annual cause of death worldwide, according to data from the Global Burden of Diseases Study [6–8].

Dental caries is a non-communicable oral health condition; untreated dental caries in the permanent dentition was cited as the most prevalent medical condition in the Global Burden of Diseases Study in 2010 [9]. A systematic review and meta-analysis found a significant relationship between obesity and dental caries in children from industrialized countries, but the authors concluded that future analyses should focus on common risk factors as confounders in this association [10]. Another recent systematic review and meta-analysis confirmed that, in high-income countries, overweight and obese children had more dental caries when compared to normal-weight children [11]. The authors called for future studies to address confounding factors, including possible common risk factors. A study among adults in Australia found that, after adjustment for confounders, the association between overweight/obesity and dental caries experience disappeared, but dental caries experience was associated with SEP [12]. Therefore, it would be reasonable to look at common risk factors in the broader social context when investigating links between non-communicable general and oral health conditions [13].

Even though Norway is a so-called welfare state and a high-income country, social inequalities in general and oral health have been shown, with those with lower SEP
reporting poorer outcomes [14-16]. To our knowledge, there are no studies investigating social inequalities in general and oral health conditions among adolescents in Norway.

Methods

**Study aim, design, and participants**

The aim of the present study was to investigate and compare social inequalities in body weight and dental caries experience based on several social determinants in a sample of adolescents from Northern Norway. Therefore, we investigated the association between SEP indicators and body weight (as a general health outcome) and dental caries experience (as an oral health outcome), and compared the magnitude of social inequalities between body weight and dental caries experience among adolescents from Fit Futures 1 (FF1).

This cross-sectional study included data from a population-based cohort study, the Tromsø Study Fit Futures. FF1 was conducted in two municipalities in Troms County, Northern Norway (the urban Tromsø municipality and the rural Balsfjord municipality). All first-year students attending upper secondary school (7 in Tromsø and 1 in Balsfjord) in 2010-2011, mainly aged 15-19 years, were invited to participate in FF1. Of a total of 1117 invited students, 1038 participated (93% participation rate), while 1010 (498 girls and 512 boys) volunteered to participate in the oral health portion (90% participation rate), which consisted of a dental evaluation [17, 18]. Data on general health was collected at the Clinical Research Unit, University Hospital of North Norway [17]; data on oral health was collected at the University Dental Clinic [18]. All procedures were done during school hours [18]. After exclusion of participants aged 19 years or older, and those with missing data
on height, weight, and dental caries experience, 477 girls and 508 boys (88% participation rate) were eligible for inclusion in the analyses.

**Variables and measurements**

*Socioeconomic position indicators, demographic characteristics, health, and health behavior*

SEP indicators (mother’s education, parents’ employment, and adolescent’s study program) were taken from the validated, pretested, electronic self-administered Fit Futures questionnaire, as were demographic characteristics (age, sex, birth country, and household composition) [Furberg 2010, cited in 19] (Table 1).

Twelve variables were selected to reflect health and health behavior: history of chronic disease, alcohol intake, smoking, snuff use, physical activity, sugar-containing sweets and beverages intake, other dietary factors (including intake of omega 3 fatty acids-rich food/supplements, dairy products, fruits/vegetables, vitamin or mineral supplements), oral hygiene habits, dental satisfaction and self-esteem, mental health and sleep, which were taken from the Fit Futures questionnaire, and vitamin D status, which was measured as serum vitamin D (25-hydroxyvitamin D) level. In order to depict overall health and health behavior, a “composite health/health behavior” variable was composed of these 12 variables (Table 1). The 12 variables were dichotomized (0 and 1) and the scores were added up, resulting in 13 groups (scores 0-12), which were later categorized into very good health/health behavior (composite health/health behavior score 0-3), good health/health behavior (score 4-6), and less than good health/health behavior (score 7-12).

*Outcome variables*

The general health outcome body weight was expressed as body mass index (BMI).
Height and weight were measured to the nearest 0.1 cm and 0.1 kg, respectively, on an automatic electronic scale/stadiometer (Jenix DS 102 stadiometer, Dong Sahn Jenix, Seoul, Korea), with participants wearing light clothing and no footwear. BMI was calculated based on the WHO index for students aged ≥18 years [20]. For 15-17-year-olds, International Obesity Task Force age- and sex-specific cut-off values were used [21]. BMI was categorized as underweight (corresponding to adult BMI <18.5 kg/m²), normal weight (adult BMI value 18.5-24.9 kg/m²), overweight (adult BMI value 25-29.9 kg/m²), and obese (adult BMI value ≥30 kg/m²). In binary logistic regression analysis, this variable was dichotomized into normal weight (corresponding to adult BMI value <25 kg/m²) and overweight/obese (corresponding to adult BMI value ≥25 kg/m²) [22, 23].

The oral health outcome dental caries experience was expressed as a decayed, missing, and filled teeth (DMFT) score, which was recorded by a single dentist [18]. DMFT score was dichotomized into high and low dental caries experience, with a cut-off value of 4.46, i.e., the mean DMFT score among participants.

