

Estonian Adolescents' Self-Assessment of Health, More Frequent Health Complaints and Their Relationship with Physical Activity, Screen Time, and Sleep Duration

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Abstract

It is common knowledge that regular physical activity is good for health, improves general well-being and prevents health complaints. It is also known that excessive screen time and insufficient sleep can lead to various health complaints, including psychological problems. However, which physical activity factors have a greater impact on health assessments and more frequent health complaints, including mental health indicators: exercise frequency, exercise intensity, or time spent being physically active outdoors? Additionally, in terms of health-related indicators, which is more critical: longer screen time or shorter sleep duration? Based on this, the aim of this study was to explore the relationships between health assessments, more frequent health complaints, and various factors related to physical activity, screen time, and sleep duration. The study was conducted among school students aged 12 - 17. Data on self-assessment of health, more frequent health complaints, frequency of exercise, intensity of exercise or physically active time outdoors, screen time and sleep duration were collected using a self-reported questionnaire. Spearman's correlation analysis was used to find relationships. The results of the study revealed that: 1) Among the various physical activity indicators, exercise frequency and the duration of intensive exercise were found to be more significant for better health assessments and fewer health complaints compared to the time spent being physically active outdoors. 2) Longer sleep duration was found to be more important than shorter screen time for improving health assessments and reducing the frequency of health complaints. 3) More frequent exercise, extended periods of moderate and vigorous intensity exercise, reduced screen time, and longer sleep duration were equally important for reducing both somatic and psychological health complaints.

Keywords

Self-Assessment of Health, More Frequent Health Complaints, Physical Activity, Screen Time and Sleep Duration, Adolescents

1. Introduction

Growing concern is leading more and more people to talk about the mental health of adolescents. The results of the Estonian HBSC (Health Behavior in School-aged Children) study show that the proportion of students with health problems among 11 - 15-year-old schoolchildren has increased by approximately 10% over the past ten years (Oja et al., 2023). A similar continuous deterioration in self-reported psychosomatic health complaints is also shown by the German HBSC study (Reiß et al., 2024). The frequency of complaints increased especially regarding headache, feeling low, irritability/bad mood, difficulties falling asleep, drowsiness/dizziness and nervousness (Oja et al., 2023). According to Oja et al. (2023), the frequency of health complaints among girls was higher than among boys. 85% of girls and 71% of boys complained about at least one health problem every week (Oja et al., 2023). Also, Reiß et al. (2024) pointed out that girls had a higher risk of various health complaints and this risk increases with age in both boys and girls. One recent health factor may be the past period of restrictions during the COVID-19 pandemic. The last WHO report on the health and well-being of school-aged children after the COVID-19 pandemic presents that the period of the pandemic had the greatest negative impact on the mental health of adolescents (Rakić et al., 2024). Ma et al. (2021) conducted a meta-analysis and identified that depression, anxiety, sleep disorders, and posttraumatic stress were the most prevalent issues among adolescents during COVID-19. Both Ma et al. (2021) and Rakić et al., (2024) also recognize that girls reported negative effects more often than boys. In addition to the difference between the sexes, age also affects the frequency of health complaints. In older school age, students had more complaints than in younger school age (Faridizad et al., 2020; Oja et al., 2023; Reiß et al., 2024). For example, a study of Iranian school children and adolescents showed that both psychological health complaints and headaches occurred more in the over 14-year-old group in both boys and girls (Faridizad et al., 2020). In their longitudinal study, Nilsen et al. (2023) observed an increase in the frequency of physical health problems with age among schoolchildren. The most common complaint was headaches, which occurred approximately twice as often in girls (42.6%) compared to boys (19.5%) (Nilsen et al., 2023). In addition to headaches, boys experienced more neck and shoulder pain as well as muscle and joint issues, while girls were more affected by abdominal pain and neck and shoulder pain (Nilsen et al., 2023). However, despite the presence of health complaints, young people still rated their health as good (Oja et al., 2023; Reiß et al., 2024).

