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Resilience and lifestyle-related factors as predictors for health-related quality of life among early adolescents: a cross-sectional study

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Abstract

Objective: To examine whether lifestyle-related factors and resilience predict health-related quality of life (HRQoL) in a sample of early adolescents.

Methods: A total of 611 eighth grade pupils (response rate: 79%) participated in this cross-sectional study. The variables measured were physical activity (accelerometer), cardiorespiratory fitness (Andersen test) and a questionnaire assessing dietary habits, sleep disturbance, resilience (Resilience Scale for Adolescents) and HRQoL (KIDSCREEN-27).

Results: A total of 36% of the sample met the official recommendations of 60 minutes of daily physical activity. Univariate analysis identified physical activity, dietary habits, sleep disturbances, body mass index (BMI), cardiorespiratory fitness and resilience, but not sedentary time, as predictors of HRQoL. Multivariate regression analysis identified resilience as a positive predictor (β 0.18 to 0.27) of all HRQoL domains and sleep disturbance as a negative predictor (β −0.65 to −0.24) of four HRQoL domains. BMI ($\beta = -0.27$) and cardiorespiratory fitness ($\beta = 0.021$) were predictors of the HRQoL domain physical well-being. Adherence to dietary recommendations was both a positive and a negative predictor of HRQoL (β −0.45 to 0.59).

Conclusion: Resilience and sleep disturbances were the main predictors of HRQoL.

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Introduction

Adolescence is a key transitional stage in which lifestyle choices that determine long-term health, well-being and quality of life are made.[1] It is also a life phase characterized by substantial physical, psychological, social and emotional changes that lead to greater vulnerability related to health and well-being.[2] Some adolescent lifestyle changes are temporary, whereas others continue into adulthood. Physical activity level declines and sedentary time increases rapidly from childhood to adolescence.[3] To some extent, physical activity and sedentary behaviour in adolescence predict such behaviour in adulthood.[4,5] Currently, only approximately half of Norwegian adolescents adhere to the official recommendations of 60 minutes of daily physical activity[6] Dietary habits also persist from adolescence to adulthood,[7,8] and in Norwegian adolescents they are currently characterized by an irregular meal pattern with frequent snacking and intake of light meals.[9] Alarmingly, few Norwegian adolescents adhere to the official dietary recommendations of (for example) an intake of >five portions of fruit/vegetables/berries (10% adherence) and a sugar limit of <10% of total daily energy intake (17% adherence).[10,11] There is evidence that dietary adherence is associated with parental socioeconomic status (SES).[10]

Adequate sleep is fundamental for health and well-being.[12] Sleeps affects both biological processes, such as energy expenditure, appetite regulation and hormonal regulation, and psychological processes such as attention and memory.[13] Sleep is one of the most prominent lifestyle-related behaviour changes from childhood to adolescence; these changes include altered bedtimes, poorer sleep quality and more daytime sleepiness.[14] Social changes during adolescence, such as less parental control, more social interaction with peers and increased use of electronic devices, may affect several aspects of sleep.[15,16] Despite this, sleep has been neglected in studies of lifestyle and health among adolescents.[14] To acknowledge the importance for health and well-being of lifestyle behaviour throughout the 24-hour period, the Canadian 24-hour Movement Guidelines were published in 2016.[17] These guidelines provide recommendations for sleep hygiene (i.e. 8–10 hours of uninterrupted sleep per night for adolescents) in addition to recommendations for physical activity (i.e. 60 minutes per day) and sedentary time (i.e. 2 hours maximum of daily recreational screen-time, limited sitting for extended periods). Although adherence to sleep recommendations is better than adherence to physical activity and dietary recommendations, an Australian study found that as many as 44% of adolescents sleep for an insufficient number of hours each night.[18] It is therefore important to include sleeping patterns and disturbances in any analysis of lifestyle factors that predict health and well-being.