**Statistical analysis**

Statistical analyses were performed in Statistical Package for the Social Sciences (SPSS, Version 24.0, IBM Corp., Armonk, NY, USA). Chi-square and likelihood ratio tests were used for categorical variables to analyze the differences in SEP indicators, demographic characteristics, health, health behavior, body weight and dental caries experience between the sexes and study programs (general studies, sports and physical education, and vocational). The binary logistic regression analysis was stratified by sex, as it has been shown that health behavior differs between adolescent girls and boys [24, 25]. Univariable binary logistic regression
analysis was used to identify the characteristics associated with the outcomes. Multivariable binary logistic regression Model 1 was constructed separately for girls and boys, and was adjusted for all SEP indicators and demographic characteristics (independent of significance), and for all health and health behavior characteristics that achieved statistical significance ($p \leq 0.05$) in the univariable binary logistic regression analyses for that sex. Multivariable binary logistic regression Model 2 was comparative; therefore it was the same for girls and boys and was adjusted for all SEP indicators, demographic characteristics, and the composite health/health behavior variable. The hierarchical regression (blockwise) method was used. All SEP indicators were entered in the first block and the covariates in the second block. The number of participants in analyses varied due to incomplete data; those with missing values were excluded. The assumption of multicollinearity (tolerance, VIF statistics and eigenvalues) was not violated in any of the models [26]. The Hosmer-Lemeshow goodness-of-fit statistic yielded $p > 0.05$ for all models constructed. Nagelkerke $R^2$ was recorded for the first (SEP) block and the whole model for each model [26]. The level of significance was set at $p = 0.05$ and odds ratios (ORs) are presented with 95% confidence intervals (CIs).

**Ethical considerations**

FF1 was performed in compliance with Good Clinical Practice and the Declaration of Helsinki. The Norwegian Data Protection Authority (reference number 2009/1282) and the Regional Committee of Medical and Health Research Ethics (reference number 2011/1702/REK nord) approved the study at start-up. Participation was based on signed written informed consent: participants aged 16 years and above signed themselves, and younger participants brought written permission from their guardians. The present study was approved by the Regional Committee of Medical
and Health Research Ethics (reference number 2018/172/REK nord).

Results

**Sample characteristics**

The mean age of the 477 included girls was 16.16 (standard deviation (SD) 0.48) years and for the 508 included boys it was 16.12 (SD 0.56) years. There were fewer boys than girls in the general studies program (p<0.05), but the proportion of girls and boys was the same in regard to mother’s education and parents’ employment (Table 2). More boys were underweight and had less than good health/health behavior compared to girls (p<0.05) (Table 2).

When participants were stratified by study program, there were more adolescents in the vocational program who had mothers with high school education or lower and at least one parent not working full time (Table 3). More adolescents in the vocational program had high dental caries experience and were obese compared to adolescents in the general studies program, and in the sports and physical education program (Table 3).

**Body weight and dental caries experience**

*Associations with socioeconomic position indicators*

Girls in the sports and physical education study program compared to girls in the vocational study program had 80% lower odds of being overweight/obese (adjusted OR 0.20, 95% CI 0.04-0.96) and 74% lower odds of having high dental caries experience (OR 0.26, 95% CI 0.10-0.67) (Tables 4 and 5, Fig. 1). Girls enrolled in the general studies program versus the vocational program had 61% lower odds of having high dental caries experience (OR=0.39, 95% CI 0.22-0.69) (Table 5, Fig. 1).

Boys who had mother with a lower education level (college less than 4 years vs
college 4 years or more) had almost three times higher odds of being overweight/obese (OR 2.78, 95% CI 1.08-7.17). Moreover, boys enrolled in the sports and physical education program had 84% lower odds of being overweight/obese (OR 0.16, 95% CI 0.04-0.59) (Table 4). Boys were almost twice as likely to have high dental caries experience if at least one of the parent did not work full time (OR 1.93, 95% CI 1.09-3.04) (Table 5).

Associations with demographic characteristics, health, and health behavior

Among girls, less than good health/health behavior (versus very good health/health behavior) was statistically significantly associated with being overweight/obese (OR 2.98, 95% CI 1.06-8.38) and high dental caries experience (OR 2.42, 95% CI 1.001-5.87), while living in a household without adults was associated with higher odds for high dental caries experience according to Model 2 (OR 2.33, 95% CI 1.14-4.76) (data not shown). For boys, living in a household without adults was associated with higher odds of high dental caries experience (OR 2.29, 95% CI 1.08-4.836) and being overweight/obese (OR 2.78, 95% CI 1.23-6.29) according to Model 2 (Fig 1).

Discussion

To our knowledge, this is the first study investigating body weight and dental caries experience among adolescents using social determinants as common risk factors. The present study demonstrated social inequalities in body weight and dental caries among girls, with poorer outcomes observed among those enrolled in a vocational program compared to those enrolled in a sports and physical education program or a general studies program. Social inequalities in body weight among boys were based on mother’s education, and adolescent’s study program, while in dental caries experience on parents’ employment. In addition, among boys social
inequalities in body weight and dental caries were based on demographic characteristic, household composition, with poorer outcomes observed among those living without adults.

This was a cross-sectional study, whose design in general is prone to confounding and does not allow to establish causality [27]. One way to control for confounders is to adopt a multivariable analysis, as was implemented in the present study [27].

