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ORIGINAL ARTICLE

Examining the association between breakfast and health-related quality of life (HRQoL): a cross-sectional study of tenth-grade students in Witten, Germany (GeWIT study)

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Abstract

Aim To investigate Health-Related Quality of life (HRQoL), a multidimensional perceptive about physical, psychological and social well-being, and its association with skipping breakfast among adolescents.

Subject and methods This cross-sectional study is part of GeWIT Project (November 2021-February 2022). Tenth-grade students from nine secondary municipally managed schools in Witten, Germany were included. Data was obtained from self-reported questionnaire. Overall HRQoL was measured with KIDSCREEN-10, which covered physical, psychological, relationships with parents and friends, and school performance. Logistic regression of breakfast skipping and HRQoL adjusted for gender, age, school type, Subjective Social Status (SSS), migration background, body mass index, and physical activity was performed.

Results From 649 participants, 644 adolescents were included in the analysis (response rate: 98.3%). 46.1% and 50.8% of the adolescents reported low HRQoL and skipped breakfast respectively. There was higher percentage of low HRQoL in skipping breakfast group than breakfast group (54.7% vs. 37.2%). Adolescents who skipped breakfast had significantly two times greater odds of having low HRQoL than did those who ate breakfast (aOR: 1.93, 95%CI: 1.36–2.74).

Conclusions Skipping breakfast was shown to be significantly associated with higher odds of low HRQoL. In addition with health campaign to raise awareness about the importance of breakfast, monitoring on existing breakfast programs could be advantageous. Future studies to investigate the reasons of skipping breakfast among adolescents as basic for public health efforts could be valuable. Longitudinal study about breakfast and its effect to HRQoL is needed.

Keywords Breakfast consumption · Breakfast skipping · Nutrition · Well-being · Adolescents · School performance

Abbreviations

aOR	Adjusted Odds Ratio
BMI	Body Mass Index
CI	Confidence IntervalGeWIT Study
Cm	Centimeters
COVID-19	Coronavirus Disease 2019
DBC	Daily Breakfast Consumption
GeWIT Study	*GesundeStadt Witten Studie* Or Healthy City Witten Study
HRQoL	Health-Related Quality of Life
Kg	Kilogramm
MCI	Most Common Imputation
MedDiet	Mediterranean Diet
MIM	Missing Indicator Method
MVPA	Moderate to Vigorous Physical Activity
OR	Odds Ratio
PP	Person Parameters
SD	Standard Deviation
SSS	Subjective Social Status

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Background

Adolescence is a crucial phase in the human development that involves rapid changes in physical, psychological, and social well-being (Patton and Viner 2007). This important transitional phase in life could shape the development of health and well-being capabilities, where future patterns of the adult health of individuals may be affected (Sawyer et al. 2012; Patton et al. 2016). The intake of nutrients has long-term effects on health and well-being throughout all life phases (Koletzko et al. 2004). While adolescents are assets for future generations, they face challenges (World Health Organization 2023). Their health and wellness are important cores for creating healthier and more sustainable societies (World Health Organization 2023). However, during this stage of transition from childhood to adulthood, adolescents may have greater nutritional vulnerability due to increased and higher nutrient and energy requirements, increased exposure to morbidity risk, and emerging psychological or mental health problems (European Food Safety Authority 2017; Public Health England 2016; Koletzko et al. 2004; Solmi et al. 2022). Despite the general belief of good health, adolescents are largely considered to have decreased disease susceptibility, which causes them to be overlooked in public health studies (Patton et al. 2016; World Health Organization n.d.). According to the World Health Organization, investments in the health of adolescents could bring tremendous advantages for adolescents in the present, their future life stage of adulthood, and the next generation (World Health Organization 2023). Health is traditionally assessed primarily in terms of physical outcomes, but HRQoL provides a broader view (Ravens-Sieberer et al. 2005). It provides insight into the physical, psychological, emotional, and social aspects of individuals' well-being and is an important indicator of perceived health (World Health Organization 1997; Ravens-Sieberer et al. 2014). Examining HRQoL among adolescents is also crucial for planning effective policies and health promotion measures since it affects well-being and health in later stage of life (National Research Council 2004; Da Costa et al. 2020).

Lifestyle behaviors such as dietary habits may influence HRQoL. Skipping breakfast has been previously identified as a contributing factor of unhealthy behaviors and health problems that are also linked to poor quality of life (Wu et al. 2022; Mitri et al. 2022, 2023). A study by Jiménez-López et al. (2023) revealed that breakfast skippers with a medium intake of pulse and vegetables had a lower HRQoL than did adolescents who ate breakfast and had the lowest vegetable consumption, breakfast eaters and high intake of plant-based foods (Jiménez-López et al. 2023). No difference in HRQoL was found between groups of breakfast eaters with opposing intake of fruits and vegetables (Jiménez-López et al. 2023). It seems that the advantage of adhering to certain diet patterns, such as eating breakfast, may mitigate the detrimental effects of low intake of vegetables and fruits on HRQoL (Coulthard et al. 2017). Research on the impact of diet among teenagers has focused mainly on the assessment of individual nutrients, particular diet groups, or diet quality (Vik et al. 2013; Monzani et al. 2019; Wu et al. 2019). Additionally, there is a growing body of literature examining breakfast as a whole healthy dietary habit and HRQoL (Wu et al. 2022; Mitri and Ziade 2019; Mitri et al. 2022). However, the benefits of breakfast as a whole healthy dietary habit may be mixed and complicated, as the fundamental about adherence to the Mediterranean Diet (MedDiet), in which breakfast is incorporated, and its association with HRQoL is complex (Gómez-Pinilla 2008; Serra-Majem et al. 2019). To date, studies investigating the relationship between breakfast as a specific factor without the role of other factors and HRQoL are scarce.