Health-related quality of life (HRQoL) has been defined by the World Health Organization as a multidimensional and integrative construct comprising physical,

psychological and social well-being and functioning.[19] HRQoL is a core aspect of general health and well-being, and it is relatively stable in healthy adolescents.[20,21] Associations between HRQoL and sleep,[14] physical activity and sedentary behaviour,[22] dietary habits[23] and cardiorespiratory fitness[24] have been found in adolescents. Unfortunately, most studies consider only a limited set of lifestyle-related factors as predictors of HRQoL. Muros et al.[25] found that dietary habits, physical activity and body mass index (BMI) explained 20% of the variance in HRQoL in adolescents aged 11 to 14 years, but this study did not measure sleep and cardiorespiratory fitness. Although physical activity and cardiorespiratory fitness are related, they are different constructs. Physical activity is a behavioural component and is the most important contributor to physical fitness,[26] whereas cardiorespiratory fitness is one of several components of physical fitness.[26] Both physical activity and physical fitness are independently associated with various domains of HRQoL. A study using path analysis demonstrated that physical fitness mediates the relationship between physical activity and HRQoL in children.[27] This indicates the importance of examining both these constructs as possible predictors of HRQoL.

Furthermore, most existing studies have not included important confounding factors such as resilience. Resilience is a protective factor that contributes to good outcomes despite the substantial risk of disease burden,[28] and is associated with both HRQoL[29] and lifestyle[30] in adolescents. Resilience also mediates 60% of the relationship between physical activity and mental health.[31] To our knowledge, this current study is the first to examine the relationship between resilience and a wide set of lifestyle-related factors as predictors of HRQoL. The study aim was to examine 1) lifestyle-related factors, resilience and HRQoL, and 2) the relative importance of lifestyle-related factors and resilience as predictors of HRQoL in a sample of early adolescents. The results have the potential to increase the understanding of the relative importance of various lifestyle-related factors, and hence provide evidence for future experimental studies to improve adolescent HRQoL.

Materials and methods

Sample and study design

The cross-sectional data presented in this paper are baseline data from the quasi-experimental study 'Active and Healthy Kids in Telemark', a study initiated and implemented by the Telemark County Council Department of Public Health, Telemark, Norway. Participants were recruited using a non-probability convenience sampling method. Inclusion criteria were enrolment as an eighth grade pupil in school year 2017/2018 at a public secondary school in one of the six municipalities that had agreed to participate in the Telemark study. Telemark County Council selected four rural municipalities and two urban municipalities for participation; these municipalities contained 15 secondary schools. Exclusion criteria for participation were language barriers, and any injuries or illnesses that affected the assessment of physical fitness and physical activity.

Data collection was conducted during one school day within 4 weeks after the start of the school semester; pupils absent from school that day were unable to participate. The research group provided oral and written information about the study to school principals and staff. Prior to data collection, the primary teachers for each included class distributed written information about the study to the pupils and their parents on behalf of the research group prior to data collection. This study was

conducted in accordance with the Helsinki Declaration, was evaluated by the Regional Committee for Medical and Health Research Ethics (ID 2017/387), approved by the Norwegian Data Protection Services (ID number 54327) and registered in ClinicalTrials.gov (NCT03906851). Parents of the included participants gave written consent for participation. The data presented in this paper were collected during September 2017.

Assessment

SES. Parental education level is considered the most fundamental SES indicator.[32] The parents of each pupil were thus asked to classify their completed educational level as one of the five following categories: 'elementary school', 'vocational school', 'high school', 'higher education, undergraduate level' or 'higher education, graduate level'. If each parent of a child had different completed educational levels, the highest level was used for the analyses.

Physical activity. Physical activity was measured objectively using a triaxial Actigraph accelerometer (ActiGraph GT3X+, LLC, Pensacola, FL, USA). Each participant was fitted with an accelerometer in an elastic belt, fitted around the waist and placed on the right hip. The accelerometer was worn for 4 consecutive days (2 weekdays and 2 weekend days). Participants were instructed to wear their accelerometers for the whole day, except during water-based activities or while sleeping. Accelerometers were initialized to start recording at 06:00 on the day after they were distributed. Epoch length was set to 10-second intervals. The criterion for a valid day was set as a weartime of 480 minutes/day between 06:00 and 24:00. A total of $\geq$2 days (weekdays and/or weekend days) was the criteria for a valid measurement, following Kolle et al.[33] All sequences of $\geq$20 minutes of consecutive zero counts from each subject's recording were excluded and defined as non-weartime, as this indicates periods in which participants did not wear the accelerometer.[34] We used ActiLife software (ActiGraph, LLC, Pensacola, FL, USA) to initialize the monitors and to download the accelerometer files. The outcomes for total physical activity were counts per minute (cpm) from the accelerometer's vertical axis (cpm axis 1). Sedentary time was defined as all activities less than 100 cpm, a threshold that corresponds with sitting, reclining or lying down.[35,36] Evenson's criteria[35] were used to define cutoffs for moderate-to-vigorous physical activity. We analysed all accelerometer data using ActiLife software (ActiGraph, LLC, Pensacola, FL, USA).