It is widely recognized that regular physical activity enhances mental capacity

and helps prevent health problems. [Tahira \(2022\)](#) points out in her review article that participation in sports improves psychological well-being and prevents mental problems. A longitudinal study by [Bell et al. \(2019\)](#) found that moderate and vigorous physical activity (MVPA) improves mental well-being and reduces mental health problems among adolescents. Regular physical activity over an extended period, with at least 60 minutes of MVPA per day, was shown to reduce emotional problems in this age group. However, there are also limitations to consider. Attention should be given to periods of high-intensity exercise. [Costigan et al. \(2019\)](#) highlighted that vigorous physical activity has a positive impact on well-being only up to a certain threshold—an average of 36.5 minutes per day. When high-intensity training exceeds this duration, the positive effects on well-being begin to diminish. Participation in organized sport reduces the symptoms of anxiety and depression the most ([Neill et al., 2020](#); [Panza et al., 2020](#); [Tahira, 2022](#)). [Vella et al. \(2017\)](#) clearly show an inverse relationship between time spent in organized sports and mental health problems. Not only does organized sport improve mental well-being and reduce depression, so does leisure-time physical activity ([Sam-sudin et al., 2024](#)). [Dahlstrand et al. \(2021\)](#) also highlight the importance of leisure-time physical activity, noting in their study that, regardless of intensity, such activity helps reduce stress and stress-related mental health issues. In addition to physical activity, the physical fitness of adolescents, as well as the muscular endurance and the cardiorespiratory fitness, is of decisive importance in maintaining mental health and preventing depression and anxiety ([Chiang et al., 2024](#)).

Apart from physical activity and fitness, screen time and sleep duration also affect the health of young people. A 37-country summary of the HBSC study shows that an overall healthy lifestyle, including daily physical activity and less than 2 hours of screen time per day, is associated with fewer health complaints ([Marques et al., 2019](#)). The same conclusion was supported by a study conducted on adolescents in Iceland, where researchers claim that less screen time and more vigorous physical activity were associated with lower rates of depression and anxiety ([Hrafnkelsdottir et al., 2018](#)). A study of Iranian school children demonstrated the inverse effect: increased time spent watching television was linked to more frequent stomachaches and irritability, while extended computer use was also associated with more frequent stomachaches, irritability, nervousness, and difficulty falling asleep ([Faridizad et al., 2020](#)). [Nilsen et al.](#), in their longitudinal study (2023), also demonstrated an increase in physical health problems associated with increased screen time and social media use. In addition to the findings that the frequency of health complaints increases with more screen time, these complaints seem to occur more in girls than in boys ([Khan et al., 2022](#)). Increased screen time is a serious problem. Having high potential for sleep disorders ([Hisler et al., 2020](#)), which in turn leads to deterioration of psychological well-being and more frequent mental health problems ([Mougharbel & Goldfield, 2020](#)). In addition, it should be mentioned that it is not just screen time, but the use of mobile phones that harms the quality of sleep, which in turn is accompanied by mental

health disorders (Martin et al., 2020). On the other hand, physical activity has been shown to have a positive effect on adolescents' sleep (Desjardins & Tanguay-Labonté, 2018; Huang et al., 2021). When children and adolescents meet the recommendations for physical activity, sleep duration and screen time, they have fewer symptoms of depression (Sampasa-Kanyinga et al., 2020). A similar positive relationship between health-related quality of life and physical activity is pointed out by Wilhite et al. (2023) in their systematic review. Both adequate physical activity and sufficient sleep have been shown to positively impact mental health. Conversely, a more sedentary lifestyle, often linked to increased screen time, is associated with poorer health-related quality of life. Additionally, insufficient sleep is correlated with higher rates of anxiety and depression symptoms (Wilhite et al., 2023).

To the knowledge of the authors, the relationships between the five aspects mentioned—self-assessment of health, more frequent health complaints, physical activity, screen time, and sleep duration—have not been examined simultaneously in previous studies, nor have the connections between them been demonstrated. Additionally, based on the reviewed literature and identified knowledge gaps, we propose further research questions: Which physical activity factors have a greater impact on health assessments and more frequent health complaints, including mental health indicators—is it exercise frequency, exercise intensity, or time spent being physically active outdoors? And, in terms of health-related indicators, which is more decisive—longer screen time or shorter sleep duration? Based on the above, the aim of this study was to explore the relationships between self-assessment of health, more frequent health complaints and different factors of physical activity and screen time and sleep duration.