Despite the enormous benefits of breakfast and increased nutrient requirements, adolescents often skip this important meal more than any other age group does, hence it requires special attention (Giménez-Legarre et al. 2022). Adolescents who consumed breakfast regularly were reported to have more favorable exercise patterns and cognitive performance (Keski-Rahkonen et al. 2003; Hoyland et al. 2009). It is also associated with a decreased risk of overweight or obesity among European adolescents (Szajewska and Ruszczynski 2010). However, skipping breakfast was found to be very prevalent in Europe and in national representative studies in America, with a greater frequency of childhoods until adolescence (Raaijmakers et al. 2010; Bellisle and Rolland-Cachera 2007; Pearson et al. 2009b). In Germany, 25% of children do not consume breakfast regularly (Precht et al. 2014). A significant decline in Daily Breakfast Consumption (DBC) among adolescents in several countries in Europe, including Germany, was previously reported (Lazzeri et al. 2023). According to previous studies, skipping breakfast was correlated with low adherence to the MedDiet, a dietary pattern rich from natural food resources originating from people in the Mediterannian basin which has been largely associated with positive health benefits (Mounayar et al. 2019; Vidal-Peracho et al. 2017; Bach-Faig et al. 2011). Not having breakfast was also associated with more snacking, particularly the consumption of unhealthy food choices such as energy-dense foods rather than nutrient-dense foods, and with a reduction in fruit and vegetable intake (Grosso et al. 2013; Mithra et al. 2018; Falbe et al. 2014). One systematic review reported that breakfast has positive associations with cognitive performance, academic achievement, well-being and quality of life, as well as reduced morbidity risk, particularly insulin resistance, metabolic syndrome, and increased total adiposity (Lundqvist et al. 2019).

Only few Studies that investigated association of breakfast and overall HRQoL among teenagers and such studies are still lacking (Ferrer-Cascales et al. 2018; Gürbüz et al. 2024; Mitri et al. 2023). To our knowledge, no previous study has examined the relationship between breakfast and overall

HRQoL among adolescents in Germany. Therefore, in the present study, the association of skipping breakfast with overall HRQoL among teenagers in Witten, Germany, was investigated.

Method

Objective

This current study aims to examine odds of having low HRQoL in skipping breakfast before school among adolescents in Witten, Germany. Percentage of adolescents who had low HRQoL in skipping breakfast and eating breakfast group were also reported.

Study design and setting

This cross-sectional study was part of the "*Gesunde Stadt Witten"* (GeWIT Study) or Healthy City Witten project, which was conducted between November 2021 and February 2022. After approval from the ethical committee was granted, the project was performed in nine municipal secondary schools in Witten, Germany. Prior to data collection, administrative arrangements to receive study approval by initially contacting the school authority in Ennepe-Ruhr District were provided. The study contents and objectives were provided in writing to the school authority. After consent for implementing the project was granted, further study preparation was done. The teachers were informed and the students were provided with information letter about the project two weeks prior. Written information for the parents or legal guardians was also provided and forwarded through the students by the responsible teaching staff. Afterwards, the data of the study participants were collected by providing questionnaires to the students in 28 classes on school days to be filled out during their class time. Consent and information about study contents, purposes, inclusion–exclusion criteria, data protection, non-mandatory participation, data anonymity, and the possibility of withdrawal from the study of any chance were explained before the students filled out the questionnaire. The self-report written questionnaire required approximately 25 min to complete. By completing the questionnaire and handing it in, the study participants provided consent. Ethical approval and data protection vote were obtained from Ethical Committee of Witten/Herdecke University, Witten (Ethics vote no. 97/2019, data protection vote no. DT-537, DT-630). The project was financially supported by a statutory health insurance, Techniker Krankenkasse.

Study population

The survey included all tenth-grader students of all municipal secondary schools located in Witten, one of the largest city Ennepe-Ruhr District with population around 98.000 residents (Witten Universitätsstadt an der Ruhr). It is located in North Rhine-Westphalia, Germany and covers 72km^2 area (Witten Universitätsstadt an der Ruhr). All nine municipal secondary schools agreed to participate in the project. Two Waldorf schools did not wish to participate and two special education schools were excluded because of the need for a special approach for the survey. Students who were at least 15 years old, were present at class during the questionnaire distribution, and agreed to complete the questionnaire were included in the study, resulting in a high response rate of 98.3%.