The initial participation rate in FF1 was high, reaching 93%, and participation in the oral health part of FF1 was only slightly lower (90%). It is possible that this decrease in attendance to the dental evaluation that constituted the oral health part of FF1 was associated with low parental education, unemployment, and low income [28]. After exclusions due to age and missing data, our final study sample represented 88% of all students invited to FF1, but in multivariable binary logistic regression comparative Model 2, the number of participants was reduced to 57% among girls and 52% among boys due to missing data; therefore self-selection bias cannot be ruled out. The sample was collected from both a densely populated urban area (Tromsø, 7 schools) and a sparsely populated rural area (Balsfjord, 1 school) in Troms County, Northern Norway. In this county, 29% of the population resides in sparsely populated areas; therefore, the population residing in densely populated areas might be overrepresented in the study sample. It has been shown that living in densely populated areas is associated with higher physical activity and thus better health outcomes among adolescents in Norway [24]. It must be noted that 16–18% of adolescents live without parents in Troms County. Indeed, as Troms County is large, adolescents sometimes have to move from where their parents live to where the school is located – creating the household composition of “living without adults”. This living situation occurs due to adolescents’ need for education;
not necessarily because they have a higher level of maturity. It has been also shown that having an immigrant background was related to worse general and oral health outcomes among children and adults in Norway [29-31]. In Tromsø municipality in 2012, 4.8% of immigrants were aged 16-19 years [32]. In our study sample 6% of girls and 5% of boys reported that they were born outside Norway, indicating that our sample might be representative of the national population with respect to immigrant background.

A validated, pretested, electronic, self-administered questionnaire was employed to collect data on SEP indicators and most of the covariates. In general, questionnaires are prone to bias, especially regarding sensitive data, like alcohol intake and tobacco use. However, self-administration has been shown to decrease reporting bias [33].

In order to get a global measure of health and health behavior, a composite health/health behavior variable was calculated. It has been shown that composite measures might be the best approach to study socioeconomic differences in health among adolescents [34]. The validity of our composite health/health behavior variable is debatable. On the other hand, less than good health behavior was observed more often among boys than girls (p < 0.05) and among those enrolled in a vocational program compared to those in a general studies program or in a sports and physical education program. This is in line with other studies [34, 35], and therefore the composite health/health behavior variable is likely to be of satisfactory validity. Moreover, construct validity was demonstrated in that the composite health/health behavior variable among girls discriminated significantly in the predicted direction between overweight/obese and normal-weight participants and between participants with high and low dental caries experience.
One of the SEP indicators in this study was mother’s education. Mother’s education was chosen as previous studies have shown it to be associated with child’s health behavior and adverse health events in Norway [36, 37]. There were 108 girls and 145 boys who did not know their mother’s education, mostly those enrolled in a vocational program. This finding is in line with a previous study and might denote the extent of selection bias in the present study, as students with missing values were excluded from the multivariable binary logistic regression analyses [38]. In the Norwegian school system, there is a lawful right, but not an obligation, to complete 1 year of high school. As different study programs lead to different career paths, study program was chosen as the other SEP indicator in this study. Adolescents’ choice of study program has been shown to correlate with their social background [39] and health-related behaviors [34, 40]. Parents’ employment was the other SEP used in this study, as it has been associated with health and health behaviors among adolescents [41].

The general health outcome in this study, body weight (expressed by BMI), was measured. BMI is commonly used as an indicator of body fatness, which is a health risk factor. Indeed, BMI is a ratio between weight and height, and it cannot distinguish between body fatness and fat-free mass [42]. On the other hand, it has been shown that BMI-for-age was a good indicator of body fatness, especially among heavier children and adolescents [43].

The oral health outcome in this study, dental caries experience, was measured and expressed as DMFT score. The DMFT index reflects not only the severity of disease, but also the treatment factor, as filled teeth are included in the score and might be a result of more frequent utilization of dental services [44, 45]. On the other hand, DMFT score is the most commonly used measurement of oral health [46].
Adolescence has been described as a key period for developing health behaviors, thus determining future health. West discussed that it is also a period during which social equality in health is more predominant than inequality, and he suggested that this might be related to the youth culture, secondary school, and school friends that become more important for health equality/inequality than parents’ SEP [47].

Despite the equalizing effect, school creates new inequalities related to study program and/or climate and gender [48]. In our study, the associations between study program, one of the SEP indicators, and body weight; and between study program and dental caries experience, proved to be statistically significant only among girls. This finding is in line with a previous prospective Norwegian cohort study that demonstrated social inequalities in health behaviors among girls based on admission to given study programs [34]. In Norway, the choice of study program has been shown to depend mainly on the occupation of role models, role models for adolescents being mostly their friends and acquaintances, persons from the same social environment [49].