Cardiorespiratory fitness. The Andersen test, which has been shown to provide reliable and valid data on a group level,[37] was used to assess cardiorespiratory fitness. The Andersen test is a 10-minute intermittent running test with periods of 15 seconds work and 15 seconds rest typically signalled by a test leader blowing a whistle.[38] Participants run between two parallel lines 20 m apart. At each line, they must touch the floor behind the line before turning around to run to the other line. The aim of the test is to cover the longest distance possible during the 10-minute run; the test result is the distance covered in metres. Participants were divided into pairs for the testing; half the pupils completed the test while the other half assisted in counting by writing down the number of laps on a standardized form. Afterwards, they switched tasks. Each test was filmed by a test assistant. If a counter lost count, the test leader would recount the number of laps by watching the film. The film was immediately deleted after the test results were registered. Verbal encouragements were given during all tests to motivate

participants to give their best performance. After each test, the test leader and test assistants evaluated subjective criteria for near-maximal performance. Participants who clearly did not give near-maximal efforts (assessed using physical and verbal behaviour during and immediately after the test, as well as running and breathing patterns) were excluded from the test results.

Anthropometric measurements. Height and body weight were measured wearing light clothing and without shoes. Height was measured to the nearest 0.1 cm using a wall-mounted measuring tape or stadiometer. Body weight was measured to the nearest 0.1 kg using electronic scales belonging to the school nurse's office at each school. BMI was calculated as weight in kilograms divided by height in metres squared (kg/m^2). The children were categorized as normal weight, overweight or obese according to the criteria by Cole and Lobstein.[39]

Dietary index. Dietary information was collected using a short food frequency questionnaire (FFQ), based on a previously validated FFQ used with Norwegian adolescents.[40] The FFQ included questions about habitual intake of 12 types of foods/drinks with nine answer options ranging from seldom/never to several times/day. Responses were coded from 0 to 8. Based on current Norwegian general dietary recommendations,[41] we chose four dietary indicators to form a dietary index: fruits/berries and vegetables, whole grain cereals, fish for dinner/on bread, and high intake of sugar products (sweets/bakery goods/sugary soda). Based on the recommendations, each indicator was given scores on a scale from 0 to 10; a score of 10 indicated that the respondent had a recommended/optimal intake of the respective indicator (Table 1).[42] Respondents with other intake frequencies were given scores proportionally. For indicators that included more than one question (fruits/berries and vegetables, high sugar products), a mean score for each indicator was calculated. Finally, each participant was given a mean dietary score (0–10); higher scores on the index indicated a healthier diet. The variable was labelled 'recommended diet'.

Sleep. Sleep quality, sleep latency and daytime sleepiness were assessed using six questions adapted from the Norwegian cross-national youth survey Ungdata.[43] The sleep items were as follows: 'During the past month, how many days have you ... **1**. had problems getting to sleep after

Table 1. Dietary indicators and calculation of dietary index.

	Cutoff points = criteria for max score (= 10)		Proportion fulfilling recommendations	
Dietary index indicators	Recommended frequency	Corresponding value (answer options 0–8)	Boys (%)	Girls (%)
Whole grain cereals	Daily	7	17%	18%
Fish (for dinner and on bread)	≥3 times/week*	3	24%	25%
Sweets/bakery goods/sugary soda (mean of the 3 variables)	≤1 time/week**	1	32%	33%
Fruits/berries, and vegetables (mean of the 2 variables)	Several times a day	7.5	6%	14%

*≥2 dinners/week and on sandwiches **not on schooldays/weekdays, (1 time/week).

you have switched the light off? **2**. not felt properly rested after sleeping? **3**. been so sleepy/tired that it has affected your schoolwork or leisure activities? **4**. had difficulty waking up at the right time in the morning? **5**. not managed to fall asleep before 2 a.m.? **6**. woken up too early and been unable to get back to sleep?' Questions are categorized into the following five response options: 0 to 5 times (1), 6 to 10 times (2), 11 to 15 times (3), 16 to 20 times (4), and 20 times or more (5). The questions used in this survey reflect the categories outlined in the BEARS screening tool[44] and sleep concepts assessed in other widely used subjective sleep measures.[45] To generate a sleep index, we recoded item 2 so that a higher score on all items indicated higher frequency of problems. The index was a sum score of the six items; total scores ranged from 6 to 30.