2. Materials and Methods

2.1. Participants

The participants of this study were drawn from “The Study of Testing the Physical Fitness and the Physical Activity of Estonian Schoolchildren and the Factors That Affect It”, which was conducted in the spring semester of 2021/2022. The questionnaire was completed by 1892 schoolchildren in the 6th, 8th and 10th grades. However, 11 partially completed questionnaires were excluded from the final analysis. This left a total of 1881 adolescents, aged 12 - 17 years, of whom 917 were boys (48.8%) and 964 were girls (51.2%).

In this study, the terms “boys” and “girls” are used to refer to schoolchildren aged 12 - 17 years. This terminology is chosen for brevity in tables, and it reflects the common usage in research related to adolescents. While the terms are concise, they are intended to include all students within this age range, recognizing the diverse experiences and developmental stages that may be present.

In the academic year 2021/2022, a total of 39,004 students studied in Estonian schools in the 6th, 8th and 10th grades (Haridusandmete Portaal, n.d.). Our sample represents 4.8% of this.

2.2. Organization of the Study

25 randomly selected schools across Estonia participated in the above-mentioned study of Estonian schoolchildren. Schools in a large city, including the capital, as well as small town and rural schools were included in the study. The study was carried out by the lecturers and students of the School of Natural Sciences and Health of Tallinn University, who received the necessary specialized training in advance to conduct this study.

Before the survey, the school management was asked for permission to conduct the study, and based on the positive decision, the study was introduced to the pupils, who were able to leave their informed consent with the class teacher.

All children who agreed to participate in the study and whose parents had given passive consent filled out the self-reported questionnaire in the computer classroom of the school in the presence of the researcher. The questionnaire was completed in the Google Forms environment.

2.3. Ethical Considerations

“The Study of Testing the Physical Fitness and the Physical Activity of Estonian Schoolchildren and the Factors That Affect It” was approved by the ethics committee of Tallinn University (application no.: 6-5.1/34).

All students participating in the study were introduced to the purpose and activities of the study in the classroom teacher’s lesson. Each student independently decided whether to participate in the study and informed the class teacher of their decision.

Participation in the study was entirely voluntary for all individuals involved.

In addition to the schoolchildren, their parents were also informed about the study via email (twice) and asked for permission to include their children in the study. If a parent did not consent to their child’s participation in the study, they were asked to send an email to the researcher at the respective school.

The class teacher forwarded both the students’ informed consents and the parents’ purchases to the person responsible for the study.

Each student was assigned a unique code, guaranteeing their anonymity and confidentiality. The data collected during the research was used in an aggregated form and cannot be traced back to any specific individual.

2.4. Questionnaire

The survey questionnaire for Estonian schoolchildren was compiled by the authors of this article.

The questions related to health assessment and more frequent health complaints were derived from the Estonian HBSC study (Oja et al., 2019):

- The self-assessment of health was determined with the question: “How would you describe your health in general?” The answer options were: 1) Excellent, 2) Good, 3) Fair, 4) Poor.
- The frequency of health complaints was assessed with the question: “How

often have you experienced the following issues (headache, stomach ache, backache, feeling low, irritability/bad mood, nervousness, difficulties falling asleep, drowsiness/dizziness and) in the last six months?” The answer options were: 1) Almost every day, 2) More than once a week, 3) Almost every week, 4) Almost every month, 5) Rarely or never.

The samples of the physical activity questions were taken from a similar survey that was conducted in Estonian schools in the 2017/2018 academic year (Kuu et al., 2018):

- The frequency of exercise was determined with the question: “Outside of school hours: How often do you usually exercise (at least 20 min at a time)?” The answer options were: 1) Never, 2) Less than once a month, 3) Once a month, 4) Once a week, 5) 2 times a week, 6) 3 times a week, 7) 4 times a week, 8) 5 times a week, 9) 6 times a week, 10) 7 times a week.
- The hours of intensive exercise were determined with the question: “Outside of school hours: How many hours a week do you usually exercise so that you pant and sweat?” The answer options were: 1) None, 2) About 0.5 h, 3) About 1 h, 4) About 2 - 3 h, 5) About 4 - 6 h, 6) 7 h or more.
- The physically active time outdoors was determined with the question: “How many hours a week are you physically active outdoors in your free time (do you walk, run, play ball with friends, ride a bicycle or skateboard, walk your dog, etc.)?” The answer options were: 1) None, 2) About 0.5 h, 3) About 1 h, 4) About 2 - 3 h, 5) About 4 - 6 h, 6) 7 h or more.