Questionnaire instrument

A standardized questionnaire of thirteen pages was used. Questions were classified into several aspects, such as health and sport, nutrition and development, moods and emotions, relationships with family and friends, leisure activities, health services and facilities, social media and apps related to health utilities, and Coronavirus Disease 2019 (COVID-19) preventive behavior. HRQoL questions were based on KIDSCREEN-27, a generic five dimensional HRQoL questionnaire which is valid and reliable to measure HRQoL among adolescents (Ravens-Sieberer et al. 2007). It covered physical and psychological well-being, relationship with parents and autonomy, social support and peers and school environment (Ravens-Sieberer et al. 2007). All items were provided with 5 points Likert Scale of not at all, slightly, moderately, very much and extremely or from never, seldom, quite often, very often and always (Ravens-Sieberer et al. 2006).

Sociodemographic data including gender, age, subjective social status (SSS), migration background, and school type were also provided in the questionnaire. SSS was assessed using MacArthur Scale of Subjective Social Status for Youth developed by Goodman and colleagues (Goodman et al. 2001). The scale was also used in German Health Interview and Examination Survey for Children and Adolescents (KiGGS Study) by Robert Koch Institute, a central federal institution responsible for public health and disease prevention-control in Germany (Hoebel et al. 2015). Students' perception about current social status of their family was able to be recorded using the scale (Goodman et al. 2001). Three questions covering the ownership of German citizenship of self and both of their parents were provided to obtain information about migrations background in Germany. Questions

about body weight in kilogram (kg) and height in centimeters (cm) were asked for Body Mass Index (BMI) information. Physical activity was asked with the question: "Over the past seven days, on how many days were you physically active for a total of at least 60 min per day?". The response options were physically active in no day until in seven days.

Breakfast consumption

In our study, breakfast before school was examined. To obtain information about breakfast eating among the students, a question was asked in the questionnaire: "Did you eat breakfast today before school?". Students might provide answers by crossing one of the dichotomic answers of yes or no.

Health-related quality of life

From KIDSCREEN-27 questions, HRQoL KIDSCREEN-10 were able to be assessed and was used for analysis. It is a valid generic questionnaire used to measure the overall HRQoL of children and adolescents aged 8–18 years (Ravens-Sieberer et al. 2010, 2005). This new shorter version of the KIDSCREEN-27/52 consists of ten items and provides a single Rasch-scale score of HRQoL (Erhart et al. 2009; Ravens-Sieberer et al. 2005). The ten items consisted of questions: (1) Have you felt fit and well?, (2) Have you felt full of energy?, (3) Have you felt sad, (4) Have you felt lonely?, (5) Have you had enough time for yourself?, (6) Have you been able to do the things that you want to do in your free time?, (7) Have your parent(s) treated you fairly?, (8) Have you had fun with your friends?, (9) Have you got on well at school?, (10) Have you been able to pay attention?. The self-administered questionnaire has a time frame of the last week (Ravens-Sieberer et al. 2006). Each item was scored on a 5-point Likert scale ranging from not at all/never to extremely/always respectively (Ravens-Sieberer et al. 2006). Responses from negative items, such as item 3 and 4, were recoded so that higher values represents more favorable HRQoL. The responses of each item were then summed and Rasch Person Parameters (PP) were assigned to every possible sum score (Ravens-Sieberer et al. 2010). The PPs were transformed into T values with means of 50 and standard deviations (SD) of approximately 10 (Ravens-Sieberer et al. 2006).

HRQoL group was based on European norm data for adolescents aged 12–18 years accounting for sex. We also tried to categorize the groups on the basis of European norm data without accounting for sex. Only slight difference was found in one person, resulting 296 persons compared with 297 persons in low score group. Scores that were half a standard deviation below the population mean were considered "low HRQoL", and those that were half a standard deviation above the population mean were considered "high HRQoL" (Ravens-Sieberer et al. 2006). Cut-off with mean and SD for girls (mean: 47.2, SD: 8.9) and boys (mean: 49.9, SD: 9.4) were used. In cases of missing gender data or diverse gender, European norm data without accounting for sex was taken into account (mean: 48.5, SD 9.3). Based on the values, categorization of the groups were: low (female < 42.7, male < 45.3, missing gender < 43.9), medium (female: 42.7–51.7, male: 45.3–54.7, missing gender: 43.9–53.1), and high (female: > 51.7, male: > 54.7, missing gender: > 53.1). In this study, the medium and high HRQoL groups were categorized as the good HRQoL group, since higher scores indicate better HRQoL (Baydur et al. 2016). Scores were able to be calculated when there was no more than one missing value (Ravens-Sieberer et al. 2010). In the case of missing more than one items, HRQoL score was set to missing and was excluded from the analysis (n = 5). Therefore, 644 of 649 persons were included in the analysis.