Lower mother’s education, another SEP indicator used in this study, was positively associated with higher BMI only among boys (Table 4). This finding might refer to gender orientation in adolescents’ behavior. It might be that boys are less mature and more dependent on their mothers, as mothers have been shown to be “the prime mover in the health and welfare of the child” [50]. This may also indicate that the Norwegian school system is better adapted to girls’ maturity than to boys’. In addition, social inequalities in BMI were based not only on mother’s education, but also on study program. In addition to the indirect influence, boys reported that their parents’ occupation, which depends on education, influenced their choice of study program [49]. Furthermore, more boys than girls reported to perceive people on TV
as role models; thus they were presumably less influenced by their school’s social environment than were girls at this age [49]. Our findings regarding mother’s education and boy’s health is in contrast to a study from the USA, in which father’s health-risk lifestyle, which consisted of diet, physical activity, smoking, alcohol use, and sleep, affected boys’ health-risk behavior, while mother’s behavior affected girls’ behavior; however parents’ health-risk lifestyle was not included in this study [51]. It has been shown in Norway that father’s occupation predicted changes in health behavior among 13-21-year-old girls [34]. We may speculate that father’s occupation is linked to father’s education, but in the present study, father’s education did not have a statistically significant association with outcomes among girls or among boys; thus it was not included in the final statistical models. Given the differences across genders of parents and children, future studies investigating social inequalities in adolescents should address the issue of gender in the relation between parents and their children. Parents’ employment, another SEP indicator, was independently associated with DMFT score among boys. A study in Hungary showed that incomplete parental employment (unemployed, retired, housewife) resulted in inconsistent associations; it was positively associated with health conditions, like depressive and psychosomatic symptoms, but negatively associated with behavioral factors, like smoking, drinking, and drug use among adolescents [41]. As dental caries is a condition that is highly dependent on behavioral factors, it could be argued that the negative effect of parents’ employment on behavioral factors in the Hungarian study is in line with our findings. Girls enrolled in a sports or physical education program (versus the vocational program) had similar odds for being overweight/obese and having higher dental caries experience when adjusted for the same set of variables (OR 0.20 and OR
0.26, respectively). One may deduce that body weight and dental caries experience are related through common social determinants (in this case SEP indicator, education program) rather than direct oral-general health links; thus supporting the broader concept of social determinants as common risk factors between oral and general health. It must be noted that it is not the study program itself that is a risk factor, but the social context that leads the adolescent to choose a particular program. Body weight and dental caries experience did not produce similar associations with any other SEP indicator used in this study. This may be explained by the fact that adolescence is a relatively healthy period of life, when harmful health behaviors have not yet had time to manifest. In addition, recorded health behaviors and our chosen general health outcome, body weight (expressed by BMI), are prone to change, especially during adolescence, which raises questions about whether a single measurement of these outcomes can depict the real situation over time [52]. On the other hand, boys living without adults had more than two-fold higher odds for being overweight/obese and having high dental caries experience. This finding suggests that not only SEP indicators, but also demographic characteristics, such as household composition, may be a common social determinant for general and oral health conditions among adolescents.

Conclusions

Social inequalities in body weight and dental caries experience might be expected only in adulthood, but our findings show that they were present as early as adolescence in Northern Norway, and that they were based on different social determinants for girls and boys. Similar magnitudes of social inequalities in body weight and dental caries experience among girls were observed based on the SEP
indicator study program, and, among boys, on the demographic characteristic household composition. This suggests that the relationship between body weight and dental caries experience is based on socioeconomic and demographic factors rather than directly on general-oral health. Our findings support the broader concept of social context as a common risk factor for general and oral health.

Abbreviations

BMI
body mass index
CI
confidence interval
CRHFA
common risk/health factor approach
DMFT
decayed, missed and filled teeth
FF1
Fit Future 1
OR
odds ratio
SD
standard deviation
SEP
socioeconomic position
WHO
World Health Organization

Declarations

*Ethics approval and consent to participate*

The Norwegian Data Protection Authority (reference number 2009/1282) and the
Regional Committee of Medical and Health Research Ethics (reference number 2011/1702/REK nord) approved the Fit Futures 1 study at start-up. Participation was based on signed written informed consent: participants aged 16 years and above signed themselves, and younger participants brought written permission from their guardians. The present study was approved by the Regional Committee of Medical and Health Research Ethics (reference number 2018/172/REK nord).

**Availability of data and materials**

The Fit Futures datasets used and analyzed during the current study were supplied by “Helsefak ISM Tromsøundersøkelsen” under the agreement and so cannot be made freely available. Requests for access to these data should be made to tromsous@uit.no.

**Competing interests**

The authors declare that they have no competing interests.

**Funding**

The publishing of this work was supported by the UiT The Arctic University of Norway Library.

**Authors’ contributions**

LSM drafted the manuscript, TAT substantively revised it. TAT made a substantial contribution to the conception of this work. LSM and ASF contributed to the design of the study. ASF contributed to collection of data. LSM analyzed the data, and together with TAT, interpreted it.

All authors have approved the submitted version and agreed to both be personally accountable for their own contributions and to ensure that questions related to the accuracy or integrity of any part of the work, even ones in which the author was not personally involved, are appropriately investigated, resolved, and the resolution
documented in the literature.

**Acknowledgements**

The authors of this work acknowledge “Helsefak ISM Tromsøundersøkelsen” for sharing the data. The authors are grateful for the contribution by the participants in the Fit Futures study and the staff at the Clinical Research Department, University Hospital of North Norway and the University Dental Clinic.