The questions about the screen and sleep time come from an Estonian Children Personality Behavior and Health Study (ECPBHS) (Harro et al., 2009):

- The screen time was determined with the question: “How many hours a day do you usually spend in front of the screen (watching TV + playing computer games + surfing the Internet, etc.)?” The answer options were: 1) No time, 2) Less than 1 h, 3) 2 - 3 h, 4) 4 - 5 h, 5) More than 6 h.
- The sleep duration was determined with the question: “How many hours do you usually sleep a day?” The answer options were: 1) Less than 7 h, 2) 7 - 8 h, 3) 9 - 10 h, 4) 11 - 12 h, 5) More than 12 h.

As background information, students were asked to indicate their grade, age, and gender.

2.5. Statistical Analysis

The IBM SPSS Statistics program was used for data analysis. The following statistical methods were chosen to create a robust framework for analyzing relationships within the questionnaire data. Cross-tabulations with the Chi-square test enabled the exploration of associations between categorical variables, while Spearman’s rank correlation measured the strength and direction of associations between ordinal or non-normally distributed variables. This combination of methods facilitates drawing meaningful conclusions about the relationships among the diverse variables in the study. To ensure logical consistency, the response options

for the questions on health assessment and the frequency of health complaints were reversed before conducting the correlation analysis, so that a better health assessment would have a higher numerical value, and more frequent complaints would also be represented by a higher value. Significance level set at $p < 0.05$.

Before conducting the correlation analysis, a factor analysis was performed on the most commonly reported health complaints to examine how the different characteristics were grouped. In the initial analysis, all eight characteristics from the more frequent health complaints were loaded into a single factor (KMO = 0.896, $p < 0.001$). The same has been found in previous studies (Ravens-Sieberer et al., 2008), and based on Haugland et al. (2001), the answer variants of health complaints were added together to find a general relationship, finding their own sum for each participant. (All eight of the more frequent health complaints were also strongly related, $p < 0.001$)

To specifically highlight the indicators related to mental health, a two-factor analysis was applied, following the approach of Lovis-Schmidt et al. (2022), who differentiated between somatic complaints and psychological complaints (Lovis-Schmidt et al., 2022). Based on the results of the rotated component matrix, headache, stomachache, backache, and drowsiness/dizziness were grouped together and treated as somatic complaints, with their average score considered in the correlation analysis. Meanwhile, feeling low, irritability/bad mood, nervousness, and difficulties falling asleep were grouped together as psychological complaints, with their mean score also included in the correlation analysis.

3. Results

The descriptive results (proportions of answer variants and gender differences) according to the questions used in the study (Subsections 3.1-3.3) and then the relationships between different indicators (Subsection 3.4) are presented.

3.1. Self-Assessment of Health and More Frequent Health Complaints

Students aged 12 - 17 assessed their health as good in more than half of cases and excellent in about a quarter of students (Table 1), while boys rated their health better than girls ($\chi^2 = 26.007$, $p < 0.001$).

Table 1. Distribution of the self-assessment of health of the participants (%; n) by gender.

Estimation of Health	Distribution of Participants		
	Boys	Girls	Total
Excellent	28.2% (259)	20.9% (201)	24.5% (460)
Good	55.6% (510)	55.6% (536)	55.6% (1046)
Fair	15.5% (142)	21.6% (208)	18.6% (350)
Poor	0.7% (6)	2.0% (19)	1.3% (25)

The gender difference was statistically significant for all eight of the most

common health complaints, while girls complain about various problems more often than boys ($p < 0.001$).

Girls complain of daily headaches almost three times more often than boys (**Table 2**), and among boys, more than half of the participants (52.8%) report that they rarely or never have headaches ($\chi^2 = 126.386$, $p < 0.001$).

Table 2. Frequency distribution of health complaints among the participants (%; n) by gender.