Data analysis

Data from paper-based questionnaires were transformed into digital versions via the Scan-Systems FormPro. All analyses were performed via IBM SPSS Statistics version 29. Demographic variables that were analyzed included gender, age, school type, SSS, and migration background. Other participant characteristics included BMI, physical activity frequency, and subjective health status.

All the included variables were obtained from the self-report questionnaire. Age category was divided into 15, 16, 17–19 in this study since secondary education is attended by pupils aged 15/16 until 18/19 years of age (Kultusminister Konferenz 2019). BMI was calculated with the following formula: weight (kg)/height^2 (m^2). Individuals were classified as underweight, normal weight, overweight or obese on the basis of BMI percentiles, age and sex (Kromeyer-Hauschild et al. 2015; Schienkiewitz et al. 2019). Adolescents with gender of diverse were categorized according to female BMI percentiles. SSS was presented as low (1–4), medium (5–6) or high (7–10). Migration background was determined when he or she or at least one of their parents were not born with German Citizenship according the definition of migration from the German Federal Statistical Office (Statistisches Bundesamt 2022). The physical activity frequency was defined on the basis of the WHO recommendation of MVPA for at least 60 min per day throughout the week (World Health Organization 2020). Responses were categorized into inactive (0–2 days), slightly active (3–4 days), almost fulfilling the recommendation (5–6 days), and fulfilling the recommendation (7 days). The physical activity category has moderate agreement on the basis of Cohen Kappas (0.503) (Ng et al. 2019; World Health Organization 2020).Categorical variables are presented as frequencies based on the total participants and between HRQoL groups (low versus good HRQoL). Chi-square tests were performed to compare the differences in demographic variables,

BMI, physical activity frequency, SSS, health status, as well as breakfast in the morning, between the two HRQoL groups. The association between breakfast and HRQoL was examined via binary logistic regression with dichotomous independent variable of breakfast and binary dependent variable of HRQoL. Binary logistic regression analysis was performed to examine the risk (odds ratio or OR) of low HRQoL in the breakfast skipper group compared with the breakfast group. Unadjusted logistic regression analysis with a single correlation of breakfast and HRQoL was carried out. A multivariable logistic regression model was performed with adjustment for all covariates. Covariates included in the adjusted logistic regression were age (category), gender (female, male, and diverse), BMI (category), SSS (category), migration background (dichotomous), and frequency of daily 60 min Moderate to Vigorous Physical Activity or MVPA (category). These variables are related to HRQoL according to previous literatures (Mastorci et al. 2021; Michel et al. 2009; Buchcik et al. 2021; Freire and Ferreira 2018; Rueden et al. 2006; Kelishadi et al. 2019; Grochtdreis et al. 2021; Galán et al. 2013).

In case of missing value less than 5%, it was treated with Most Common Imputation or MCI, where it was replaced with the most frequent value in the data (age n = 9, migration background n = 14, subjective health status n = 5, breakfast before school n = 1, and physical activity n = 11) (Rodwell et al. 2014; Psychogyios et al. 2023). When missing was 5% and higher, missing values were treated with Missing Indicator Method (MIM), which replaces the missing values with a new special value of missing data (SSS, n = 44; BMI, n = 209) (Groenwold et al. 2012; Zhuchkova and Rotmistrov 2022). A special value was set differently from the variable's valid value and was treated as one special category that was separated from other categories in the analysis (Groenwold et al. 2012; Zhuchkova and Rotmistrov 2022). Missing in gender was included in female group (n = 3). P value < 0.05 was considered statistical significant. 95% Confidence Interval (CI) was reported in logistic regression analysis.

Results

From all 757 of tenth-grader students from all nine municipal secondary schools, 95 students were not present during data collection and two students were younger than 15 years old, which resulted on 660 potential participants. Of the 660, seven students refused to participate and four students provided joke answers all the way, resulting 649 students who participated in the GeWIT Study. Five persons were excluded due to missing in HRQoL score and 644 persons were included in the analysis. Numbers of individuals at each stage of study and the flow can be seen in GeWIT StudyAppendix 1.

The participants' characteristics based on two HRQoL groups are presented in Table 1. 46.1% of the teenagers had low HRQoL (n = 297) and 53.9% had good HRQoL (n = 347). There were almost equal percentages of males and females (47.0% and 47.7%, respectively), and the majority of the students were 15 years of age (59.2%). Slightly more than half of the participants had high SSS (51.1%), no migration background (55.3%) and normal weight (52.3%). Around one-third of students studied in academic secondary school (35.4%). Nearly half of the participants had very good and excellent subjective health status (46.4%). About the same number reported skipping breakfast before school than did those who did not (50.8% vs. 49.2%, respectively).

In Table 1, it was shown that there were significant differences in all characteristics between two HRQoL groups. Groups that reported higher percentage of low HRQoL than good HRQoL are girls (57.3%), those who had age of 17–19 years old (60.7%), were studying in secondary school (53.4%) and secondary general schools (60.0%), had low SSS (75.0%), migration background (52.4%), BMI of overweight (54.5%) and obese (66.7%), were physically inactive (57.0%), had fair and poor (88.1%) and good subjective health status (66.9%).Among those who skipped breakfast, those who had low HRQoL was higher than those who had good HRQoL (54.7% vs 45.3 respectively). Low HRQoL is significantly higher in skipping breakfast group than having breakfast group (54.7% vs. 37.2%).