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Tables

Table 1. Operationalization of variables for statistical analyses.

| Variable                   | Measurement                                                                 | Categorization for statistical analysis                  |
|---------------------------|-----------------------------------------------------------------------------|----------------------------------------------------------|
| Socioeconomic position indicators |                                                                             |                                                          |
| Mother’s education        | “What is the highest education completed by your mother?”                     | 1. College 4 years or more                                |
|                           | 1 Primary school 9 years                                                    | 2. College less than college 4 years or more              |
|                           | 2 Occupational high school                                                  | 3. Primary/occupational high school                       |
|                           | 3 High school                                                              |                                                          |
|                           | 4 College less than 4 years                                                 |                                                          |
|                           | 5 College 4 years or more                                                   |                                                          |
|                           | 6 Don’t know                                                               |                                                          |
| Parents’ employment       | “Does your mother/father work?”                                             | 1 Both parents work                                       |
|                           | 1 Full time                                                                | 2 At least one parent does not work full time             |
|                           | 2 Part time                                                               |                                                          |
|                           | 3 Unemployed                                                               |                                                          |
|                           | 4 Disabled                                                                 |                                                          |
|                           | 5 Domestic                                                                 |                                                          |
|                           | 6 Attend school/courses                                                     |                                                          |
|                           | 7. Pensioned                                                               |                                                          |
|                           | 8. Deceased                                                                |                                                          |
|                           | 9. Don’t know                                                              |                                                          |
|                           | 10. Other                                                                  |                                                          |
| Study program             | “Main high school program”                                                  | 1 Program for specialization in general studies           |
|                           | 1 Program for specialization in general studies                            | 2 Program for sports and physical education               |
|                           | 2 Program for sports and physical education                                | 3 Vocational program                                      |
|                           | 3 Vocational program                                                       |                                                          |
| Demographic characteristics |                                                                             |                                                          |
| Age                       | “How old are you”?                                                         | Continuous                                               |
| Birth country             | “Were you born in Norway?”                                                  | 1 Yes                                                    |
|                           | 1 Yes                                                                       | 2 No                                                     |
|                           | 2 No                                                                        | 9 I do not know                                          |
| Household composition | “Who do you live with now?” |
|-----------------------|-----------------------------|
| 1. Mother             | 2. Father                   |
| 3. 1-2 siblings       | 4. 3 or more siblings       |
| 5. Mother’s new partner | 6. Father’s new partner     |
| 7. Foster parents      | 8. Adoptive parents         |
| 9. Grandparents        | 10. Friends                 |
| 11. Alone              | 12. In an institution       |
| 13. Other              |                             |

| Health and health behavior | “Do you have any chronic or persistent disease?” |
|----------------------------|-----------------------------------------------|
|                            | 0. No                                          |
|                            | 1. Yes                                         |

| Alcohol intake | “How often do you drink alcohol?” |
|----------------|----------------------------------|
|                | 0. Never                         |
|                | 1. Sometimes                     |

| Smoking | “Do you smoke?” |
|---------|-----------------|
|         | 0. Never        |
|         | 1. Sometimes/daily |

| Snuff use | “Do you use snuff?” |
|-----------|---------------------|
|           | 0. Never            |
|           | 1. Sometimes/daily  |

| Physical activity according to Gothenburg instrument | “Exercise and physical exertion in leisure time. If your activity varies much, for example between summer and winter, then give an average. The question refers only to the last twelve months.” |
|------------------------------------------------------|--------------------------------------------------------------------------------------------------|
|                                                      | 0. Moderate/sports/hard training                                                                |
|                                                      | 1. Sedentary                                                                                     |

| Sugar-containing sweets and beverages | “How often do you usually eat sweets? (e.g. chocolate, candy)?” |
|--------------------------------------|---------------------------------------------------------------|
|                                      | “How often do you usually eat snacks (e.g. chips, biscuits, cakes, buns)?” |
|                                      | 0. Low (frequency of intake in all groups less than 4-6 times/glasses per week)                 |
|                                      | 1. High (frequency in at least one group 4-6 times or 1-6 glasses per week)                     |

|                          | “How often do you usually drink juice with sugar? (“saft”)”? |
|--------------------------|-------------------------------------------------------------|
| “How often do you usually drink soft drinks with sugar (a 1/2 liter bottle equals 2 glasses)”? |
| 0. Low (frequency of intake in all groups less than 4-6 times/glasses per week) |
| 1. High (frequency in at least one group 4-6 times or 1-6 glasses per week) |
2. 1-6 glasses per week
3. 1 glass per day
4. 2-3 glasses per day
5. 4 or more glasses per day

**Other dietary factors:**
- omega 3 fatty acids-rich food/supplements,
- dairy products,
- fruits/vegetables, vitamin or mineral supplements