Health complaint	Participants	Frequency of complaints				
		Almost every day	More than once a week	Almost every week	Almost every month	Rarely or never
Headache	Boys	3.5% (32)	9.3% (85)	11.8% (108)	22.7% (208)	52.8% (484)
	Girls	11.5% (111)	17.7% (171)	17.0% (164)	22.6% (218)	31.3% (300)
	Total	7.6% (143)	13.6% (256)	14.5% (272)	22.6% (426)	41.7% (784)
Stomach ache	Boys	1.3% (12)	5.5% (50)	6.8% (62)	23.8% (218)	62.7% (575)
	Girls	4.8% (46)	10.8% (104)	12.0% (116)	38.8% (374)	33.6% (324)
	Total	3.1% (58)	8.2% (154)	9.5% (178)	31.5% (592)	47.8% (899)
Backache	Boys	4.9% (45)	7.9% (72)	8.8% (81)	19.6% (180)	58.8% (539)
	Girls	10.5% (104)	10.5% (101)	12.6% (121)	20.4% (197)	45.7% (441)
	Total	7.9% (149)	9.2% (173)	10.7% (202)	20.0% (377)	52.1% (980)
Feeling low	Boys	6.9% (63)	7.0% (64)	11.0% (101)	19.4% (178)	55.7% (511)
	Girls	20.7% (200)	18.5% (178)	17.4% (168)	18.8% (181)	24.6% (237)
	Total	14.0% (263)	12.9% (242)	14.3% (269)	19.1% (359)	39.8% (748)
Irritability/ bad mood	Boys	8.3% (76)	10.6% (97)	19.1% (175)	27.9% (256)	34.1% (313)
	Girls	23.2% (224)	21.4% (206)	20.4% (197)	20.3% (196)	14.6% (141)
	Total	15.9% (300)	16.1% (303)	19.8% (372)	24.0% (452)	24.1% (454)
Nervousness	Boys	8.4% (77)	11.7% (107)	17.4% (160)	24.4% (224)	38.1% (349)
	Girls	27.1% (261)	19.4% (187)	18.9% (182)	17.5% (169)	17.1% (165)
	Total	18.0% (338)	15.6% (294)	18.2% (342)	20.9% (393)	27.3% (514)
Difficulties falling asleep	Boys	11.5% (105)	7.5% (69)	11.9% (109)	17.6% (161)	51.6% (473)
	Girls	20.1% (194)	15.8% (152)	13.2% (127)	16.7% (161)	34.2% (330)
	Total	15.9% (299)	11.7% (221)	12.5% (236)	17.1% (322)	42.7% (803)
Drowsiness/ dizziness	Boys	5.5% (50)	6.9% (63)	11.3% (104)	18.4% (169)	57.9% (531)
	Girls	16.3% (157)	14.4% (139)	14.2% (137)	17.2% (166)	37.9% (365)
	Total	11.0% (207)	10.7% (202)	12.8% (241)	17.8% (335)	47.6% (896)

Of all the surveyed health problems, adolescents complained least about stomach aches (**Table 2**). Once a week or more, self-reported abdominal pain occurred in about a fifth (20.8%) of the participants, but it occurred almost twice as often among girls ($\chi^2 = 165.364$, $p < 0.001$).

Regarding backache, the gender difference was not as great as for headache and stomachache (**Table 2**), but girls still complained of back pain more often than boys ($\chi^2 = 45.565, p < 0.001$).

Among psychological complaints, boys complained the least about feeling low (**Table 2**). 55.7% of boys rarely or never perceived a feeling low, the same indicator among girls is more than twice lower, i.e. 24.6% ($\chi^2 = 241.125, p < 0.001$).

Irritability was the most common psychological complaint (**Table 2**). Only 24.1% of respondents rarely or never complain about irritability/bad mood, and only 14.6% of girls confirmed that they have not felt irritability/bad mood during the last six months ($\chi^2 = 185.595, p < 0.001$).

Of all assessed health complaints, including psychological complaints (**Table 2**), nervousness was the most common among girls every day, where 27.1% of respondents chose the answer option “almost every day” ($\chi^2 = 195.862, p < 0.001$).

Of all assessed health complaints, including psychological complaints (**Table 2**), difficulties falling asleep was the most common among boys every day, where 11.5% of respondents chose the answer option “almost every day” ($\chi^2 = 83.380, p < 0.001$).

Approximately one-third of adolescents (34.5%) reported experiencing drowsiness/dizziness at least once a week or more (**Table 2**). Also in this indicator, the frequency of girls’ complaints is higher compared to boys ($\chi^2 = 118.103, p < 0.001$).