Logistic regression between skipping breakfast and the association with low HRQoL among adolescents in GeWIT Study is illustrated in Table 2. The analysis revealed that breakfast is strongly associated with HRQoL. After controlling for gender, age, school type, SSS, migration background, BMI, and physical activity, students who skipped breakfast before school were significantly two times more likely to have low HRQoL than adolescents who had breakfast (aOR: 1.93, 95% CI 1.36–2.74).

Discussion

Our study examined the association between breakfast and overall HRQoL among teenagers. To the best of our knowledge, our study is the first study to investigate overall HRQoL KIDSCREEN-10, in relation to skipping breakfast before school among teenagers in Witten, Germany. This study provided insight that breakfast skipping is common among the study participants. Findings demonstrated that having no breakfast before school is strongly associated with poor HRQoL.

This current study has shown that those who skipped breakfast had higher risk to have poor well-being than those who did not skip breakfast. This is supported with previous studies from different countries. One cross sectional study performed among Lebanese adolescents with mean age of 15 showed that breakfast skipping was associated with poorer general well-being measured with KIDSCREEN-27 (Mitri et al. 2023).

Table 1 Participants Characteristics stratified by Health-Related Quality of Life from GeWIT Study (N = 644)

Characteristics	Total (N = 644)		Low HRQoL		Good HRQoL		P-Value
	N	%[a]	n	%[b]	n	%[b]	
All Participants	644	100	297	46.1	347	53.9	-
Gender							< 0.001
Boys	303	47.0	98	32.3	205	67.7	
Girls[c]	307	47.7	176	57.3	131	42.7	
Divers	34	5.3	23	67.6	11	32.4	
Age							0.007
15[c]	381	59.2	158	41.5	223	58.5	
16	207	32.1	105	50.7	102	49.3	
17–19	56	8.7	34	60.7	22	39.3	
School type							0.002
Academic secondary school	228	35.4	108	47.4	120	52.6	
Secondary school	174	27	93	53.4	81	46.6	
Comprehensive school	207	32.1	75	36.2	132	63.8	
Secondary general school	35	5.4	21	60.0	14	40.0	
SSS							< 0.001
Low	48	7.5	36	75.0	12	25.0	
Moderate	223	34.6	112	50.2	111	49.8	
High	329	51.1	127	38.6	202	61.4	
Missing	44	6.8	22	50.0	22	50.0	
Migration background							0.004
Yes	288	44.7	151	52.4	137	47.6	
No[c]	356	55.3	146	41.0	210	59.0	
BMI							0.07
Underweight	34	5.3	16	47.1	18	52.9	
Normal weight	337	52.3	142	42.1	195	57.9	
Overweight	33	5.1	18	54.5	15	45.5	
Obesity	30	4.7	20	66.7	10	33.3	
Missing Data	210	32.6	101	48.1	109	51.9	
Physical activity frequency							0.02
0–2 days (inactive)	142	22	81	57.0	61	43.0	
3–4 days (slightly active)	202	31.4	93	46.0	109	54.0	
5–6 days (do not fulfill WHO recommendations)	173	26.9	71	41.0	102	59.0	
7 days (fulfill WHO recommendations)[c]	127	19.7	52	40.9	75	59.1	
Subjective health status							< 0.001
Fair & poor	67	10.4	59	88.1	8	11.9	
Good[c]	278	43.2	186	66.9	92	33.1	
Very good & excellent	299	46.4	52	17.4	247	82.6	
Skipping Breakfast before school							< 0.001
No	317	49.2	118	37.2	199	62.8	
Yes[c]	327	50.8	179	54.7	148	45.3	

HRQoL Health-Related Quality of Life, SSS Subjective Social Status, BMI Body Mass Index

[a]Data in column percentage

[b]Data in row percentage

[c]missing below 5% is included in the group with the highest n (gender n = 3, age n = 9, migration background n = 14, subjective health status n = 5, breakfast before school n = 1, physical activity n = 11)

Table 2 Unadjusted and adjusted Logistic regression between skipping Breakfast and HRQoL among Adolescents in the GeWIT Study (n = 644)

Breakfast	Low HRQoL					
	OR	p-value	95% CI	aOR[a]	p-value	95% CI
Yes	reference group					
No	2.04	< 0.001	1.49–2.79	1.93	< 0.001	1.36–2.74

HRQoL Health-Related Quality of Life, CI Confidence Interval, OR Odds Ratio, aOR adjusted Odds Ratio

[a]Adjusted with gender, age, school type, SSS, migration background, BMI, and physical activity

Another cross sectional study among Turkish adolescents demonstrated that adolescents who skipped breakfast or only had breakfast once per week scored lower HRQoL in all five aspects of KIDSCREEN-27 than adolescents who ate breakfast in six or more days per week (Gürbüz et al. 2024).