- **How often do you usually eat fat fish (e.g. salmon, trout, mackerel, herring)?**
  1. Rarely/never
  2. 1-3 times per month
  3. 1-3 times per week
  4. 4-6 times per week
  5. Every day
- **“Do you take cod liver oil, cod liver oil capsules or fish oil capsules?”**
  1. Yes, daily
  2. Sometimes
  3. No
- **“How often do you usually eat cheese (all kinds)?”**
  1. Rarely/never
  2. 1-3 times per month
  3. 1-3 times per week
  4. 4-6 times per week
  5. Every day
- **“How much do you usually drink of whole milk, kefir and yoghurt?”**
- **“How often do you usually drink semi-skimmed milk, cultura and fat-reduced yoghurt?”**
- **“How often do you usually drink skimmed milk (sweet or sour)?”**
- **“How often do you usually drink extra semi-skimmed milk?”**
  1. Rarely/never
  2. 1-6 glasses per week
  3. 1 glass per day
  4. 2-3 glasses per day
  5. 4 or more glasses per day
- **“How often do you usually eat fruit?”**
- **How often do you usually eat vegetables?**
  1. Rarely/never
  2. 1-3 times per month
  3. 1-3 times per week
  4. 4-6 times per week
  5. 1-2 times per day
  6. 3-4 times per day
  7. 5 times or more per day
- **Do you use vitamin or mineral supplements?”**
  1. Yes, daily
  2. Sometimes
  3. No

**Oral hygiene habits**
- **“How often do you usually brush your teeth?”**
  1. Less frequently than once a week
  2. Once a week
  3. 2 to 3 times a week
  4. 4 to 6 times a week
  5. Once a day
  6. 2 or more times a day
- **“How often do you use fluoride tablets?”**
  1. Regularly, daily
  2. Not regularly, a few times weekly

0. More healthy (frequency of intake of at least two groups 1-6 times/glasses a week or more)
1. Less healthy (frequency in all groups less than 1-6 times/glasses per week)
0. Good (brushing teeth twice a day or more and/or fluoride supplement daily)
1. Less than good (brushing teeth twice a day or less)
3. Not regularly, a few times monthly
4. Seldom, never

“How often do you use fluoride mouth rinses?”
1. Regularly, daily
2. Not regularly, a few times weekly
3. Not regularly, a few times monthly
4. Seldom, never

**Dental satisfaction and self-esteem**

| Question | Answers |
|----------|---------|
| “Are you satisfied with the alignment of your anterior teeth?” | 1. Very satisfied  
2. Fairly satisfied  
3. Neither satisfied nor dissatisfied  
4. Fairly dissatisfied  
5. Very dissatisfied |
| “Do you avoid smiling due to the appearance of your teeth?” | 1. Often  
2. Sometimes  
3. Difficult to say  
4. Seldom  
5. Never |
| “I find it quite hard to make friends” | 1. Often  
2. Sometimes  
3. Difficult to say  
4. Seldom  
5. Never |
| “I have many friends” | 1. Often  
2. Sometimes  
3. Difficult to say  
4. Seldom  
5. Never |
| “My peers don't like me” | 1. Often  
2. Sometimes  
3. Difficult to say  
4. Seldom  
5. Never |
| “I am popular among my peers” | 1. Often  
2. Sometimes  
3. Difficult to say  
4. Seldom  
5. Never |
| “I feel that my peers accept me” | 1. Often  
2. Sometimes  
3. Difficult to say  
4. Seldom  
5. Never |

**Mental health**

| Question | Answers |
|----------|---------|
| Have been in therapy by a psychologist, a psychiatrist or the pedagogic-psychologic services during the last year? | 1. No  
2. Yes |

**Sleep**

| Question | Answers |
|----------|---------|
| “Do you feel that you get enough sleep?” | 1. Yes, absolutely enough  
2. Yes, normally enough  
3. No, somewhat insufficient  
4. No, clearly insufficient  
5. No, far from sufficient |

**Vitamin D status**

| Question | Answers |
|----------|---------|
| Measured 25-hydroxyvitamin D level in blood serum | 0. Optimal ≥75nmol/L  
1. Less than optimal |

**Composite health/health behavior**

| Question | Answers |
|----------|---------|
| Composed of 12 variables | 1. Very good (score 0-3)  
2. Good (score 4-6)  
3. Less than good (score 7-12) |

Table 2. Socioeconomic position indicators, demographic characteristics, health, and health behavior, body weight (general health outcome expressed as body mass index, BMI) and dental caries experience (oral health outcome expressed as dental, missing, filled teeth, DMFT) among the participants of The Tromsø Study Fit Futures 1 (FF1) stratified by sex.
### Characteristics