3.2. Physical Activity

Adolescents aged 12 - 17 did exercises mainly 3 - 5 times a week (**Table 3**). The answer option “3 times a week” turned out to be the most popular choice, while the frequency of exercise for boys was higher compared to girls ($\chi^2 = 38.901, p < 0.001$).

Table 3. Distribution of the frequency of exercise of the participants (%; n) by gender.

Frequency of Exercise	Distribution of Participants		
	Boys	Girls	Total
Never	4.6% (42)	5.2% (50)	4.9% (62)
Less than once a month	3.2% (29)	3.9% (38)	3.6% (67)
Once a month	2.3% (21)	5.1% (49)	3.7% (70)
Once a week	7.3% (67)	10.7% (103)	9.0% (170)
2 times a week	12.5% (115)	14.4% (139)	13.5% (254)
3 times a week	20.3% (186)	21.4% (206)	20.8% (392)
4 times a week	15.0% (138)	15.4% (148)	15.2% (286)
5 times a week	15.6% (143)	10.2% (98)	12.8% (241)
6 times a week	8.8% (81)	7.3% (70)	8.0% (151)
7 times a week	10.4% (95)	6.5% (63)	8.4% (158)

Also, among boys, the intensity of exercise was higher than among girls ($\chi^2 = 37.909$, $p < 0.001$), but representatives of both sexes do exercise in such a way that it makes them sweat and breathe mostly 2 - 3 hours a week (**Table 4**).

Table 4. Distribution of the hours of intensive exercise per week of the participants (%; n) by gender.

Hours of intensive exercise per week	Distribution of Participants		
	Boys	Girls	Total
None	8.3% (76)	13.2% (127)	10.8% (203)
About 0.5 h	9.5% (87)	10.2% (98)	9.8% (185)
About 1 h	17.2% (158)	19.0% (183)	18.1% (341)
About 2 - 3 h	26.9% (247)	28.0% (270)	27.5% (517)
About 4 - 6 h	21.2% (194)	21.2% (204)	21.2% (398)
7 h or more	16.9% (155)	8.5% (82)	12.6% (237)

They were also physically active time outdoors, mainly 2 - 3 hours a week (**Table 5**). For this indicator of physical activity, the boys' results also exceeded those of the girls ($\chi^2 = 21.582$, $p < 0.001$).

Table 5. Distribution of the physically active time outdoors per week of the participants (%; n) by gender.

Physically active time outdoors per week	Distribution of Participants		
	Boys	Girls	Total
None	5.0% (46)	4.3% (41)	4.6% (87)
About 0.5 h	7.3% (67)	10.9% (105)	9.1% (172)
About 1 h	17.3% (159)	18.9% (182)	18.1% (341)
About 2 - 3 h	33.0% (303)	36.9% (356)	35.0% (659)
About 4 - 6 h	22.7% (208)	19.3% (186)	20.9% (394)
7 h or more	14.6% (134)	9.8% (94)	12.1% (228)

3.3. Screen Time and Sleep Duration

53.6% of boys and 62.5% of girls spent more than 4 hours a day on the screen (**Table 6**; $\chi^2 = 18.736$, $p < 0.001$).

Approximately one-third of girls aged 12-17 and one-fifth of boys slept less than 7 hours a day (**Table 7**; $\chi^2 = 40.278$, $p < 0.001$).

3.4. Relationships between Self-Assessment of Health, More Frequent Health Complaints and Indicators of Physical Activity, Screen Time, and Sleep Duration

Self-assessment of health was moderately and inversely related to all indicators characterizing health complaints ($p < 0.001$), including the total number of health

Table 6. Distribution of screen time per day of the participants (%; n) by gender.

Screen time per day	Distribution of Participants		
	Boys	Girls	Total
No time	0.3% (3)	0.2% (2)	0.3% (5)
Less than 1 h	6.1% (56)	4.1% (40)	5.1% (96)
2 - 3 h	40.0% (367)	33.1% (319)	36.5% (686)
4 - 5 h	40.7% (373)	45.0% (434)	42.9% (807)
More than 6 h	12.9% (118)	17.5% (169)	15.3% (287)

Table 7. Distribution of sleep duration per day of the participants (%; n) by gender.