Attention to the adolescents who skipped breakfast should be given. Eventhough the causal relationship was unknown, whether the breakfast skipping caused the poor well-being or vice versa, it is important to note that those who did not eat breakfast may miss the nutrition benefits which can be linked to poor HRQoL. Breakfast as part of a healthy and balanced lifestyle has benefits which has been widely known from nutritional, psychological, and societal perspectives (Gibney et al. 2018). Breakfast allows adolescents and children to receive nutritional benefits through the intake of micronutrients and macronutrients (Coulthard et al. 2017). Eating breakfast is important for maintaining the release of glucose into the blood and brain in the morning to promote energy, concentration, and memory for cognitive processes during school (Mahoney et al. 2005; Adolphus et al. 2013; Hasz and Lamport 2012; Rani et al. 2021; Murphy 2007; Martin et al. 2024; Pearson et al. 2009a; Vereecken et al. 2009). One trial study confirmed that breakfast among adolescents improved cognitive function, including higher self-report energy and fullness, lower level self-reported tiredness and hunger, higher visual accuracy test, and quicker response on complex level memory test (Cooper et al. 2011). In terms of promoting well-being and reducing stress, intake of carbohydrates is advantageous for the brain after night fasting through reducing cortisol production (Lee et al. 2017; Miller et al. 2009). Ingesting nutrients from breakfast supports the body in restoring glycogen, stabilizing insulin level, and decreasing cortisol level, a stress hormone which is highest in the early morning and therefore has a role in maintaining stress levels (Adolphus et al. 2013; Witbracht et al. 2015). A previous study also supports this premise, showing that breakfast is related to four more favorable aspects of HRQoL among Taiwanese adults, such as general emotional role, mental health, vitality, and general health perceptions (Huang et al. 2010).

Since skipping breakfast was shown to be associated with low HRQoL, poor HRQoL among adolescents should be of a big concern. The poor well-being among adolescents may also be the cause of skipping breakfast. According to previously published study with the same participants, general health perception was previously linked to skipping breakfast among adolescents (Mohamed et al. 2025). The study from the same project revealed that breakfast is significantly associated with general health perception. The better the general health perception, the lower the odds of skipping breakfast (Mohamed et al. 2025). However, the general health perception was measured only from one question, unlike the current study, which measured the health perception with more detail aspects from ten questions. The participants included were general adolescents, any other specific factors such as cultural or physiological, which possibly play a role in the association were not included in the analysis. Further study to examine the causal relationship between poor well-being and skipping breakfast to confirm this finding is needed in this case.

There is not much research on breakfast and relationships with parents-guardians and friends. However, some studies could support our findings. One qualitative study reported that children were aware that their parents wanted them to stay healthy by ensuring breakfast (Eck et al. 2019). The feeling of being taken care of could be something that might promote positive perceptions of relationships with parents. In terms of experiencing enjoyment, breakfast may be considered a factor that fuels individuals, energizes them, and elevates good moods via the fulfillment of energy necessity (Jackson and Vaughn 2019; Murphy 2007; Widenhorn-Müller et al. 2008; Martin et al. 2024). Furthermore, compared with fasting condition, consuming breakfast was reported in a trial to make more positive feelings among male students and eating breakfast regularly has been reported to be associated with better school connectedness (Widenhorn-Müller et al. 2008; Sampasa-Kanyinga and Hamilton 2017; Martin et al. 2024). Breakfast intake may be considered a promoter factor to improve students' motivation (Martin et al. 2024). This may be an explanation why breakfast is associated to positive feelings.

Besides numerous advantages of breakfast have been reported, high number of breakfast skippers was found in this study and also in line with other studies. According to HBSC study, around seventy percent of boys and girls aged 11 years old consumed breakfast everyday in Germany, but the number falls down when it comes to fifteen years old group: 52% among girls and 59% among boys (Inchley et al. 2016; Dye 2017). Similarly with our study which found around 50% who skipped breakfast. The falling trend was not only found in Germany, but also in neighborhood countries according to HBSC Study

such as Austria, Belgium, Czech Republic, Denmark, France, Greece, and Italy (Dye 2017). Skipping breakfast among the general population in Germany and several other neighborhood countries is mainly attributed to lack of time and lack of appetite (Dye 2017).