| Characteristics                                                                 | Girls     | Boys     |
|--------------------------------------------------------------------------------|-----------|----------|
|                                                                              | FF1 N (%) | FF1 N (%)|
| **Socioeconomic position indicators**                                          |           |          |
| Mother’s education                                                            | 363 (45)  | 351 (46) |
| High school or less                                                           | 162 (45)  | 162 (46) |
| College less than 4 years                                                     | 89 (24)   | 81 (23)  |
| College 4 years or more                                                       | 112 (31)  | 108 (31) |
| Parents’ employment                                                           | 426       | 452      |
| Both parents work full time                                                   | 258 (61)  | 270 (60) |
| At least one parent does not work full time                                   | 168 (39)  | 182 (40) |
| **Adolescent’s study program [*]**                                            | 477       | 508      |
| For specialization in general studies                                         | 239 (50)  | 151 (30) |
| For sports and physical education                                            | 38 (8)    | 46 (13)  |
| Vocational                                                                    | 200 (42)  | 291 (57) |
| **Demographic characteristics**                                              |           |          |
| Age in years *                                                                | 477       | 508      |
| 15                                                                            | 15 (3)    | 37 (7)   |
| 16                                                                            | 380 (80)  | 390 (77) |
| 17                                                                            | 74 (15)   | 65 (13)  |
| 18                                                                            | 8 (2)     | 16 (3)   |
| Birth country                                                                 | 474       | 500      |
| Norway                                                                        | 448 (94)  | 476 (95) |
| Other                                                                         | 26 (6)    | 24 (5)   |
| Household composition                                                         | 474       | 500      |
| Without adults                                                                | 85 (18)   | 78 (16)  |
| With adults                                                                   | 389 (82)  | 422 (84) |
| **Health and health behavior**                                                |           |          |
| Composite health/health behavior *                                           | 358       | 387      |
| Very good                                                                     | 83 (23)   | 76 (20)  |
| Good                                                                          | 217 (61)  | 220 (57) |
| Less than good                                                                | 58 (16)   | 91 (23)  |
| **General health outcome**                                                    |           |          |
| Body weight (BMI)*                                                            | 475       | 508      |
| Underweight                                                                   | 10 (2)    | 42 (8)   |
| Normal weight                                                                 | 353 (74)  | 352 (70) |
| Overweight                                                                    | 79 (17)   | 77 (15)  |
| Obese                                                                         | 33 (7)    | 37 (7)   |
| **Oral health outcome**                                                       |           |          |
| Dental caries experience (DMFT)                                               | 467       | 494      |
| Low (DMFT <4.46)                                                              | 265 (57)  | 303 (61) |
| High (DMFT >4.46)                                                             | 202 (43)  | 191 (39) |

*p<0.05 according to Chi-square test between girls and boys in FF1.

Table 3. Socioeconomic position indicators, demographic characteristics, health, and health behavior, body weight (general health outcome expressed as body mass index, BMI) and dental caries experience (oral health outcome expressed as dental, missing, filled teeth, DMFT) among the participants of The Tromsø Study Fit Futures 1 (FF1) stratified by adolescent’s study program.
| Characteristics                                      | General N (%) | Study program N (%) | Vocational N (%) |
|-----------------------------------------------------|---------------|---------------------|------------------|
| **Socioeconomic position indicators**               |               |                     |                  |
| Mother’s education[†]                                | 324           | 86                  | 304              |
| High school or less [†]                              | 108 (33)      | 26 (30)             | 190 (6)          |
| College less than 4 years                            | 87 (27)       | 32 (37)             | 51 (17)          |
| College 4 years or more                              | 129 (40)      | 28 (33)             | 63 (21)          |
| Parents’ employment*                                 | 360           | 94                  | 268              |
| Both parents work full time                          | 246 (68)      | 65 (69)             | 145 (5)          |
| At least one parent does not work full time          | 114 (32)      | 29 (31)             | 123 (4)          |
| **Demographic characteristics**                      |               |                     |                  |
| Sex*                                                 | 390           | 104                 | 491              |
| Girls                                                | 239 (61)      | 38 (37)             | 200 (4)          |
| Boys                                                 | 151 (39)      | 66 (63)             | 291 (5)          |
| Age in years at FF1[‡]                               | 390           | 104                 | 491              |
| 15                                                   | -             | -                   | 52 (11,          |
| 16                                                   | 345 (88)      | 83 (80)             | 342 (7)          |
| 17                                                   | 43 (11)       | 21 (20)             | 75 (15)          |
| 18                                                   | 2 (1)         | -                   | 22 (4)           |
| Birth country                                        | 389           | 104                 | 481              |
| Norway                                               | 367 (94)      | 99 (95)             | 458 (9)          |
| Other                                                | 22 (6)        | 5 (5)               | 23 (5)           |
| Household composition*                               | 389           | 104                 | 481              |
| Without adults                                       | 42 (11)       | 26 (25)             | 95 (20)          |
| With adults                                          | 347 (89)      | 78 (75)             | 386 (8)          |
| **Health and health behavior**                       |               |                     |                  |
| Composite health/health behavior*                   | 323*          | 88                  | 334              |
| Very good                                            | 83 (26)       | 25 (28)             | 51 (15)          |
| Good                                                 | 191 (59)      | 53 (60)             | 193 (5)          |
| Less than good                                       | 49 (15)       | 10 (12)             | 90 (27)          |
| **General health outcome**                           |               |                     |                  |
| Body weight (BMI)*                                   | 390           | 104                 | 489              |
| Underweight                                          | 22 (6)        | -                   | 30 (6)           |
| Normal weight                                        | 294 (75)      | 94 (90)             | 317 (6)          |
| Overweight                                           | 57 (15)       | 10 (10)             | 89 (18)          |
| Obese                                                | 17 (4)        | -                   | 53 (11)          |
| **Oral health outcome**                              |               |                     |                  |
| Dental caries experience (DMFT)*                     | 388           | 104                 | 469              |
| Low (DMFT <4.46)                                     | 257 (66)      | 68 (65)             | 243 (5,          |
| High (DMFT >4.46)                                    | 131 (34)      | 36 (35)             | 226 (4)          |

[1] p<0.05 according to Chi-square test between study programs in FF1.
[2] p<0.05 according to Likelihood Ratio test between study programs in FF1.