Resilience. To measure participants' resilience we used the 28-item Resilience Scale for Adolescents (READ).[28,46] The scale comprises five subscales labelled 'personal competence', 'social competence', 'structured style', 'family cohesion' and 'social resources'. Responses are on a 5-point Likert scale ranging from strongly disagree (1) to strongly agree (5). All items are positively phrased, such that high scores indicate high resilience for all items. Initial work on the READ scale has shown the instrument to have adequate internal reliability and factorial validity.[46] The alpha coefficient in this study was 0.95 for the mean total READ score and ranged from 0.69 to 0.86 for the subscales; these values were deemed acceptable.

HRQoL. KIDSCREEN is a multidimensional, widely used and validated instrument that assesses physical, psychological, social and behavioural components of well-being in children and adolescents aged 8 to 18 years.[47,48] The KIDSCREEN-27 was developed to obtain a shorter version of the original KIDSCREEN-52, and it consists of the five domains: 'physical well-being', 'psychological well-being', 'social support and peers', 'parent relations and autonomy', and 'school environment'.[49] Cronbach's alpha in this sample ranged from 0.79 to 0.82 for the five domains.

Statistical analysis

Missing data for the independent variables (physical activity (18%), sedentary activity (18%), BMI (17%) and physical condition (11%)) were imputed using mean values for all analysis. Excluding all cases with missing values did not significantly alter the results. The Pearson correlations between the independent variables ranged from −0.360 for BMI and physical condition and 0.339 for physical condition and physical activity. Sex differences were analysed using the independent t-test. Univariate linear regression was used to assess univariate associations between the independent variables and the five domains of the KIDSCREEN-27. Stepwise linear regression was used to assess associations between all the independent variables and the five KIDSCREEN-27 domains, adjusted for each other and SES, sex and place of birth, resulting in a model with only significant associated predictors. $P < 0.05$ was considered to indicate significance in all analyses. IBM SPSS version 25.0 (IBM Corp., Armonk, NY, USA) was used for all analyses.

Results

As shown in Figure 1, 611 pupils participated in this cross-sectional data collection (response rate: 79%). The mean respondent age was 13.2 years (Table 2). There was an equal distribution of female (49.1%) and male (50.9%) respondents; 9% of the respondents were immigrants (Table 2). As shown in Table 2, 69% of the respondents had high SES. A total of 36% of the sample

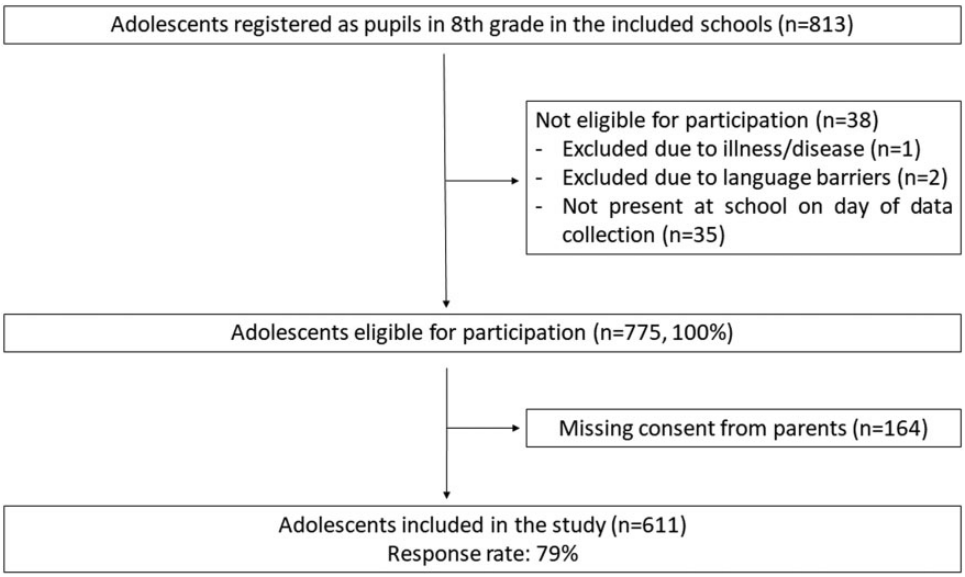

Figure 1. Flow chart of study participation.