The observed association between skipping breakfast and lower HRQoL remained significant after adjusting for other demographic and charateristics, suggesting independent effect and the role should be considered when interepreting the findings. Gender, age, school type, SSS, migration history, BMI, and physical activity may still play a complex, indirect role in shaping both dietary patterns and health outcomes. Gender, typically girls compared than boys, or adolescents with excess weight, tend to skip breakfast which has been frequently linked to higher body concerns and breakfast avoidance, which at the same time may influence HRQoL (Esquius et al. 2021; Burazeri et al. 2016). Increased age was previously reported to have association with decreased HRQoL, which was linked with loneliness and stress, factors of deteriorated HRQoL (Mikkelsen et al. 2022). One previous study showed that girls with low socioeconomic had higher percentage of skipping breakfast than girls with higher socioeconomic, the same case with boys (Esquius et al. 2021). Considering the educational, income or occupation level, adolescents who had low SSS may face food insecurity, pressure and stress due to living standard and lack of resources, which may be associated with both skipping breakfast and reduced HRQoL (Esquius et al. 2021). Furthermore, adolescents with migration background may experience cultural barriers such as languange and meal timing which might shape eating patterns and lower HRQoL (Esquius et al. 2021). Having migration background and being in intermediate secondary school and comprehensive school were also reported to be associated with skipping breakfast in our previous study among the current participants (Mohamed et al. 2005). Risk factors associated with skipping breakfast among European adolescents mentioned in previous literatures includes family condition such as mother with low/medium education for girls, having single parent or perceived high economic status among boys and unhealthy peers (Hallström et al. 2011). Health promotion for teenagers considering those factors with further consideration could be useful. In this case, further study to investigate the reasons is needed. Studies have suggested that families may be a good target for implementing breakfast programs (Keski-Rahkonen et al. 2003; Matthys et al. 2007). Health promotion for teenagers that engaged parents may be relevant for increasing awareness of the importance of breakfast and healthy dietary habits. An explorative study to investigate main reasons of skipping breakfast among adolescents is needed to provide scientific evidence of skipping breakfast reasons. This could be basis for focused public health efforts.

Strengths and limitations

Although the present study provides important scientific evidence of the association between breakfast skipping and low HRQoL among adolescents, several limitations should be addressed. First, this study is a cross-sectional study, in which breakfast and HRQoL was measured at the same time and a causal relationship between the studied variables could not be established. Only the statistical association between breakfast and HRQoL-groups could be examined. Breakfast before school in one day was examined. Because the data included only breakfast in one day, breakfast habit among the study participants in typical school week was unknown. Furthermore, data collection was performed among general adolescents. Other varied physiological, cultural, organizational and other potential factors were not included in our study. However, factors such as gender, age, school type, SSS, migration history, BMI, and physical activity were able to be included in the analysis. In the data, SSS Furthermore, data was obtained from only one city in Germany. It will be difficult to generalize the results at higher scales of national and international degrees. Two Waldorf schools and two special schools were excluded which may have implication for the study results.

Our strength is also worth mentioning. Our study received a high response rate, which brings benefit to our study and could provide good quality data from participant. A significant relationship between breakfast skipping and low HRQoL was found. Studies on breakfast in particular and its association with HRQoL among adolescents are lacking. Breakfast has been investigated as a whole healthy dietary habit (Mitri and Ziade 2019; Jiménez-López et al. 2023). This study explored a specific diet that could fill the knowledge gap to address the insufficient understanding of breakfast with respect to HRQoL among adolescents. It provides findings about risk of low HRQoL among skipping breakfast group and could be a scientific background to potential longitudinal study to discover breakfast and its effect on the adolescents' well-being.