Table 4. Odds ratios (ORs) and 95% confidence intervals (CIs) for the association between age- and sex-adjusted body weight (body mass index, BMI) and socioeconomic position (SEP) indicators according to univariable and multivariable binary logistic regression analyses. The number of participants in each analysis differs due to missing data. The Tromsø Study Fit Futures 1.
| Characteristic                  | GIRLS                                                                 |
|--------------------------------|-----------------------------------------------------------------------|
|                                | Crude OR (95% CI)                                                    | Model 1[iv] adjusted OR (95% CI) | Model 2 adjusted OR (95% CI) |
|                                | Model OR (95% CI)                                                    | N=310                            | N=27                          |
| Socioeconomic position indicators |                                                                       |                                  |                               |
| Mother’s education             |                                                                        |                                    |
| College 4 years or more        | 1                                                                     | 1                                 | 1                             |
| High school or less            | 0.96 (0.55-1.68)                                                     | 0.70 (0.36-1.36)                  | 0.81 (0.47-1.41)               |
| College less than 4 years      | 0.88 (0.46-1.70)                                                     | 0.79 (0.38-1.65)                  | 0.92 (0.51-1.68)               |
| Parents’ employment            |                                                                        |                                    |
| Both full time                 | 1                                                                     | 1                                 | 1                             |
| At least 1 not full time       | 1.21 (0.77-1.88)                                                     | 1.36 (0.78-2.37)                  | 1.40 (0.83-2.34)               |
| Adolescent’s study             |                                                                        |                                    |
| Vocational                     | 1                                                                     | 1                                 | 1                             |
| General studies                | 0.69 (0.44-1.07)                                                     | 0.55 (0.30-1.00)                  | 0.66 (0.37-1.20)               |
| Sports                         | 0.38 (0.14-1.03)                                                     | 0.26 (0.07-0.95)                  | 0.20 (0.05-0.79)               |

Nagelkerke $R^2$ first (SEP) block

0.047 0.047

Nagelkerke $R^2$ whole model

0.072 0.090

[1] Adjusted by all SEP indicators, age, demographic characteristics (independent of significance), and health and health behavior characteristics that proved statistical significance ($p \leq 0.05$) in univariable binary logistic regression analysis.

[2] Adjusted by all SEP indicators, demographic characteristics and the composite health/health behavior variable.

[3] Adjusted by all SEP indicators, age, demographic characteristics (independent of significance), health and health behavior characteristics that proved statistical significance ($p \leq 0.05$) in univariable binary logistic regression analysis.

Table 5. Odds ratios (ORs) and 95% confidence intervals (CIs) for the association between dental caries experience (decayed, missing, filled teeth, DMFT score) and socioeconomic position (SEP) indicators according to univariable and multivariable binary logistic regression analyses. The number of participants in each analysis differs due to missing data. The Tromsø Study Fit Futures 1.
| Characteristic                      | GIRLS Crude OR (95% CI) | GIRLS Model 1[vii] adjusted OR (95% CI) N=276 | GIRLS Model 2 adjusted OR (95% CI) N=274 |
|------------------------------------|-------------------------|-----------------------------------------------|-------------------------------------------|
| **Socioeconomic position indicators** |                         |                                               |                                           |
| **Mother’s education**             |                         |                                               |                                           |
| College 4 years or more            | 1                      | 1                                             | 1                                         |
| High school or less                | 1.56 (0.95-2.57)        | 1.06 (0.56-1.99)                              | 1.23 (0.52-2.85)                          |
| College less than 4 years          | 1.53 (0.87-2.69)        | 1.10 (0.53-2.25)                              | 1.56 (0.79-3.07)                          |
| Both full time                     | 1                      | 1                                             | 1                                         |
| **Parents’ employment**            |                         |                                               |                                           |
| At least 1 not full time           | 1.08 (0.74-1.59)        | 0.90 (0.51-1.57)                              | 1.04 (0.52-2.08)                          |
| **Adolescent’s study program**     |                         |                                               |                                           |
| Vocational                         | 1                      | 1                                             | 1                                         |
| General studies                    | 0.49 (0.34-0.73)        | 0.32 (0.17-0.62)                              | 0.39 (0.20-0.78)                          |
| Sports                             | 0.51 (0.25-1.04)        | 0.27 (0.10-0.71)                              | 0.26 (0.10-0.67)                          |
| **Nagelkerke R² first (SEP) block**| 0.075                   | 0.089                                         |                                           |
| **Nagelkerke R² whole model**      | 0.178                   | 0.137                                         |                                           |

[1] Adjusted by all SEP indicators, age, demographic characteristics (independent of significance), health and health behavior characteristics that proved statistical significance (p≤0.05) in univariable binary logistic regression analysis.

[2] Adjusted by all SEP indicators, demographic characteristics and the composite health/health behavior variable.

[3] Adjusted by all SEP indicators, age, demographic characteristics (independent of significance), health and health behavior characteristics that proved statistical significance (p≤0.05) in univariable binary logistic regression analysis.

**Figures**
Social inequalities in body weight and dental caries experience among girls based on the socioeconomic position and education program versus vocational program.

Figure 1

Social inequalities in body weight and dental caries experience among girls based on household with adults versus household without adults.