met the recommendations of 60 minutes of daily physical activity; of these, more boys met the recommendations than girls. The READ scores showed higher personal competence ($P < 0.05$) and lower social competence ($P < 0.05$), social resources ($P < 0.001$) and family cohesion ($P < 0.05$) in boys compared with girls (Table 2). The sleep data showed that 23% of participants reported daytime sleepiness >1 time/week, 27% reported feeling rested after sleep <5 times/month, and 29% reported long sleep latency >1 time/week. Girls reported a higher frequency of feeling inadequately rested after sleep compared with boys ($P < 0.05$) (Table 2). Sex differences were found for two of the five HRQoL domains (parent relations and autonomy ($P < 0.05$) and social support and peers ($P < 0.01$)) (Table 2).

Predictors of HRQoL

Sedentary time did not predict scores on any of the HRQoL domains. Physical activity and cardiorespiratory fitness ($\beta = 0.021$) were positive predictors of physical well-being and psychological well-being, BMI was a negative predictor of physical well-being ($\beta = -0.27$), and sleep disturbance was a negative predictor of four of the five HRQoL domains (β −0.65 to −0.24) (all $P < 0.05$) (Table 3). Recommended dietary intake and resilience were positive predictors of physical well-being, psychological well-being, parent relations and autonomy, and school environment (all $P < 0.05$). The multivariate analyses identified resilience as a positive predictor for all five HRQoL domains (β 0.18 to 0.27; all $P < 0.05$). Sleep disturbance negatively predicted four out of five domains (all $P < 0.05$). Recommended dietary intake positively predicted physical well-being and school environment and negatively predicted social support and peers (β −0.45 to 0.59), whereas cardiorespiratory fitness positively predicted physical well-being (all $P < 0.05$) (Table 4). Physical activity level and sedentary time did not predict

Table 2. Descriptive data.

	Boys (n = 311)	Girls (n = 300)	Difference	Total (n = 611)
Background				
Age, years, mean (SD)	13.2 (0.3)	13.2 (0.3)	t = 0.65	13.2 (0.3)
Immigrants, n (%)	26 (9)	25 (9)	$\chi^2(1) = 0.01$	51 (9)
Parental higher education, n (%)	133 (69)	132 (70)	$\chi^2(1) = 0.72$	265 (69)
Lifestyle-related variables				
BMI, kg/m^2, mean (SD)	19.6 (3.2)	20.5 (3.6)	t = 2.84**	20.1 (3.4)
Overweight/obesity, n (%)	41 (17)	54 (22)	$\chi^2(1) = 2.13$	95 (19)
Physical activity, CPM, mean (SD)	513.0 (186.7)	445.2 (155.6)	t = 4.36***	476.8 (174.0)
MVPA, minute/day, mean (SD)	58.4 (24.8)	50.3 (20.3)	t = 3.95***	54.1 (22.9)
Compliance with PA recommendations, n (%)	94 (41)	80 (31)	$\chi^2(1) = 5.98$	174 (36)
Sedentary time, hours/day, mean (SD)	8.8 (1.3)	9.1 (1.1)	t = 3.02**	9.0 (1.2)
Andersen test, mean (SD)	1018 (128)	973 (111)	t = 4.31***	996.4 (122.2)
Recommended dietary intake, index, mean (SD)	5.8 (1.7)	6.4 (1.8)	t = 3.84***	6.2 (1.8)
Sleep item #1[a] mean (SD)	1.50 (1.06)	1.66 (1.16)	t = 1.69	1.58 (1.11)
Sleep item #2[b] mean (SD)	2.82 (1.59)	3.14 (1.50)	t = 2.48*	2.98 (1.56)
Sleep item #3[c] mean (SD)	1.42 (0.85)	1.34 (0.80)	t = 1.09	1.38 (0.83)
Sleep item #4[d] mean (SD)	2.25 (1.42)	2.37 (1.46)	t = 1.00	2.31 (1.44)
Sleep item #5[e] mean (SD)	1.26 (0.78)	1.22 (0.69)	t = 0.70	1.24 (0.74)
Sleep item #6[f] mean (SD)	1.43 (0.82)	1.32 (0.76)	t = 1.65	1.37 (0.80)
Sleep index, mean (SD)	10.68 (3.49)	11.04 (3.54)	t = 1.26	10.86 (3.5)
Resilience				
READ, mean	3.99 (0.65)	4.96 (0.60)	t = 1.36	4.02 (0.63)
Personal competence	3.97 (0.68)	3.85 (0.60)	t = 2.00*	3.91 (0.69)
Structured style	3.63 (0.76)	3.69 (0.75)	t = 1.09	3.66 (0.76)
Social competence	3.79 (0.79)	3.94 (0.75)	t = 2.38*	3.87 (0.77)
Social resources	4.28 (0.74)	4.49 (0.61)	t = 3.77***	4.39 (0.69)
Family cohesion	4.17 (0.74)	4.30 (0.68)	t = 2.37*	4.23 (0.71)
Health-related quality of life				
Physical well-being	46.7 (9.4)	46.1 (9.1)	t = 0.70	46.4 (9.2)
Psychological well-being	51.0 (9.3)	50.5 (9.6)	t = 0.68	50.7 (9.5)
Parent relations and autonomy	52.4 (10.1)	54.1 (9.6)	t = −2.07*	53.3 (9.9)
Social support and peers	50.3 (10.1)	52.4 (9.4)	t = −2.61**	51.4 (9.8)
School environment	51.5 (9.7)	52.6 (9.4)	t = −1.30	52.0 (9.6)