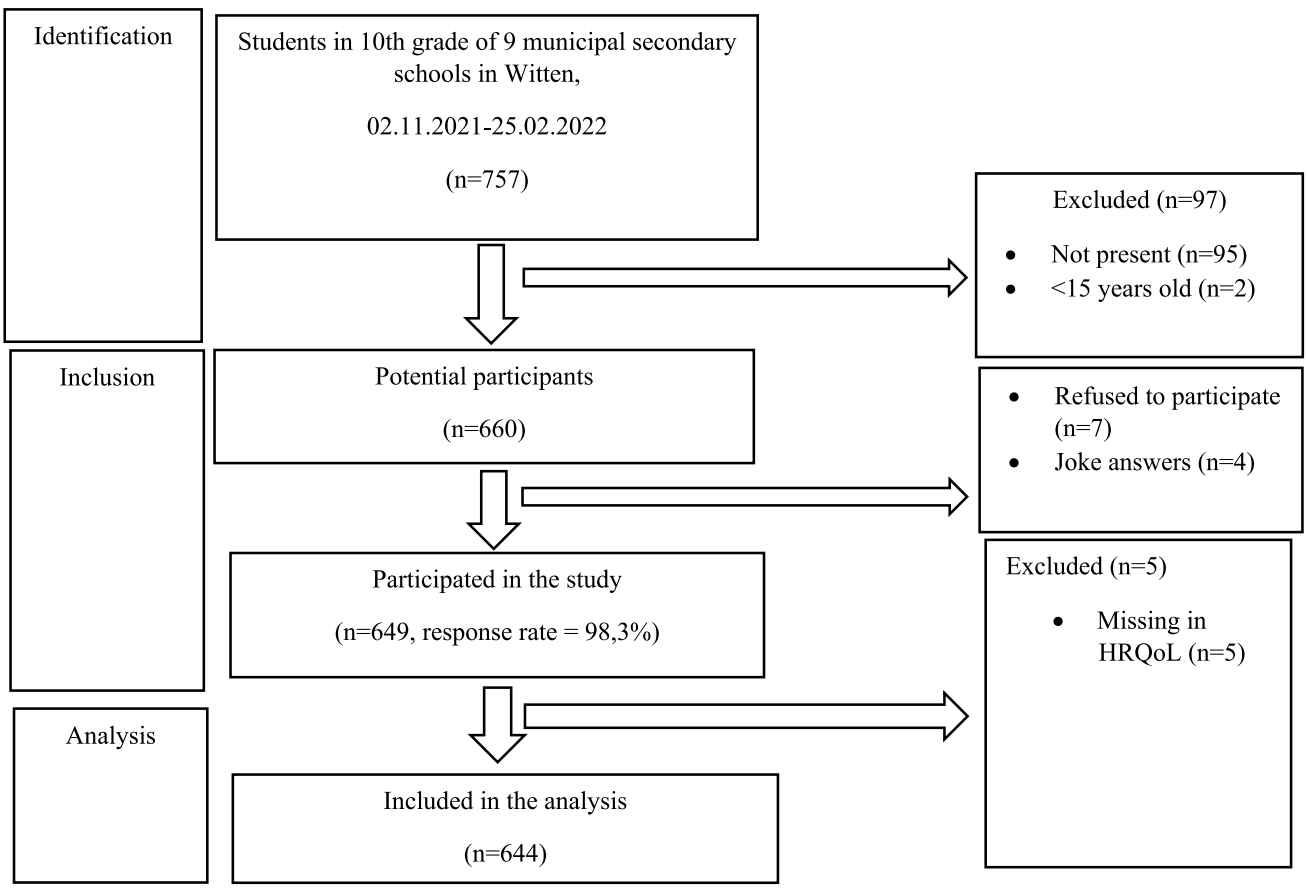
The self-reported KIDSCREEN-10 was used to examine the overall HRQoL among the adolescents. Self-assessed HRQoL was previously mentioned to indicate better HRQoL among the healthy population than parent-reported measurement (Rajmil et al. 2013; Helseth et al. 2015). Second, overall HRQoL was determined, and summarizing a score into a single value can be effective for assessing HRQoL and may allow the results to be comparable with those of other HRQoL studies. This score is a prerequisite for specific types of health economic studies, where the score is combined with other indicators to be a new summary score measure (Murray and Lopez 1997). The score may also be important for public health in terms of formulating effective and comprehensive strategies to promote HRQoL among adolescents.

Conclusion

Our study provides scientific evidence that skipping breakfast is strongly associated with low HRQoL among general adolescents in Germany. Along with other complex factors linked with both skipping breakfast and reduced HRQoL, public health measures may involve the systematic promotion about healthier lifestyle and policy to support breakfast among adolescents. It could start from the family scale and society or schools through healthy habits promotion. Public health campaign for example through school about the importance of daily breakfast consumption is needed to raise students' and parents' awareness. This could be important to tackle limited knowledge about healthy habits especially the importance of meals before school. Collaboration between government and school to ensure breakfast among adolescents could be impactful. School breakfast program to provide free breakfast to pupils may be important as efforts to prevent skipping breakfast. When a breakfast program already exists, the government is suggested to actively monitor the breakfast behavior and the program's effectiveness by measuring the impact. A future longitudinal study to measure the impact of breakfast skipping to HRQoL among adolescents is needed. Furthermore, a study about factors of skipping breakfast among adolescents is also recommended. This is especially to explore the multiperspective reasons why skipping breakfast remains high and main reasons behind skipping breakfast among the youths. This could be very impactful as basis for future public health strategies.

Appendix 1

Flowchart of the inclusion of GeWIT Study Participants



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Authors' contributions NRD and EM conceived the idea for the current article. MSAM provided relevant findings of the same population from previous research as support for the current article. NRD and EM developed the idea concept and research question. AH, KW and EM organized the GeWIT Study administration and resources. KV organized the cooperation between the Witten municipality office, schools and Witten/Herdecke Universit for GeWIT Study arrangement with AH and OK. AH, OK organized the GeWIT Study execution in cooperation with KV. OK, KV, KW, and EM managed the GeWIT Study and data collection execution. KW and EM supervised the GeWIT Study. MM, PW, OK documented the GeWIT Study questionnaire and organized the data. OK, NRD, AH and PW checked and managed the quality of the GeWIT Study data. NRD and EM organized the analysis. NRD carried out the data analysis. NRD wrote the original draft. All authors made significant contributions o the current study. All the authors have read and agreed to the final version of the final manuscript.

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Data availability The datasets generated and/or analyzed during the current study are not publicly available due to data protection and are only available upon request.

Declarations

Ethics approval and consent to participate The GeWIT Study received positive ethical approval from the Ethics Committee of Witten/Herdecke University, Germany and data protection vote from data protection officer of Witten/Herdecke University, Germany (Ethics Approval no. 97/2019, data protection vote no. DT-537, DT-630). Study was conducted in accordance with The Declaration of Helsinki. Consent to participate was documented by completion and submission of the anonymous questionnaire from the participants.

Consent for publication Not applicable.

Competing interests The authors declare that they have no competing interests.

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