*$P < 0.05$. **$P < 0.01$. ***$P < 0.001$. CPM: counts per minute; MVPA: moderate-to-vigorous physical activity; PA: physical activity; SD: standard deviation; BMI: body mass index; READ: Resilience Scale for Adolescents. [a]During the past month, how many days have you had problems getting to sleep after you have switched the light off? [b]During the past month, how many days have you not felt properly rested after sleeping? [c]During the past month, how many days have you been so sleepy/tired that it has affected your schoolwork or leisure activities? [d]During the past month, how many days have you had difficulty waking up at the right time in the morning? [e]During the past month, how many days have you not managed to fall asleep before 2 a.m.? [f]During the past month, how many days have you woken up too early and been unable to get back to sleep?

Table 3. Univariate linear regression of association between lifestyle-related factors, resilience and each of the five KIDSCREEN-27 (HRQoL) dimensions.

	Physical well-being Beta (95% CI)	Psychological well-being Beta (95% CI)	Parent relations and autonomy Beta (95% CI)	Social support and peers Beta (95% CI)	School environment Beta (95% CI)
Physical activity	**0.010 (0.005, 0.014)**	**0.0044 (0.0005, 0.0092)**	−0.0003 (−0.0054, 0.0047)	0.0030 (−0.0020, 0.0080)	0.0007 (−0.0042, 0.0056)
Sedentary time	−0.6 (−1.2, 0.1)	−0.1 (−0.8, 0.6)	0.2 (−0.5, 0.9)	−0.2 (−0.9, 0.5)	0.6 (−0.1, 1.3)
Recommended dietary intake	**1.2 (0.8, 1.6)**	**0.7 (0.3, 1.2)**	**0.8 (0.4, 1.3)**	0.2 (−0.2, 0.7)	**1.1 (0.7, 1.6)**
BMI	**−0.57 (−0.81, −0.34)**	−0.05 (−0.29, 0.19)	0.03 (−0.22, 0.29)	−0.13 (−0.38, 0.13)	−0.02 (−0.27, 0.22)
Sleep disturbance	**−0.50 (−0.71, −0.29)**	**−0.82 (−1.03, −0.61)**	**−0.49 (−0.72, −0.27)**	−0.12 (−0.34, 0.11)	**−0.63 (−0.84, −0.41)**
Cardiorespiratory fitness	**0.028 (0.022, 0.034)**	**0.007 (0.001, 0.013)**	0.001 (−0.006, 0.008)	0.003 (−0.004, 0.010)	0.002 (−0.004, 0.009)
Resilience	**0.21 (0.17, 0.25)**	**0.28 (0.25, 0.32)**	**0.26 (0.22, 0.30)**	**0.26 (0.22, 0.30)**	**0.29 (0.26, 0.33)**

Bold text: significance level $P < 0.05$. Beta values are unstandardized. SES: socioeconomic status; BMI: body mass index (kg/m^2); CI: confidence interval.

Table 4. Stepwise multivariate linear regression of association between lifestyle-related factors, resilience and each of the five KIDSCREEN-27 dimensions (HRQoL), adjusted for sex, SES and place of birth.

	Physical well-being Beta (95% CI)	Psychological well-being Beta (95% CI)	Parent relations and autonomy Beta (95% CI)	Social support and peers Beta (95% CI)	School environment Beta (95% CI)
Physical activity					
Sedentary time					
Recommended dietary intake	**0.59 (0.22, 0.96)**			**−0.45 (−0.86, 0.04)**	**0.40 (0.02, 0.78)**
BMI	**−0.27 (−0.48, -0.06)**				
Sleep disturbance	**−0.24 (−0.42, −0.06)**	**−0.65 (−0.83, −0.47)**	**−0.34 (−0.54, −0.14)**		**−0.42 (−0.60, −0.24)**
Cardiorespiratory fitness	**0.021 (0.016, 0.027)**				
Resilience	**0.18 (0.15, 0.22)**	**0.27 (0.23, 0.30)**	**0.25 (0.22, 0.29)**	**0.27 (0.23, 0.31)**	**0.27 (0.24, 0.31)**

Bold text: significance level $P < 0.05$. Beta values are unstandardized. SES: socioeconomic status; BMI: body mass index; CI: confidence interval.

scores on any of the HRQoL domains in the multivariate analyses (Table 4).

Discussion

The main findings of this study were that sleep and resilience predicted scores on most HRQoL domains in early adolescents, and that physical activity disappeared as a predictor of HRQoL in the multivariate analysis. In addition, an alarmingly low percentage of the sample met the recommended level of physical activity and the dietary recommendations (and the percentage was lower than reported in other national and international studies of adolescents).[3,11,50] Together with the lower cardiorespiratory fitness and higher BMI than found in previous studies,[33,51] this indicates a general poor physical health profile in the sample. Reported sleep was more in accordance with findings from other studies of the same age group,[52] as were the mean READ total and subscale scores.[28] Telemark County's public health profile shows a lower SES, shorter life expectancy and higher prevalence of mental health challenges in adolescents and early adults compared with the national average for Norway;[53] therefore, the low adherence to both physical activity and dietary recommendations was not surprising.

The total scores for the HRQoL subscale physical well-being were lower in this sample compared with norm data for a similar age group provided by the KIDSCREEN group,[47] and Norwegian data on 10-year-old children.[54] This was the only domain for which BMI and cardiorespiratory fitness remained as predictors in the multivariate analysis, indicating that the lower scores on these variables may explain the overall lower level of physical well-being in this sample. Interestingly, the total scores for parent relations and autonomy and school environment were higher in this sample compared with the norm data for this age group.[47] Scores on school environment were comparable with other Norwegian data,[54] suggesting some cultural differences within the school system. Scores on parent relations and autonomy are higher in high-SES groups; however, the scores in this sample are even higher than in the high-SES group identified by Ravens-Sieberer et al.[49] Norway is a high-income country with relatively low rates of poverty, which means that scores on items related to personal/family economy may show less variance in Norwegian adolescent samples than in adolescent samples from other countries. We cannot exclude the possibility that there are culture-specific differences that affect parent–child relationships; these may contribute to our respondents perceiving more autonomy and parental support than adolescents in other countries.

The multivariate analysis showed that sleep was a more important lifestyle-related predictor of the five HRQoL domains than physical activity, sedentary time, dietary habits, BMI and cardiorespiratory fitness. Sleep index was a negative predictor, indicating that a higher level of sleep disturbance negatively affects various aspects of HRQoL. It is well documented that sleep disturbances are associated with impairments in psychological functioning and physical health in adolescents,[55] and our finding is in line with previous research on adults.[56] One possible explanation for this finding may be that sleep is more fundamental for daytime functioning than other lifestyle-related behaviours. In addition, sleep affects behaviour, and therefore has a major influence on the various HRQoL domains. For instance, sleep disturbances have been shown to affect appetite regulation in a way that influences dietary habits,[12] and sleep disturbance can impair athletic performance.[57] Although the data in this study are cross-sectional, other studies have found alterations in sleep from childhood to adolescence.[14] It

is therefore possible that sleep and sleep disturbances play a more central role in the HRQoL of adolescents than in other age groups.

Resilience was the most prominent positive predictor of scores on the various HRQoL domains. This prediction was strongest for the domains psychological well-being, social support and peers and school environment; all of which are great sources of stress in adolescence.[29] Higher scores on resilience indicate greater capability to cope with stress, so these results were not surprising. Interestingly, resilience was a significant predictor, together with sleep and/or dietary habits, for several of the HRQoL domains. This is in accordance with previous study findings showing that the interaction between resilience and sleep comprises a protective factor against depression in children and adolescents,[58] and that resilience influences the relationship between lifestyle and depression/anxiety.[30] Previous studies have mostly focused on resilience and lifestyle-related behaviours from a risk factor and preventive perspective. Our study adds to that knowledge by showing that these factors also promote quality of life and well-being. Especially interesting is the finding that resilience, sleep and adherence to dietary recommendations are significant predictors of the HRQoL school environment domain. The data were obtained from eighth grade secondary school pupils within 4 weeks of the start of a new school semester. For all the respondents, this meant new schools, new classes and new teachers. The transition from elementary school to secondary school may be a time in which resilience and lifestyle factors such as sleep and diet are particularly important in promoting school-related HRQoL. We have not been able to identify any studies showing an interaction between resilience and lifestyle as predictors of HRQoL in this domain. Therefore, future studies should aim to replicate these data using longitudinal designs to examine if this interaction changes as adolescents become more adapted to secondary school.

Adherence to dietary recommendations (i.e. high score on the dietary index) appeared to be an independent positive predictor of physical well-being and school environment, and a negative predictor of social support and peers. This is partly consistent with findings from a recent Australian study.[23] The negative predictive effect of healthy diet on social support and peers was a little surprising, but can perhaps be interpreted in light of previous findings on social norms for dietary behaviour among early adolescents.[59]

Strengths and limitations. The high response rate, use of well-known, acknowledged and validated assessment methods, and the generalizability of the results are the main strengths of this study. The cross-sectional design makes it impossible to determine causal relationships, and self-reported dietary data may be negatively affected by response bias or recall bias. However, the dietary questions have demonstrated good reliability and validity in comparison with other validated instruments.[40] Self-assessment methods have several limitations when used to assess sleep habits.[45] The questions used to assess sleep quality, latency and daytime sleepiness in the present study do not address possible underlying mechanisms causing the sleep disturbances. Nevertheless, sleep information self-reported by adolescents rather than by parents is more accurate, as parents tend to report more idealized sleeping patterns.[60]

Implications. The findings indicate a need to acknowledge the importance of sleep as a lifestyle-related factor that should be more prominent in health promotion strategies for early adolescents. Efforts are also

needed to advise parents of ways to detect sleep patterns and disturbances among adolescents. Future work should explore whether interventions for adolescent sleep patterns improve well-being and HRQoL. Although physical activity level and sedentary time were not found to be independent predictors of HRQoL in this study, the low level of physical activity observed may have been a confounding factor. Research is therefore needed to examine if similar results are obtained from a more active population. Future studies should include objective tools (e.g. accelerometer and/or polysomnograph) to obtain a more detailed understanding of sleep patterns and disturbances and their association with HRQoL in early adolescents. Future intervention studies should also take into account the complex way in which adherence to dietary recommendations predicts HRQoL both positively and negatively in this age group.

To conclude, this sample of early adolescents showed a low adherence to physical activity and dietary recommendations, but resilience scores similar to those found in previous studies. HRQoL differed from the norm data on three out of five domains, with no sex difference. Resilience and sleep were the most prominent predictors of HRQoL, whereas adherence to dietary recommendations was both a positive and negative predictor for the different HRQoL domains.

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Declaration of conflicting interest

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