Sleep duration per day	Distribution of Participants		
	Boys	Girls	Total
Less than 7 h	21.7% (199)	34.3% (331)	28.2% (530)
7 - 8 h	61.6% (565)	53.8% (519)	57.6% (1084)
9 - 10 h	15.8% (145)	10.9% (105)	13.3% (250)
11 - 12 h	0.7% (6)	0.6% (6)	0.6% (12)
More than 12 h	0.2% (2)	0.3% (3)	0.3% (5)

complaints, psychological complaints, and somatic complaints (**Table 8**). Similarly, self-assessment of health was positively related with all indicators of physical activity ($p < 0.001$). There were medium-strength associations with exercise frequency and hours of intensive exercise, while the association with time spent being physically active outdoors was weaker.

Both the sum of health complaints and psychological and somatic complaints were weakly and inversely related to all indicators of physical activity ($p \leq 0.001$; **Table 8**).

Self-assessment of health was weakly and inversely related to screen time and weakly but positively related to sleep duration ($p < 0.001$). At the same time, all health complaint indicators were weakly and positively related to screen time and weakly and inversely related to sleep duration ($p < 0.001$; **Table 8**).

In addition, it can be pointed out that all indicators of physical activity were weakly and inversely related to screen time and weakly and positively related to sleep duration ($p \leq 0.01 - < 0.001$). Screen time and sleep duration were also weakly and inversely related ($p < 0.001$; **Table 8**).

Age has a moderating effect on health-related indicators, screen time and sleep duration ($p < 0.001$; **Table 8**). Age showed a weak inverse relationship with health assessment and sleep duration, and weak positive relationships with all indicators of health complaints and screen time ($p < 0.001$).

4. Discussion

4.1. Health Indicators and Relationships with Physical Activity

In this study, 83.8% of boys and 76.5% of girls rated their health as good or

Table 8. Relationships between self-assessment of health, health complaints and physical activity indicators, screen time and sleep duration.

		Self-assessment of health	Sum of health complaints	Psychological complaints	Somatic complaints	Frequency of exercise	Hours of intensive exercise	Physically active time outdoors	Screen time	Sleep duration
Self-assessment of health	ρ^a	1								
	p									
Sum of health complaints	ρ	-0.360	1							
	p	<0.001								
Psychological problems	ρ	-0.340	0.937	1						
	p	<0.001	<0.001							
Somatic problems	ρ	-0.313	0.875	0.661	1					
	p	<0.001	<0.001	<0.001						
Frequency of exercise	ρ	0.343	-0.130	-0.116	-0.120	1				
	p	<0.001	<0.001	<0.001	<0.001					
Hours of intensive exercise	ρ	0.323	-0.144	-0.134	-0.125	0.656	1			
	p	<0.001	<0.001	<0.001	<0.001	<0.001				
Physically active time outdoors	ρ	0.151	-0.090	-0.078	-0.073	0.267	0.265	1		
	p	<0.001	<0.001	0.001	0.001	<0.001	<0.001			
Screen time	ρ	-0.202	0.244	0.227	0.217	-0.223	-0.137	-0.082	1	
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001		
Sleep duration	ρ	0.263	-0.351	-0.330	-0.312	0.118	0.119	0.059	-0.226	1
	p	<0.001	<0.001	<0.001	<0.001	<0.001	<0.001	0.010	<0.001	
Age	ρ	-0.083	0.155	0.155	0.121	0.012	0.000	-0.001	0.131	-0.274
	p	<0.001	<0.001	<0.001	<0.001	0.607	0.984	0.980	<0.001	<0.001

a. Spearman's rho.

excellent. These results are consistent with findings from the Estonian and German HBSC surveys (Oja et al., 2023; Reiß et al., 2024), firstly, boys tend to rate their health higher than girls, and as age increases, health assessment indicators decline. At the same time, there is a significant difference in the percentages of the “excellent” health rating. According to the Estonian HBSC survey reports that among students aged 11 - 15, 41% of boys and 29% of girls rate their health as excellent (Oja et al., 2023). However, in this study, only 28% of boys and 20% of girls aged 12 - 17 rated their health as excellent.

The findings on health complaints in this study are also consistent with the results of the HBSC study conducted in Estonia and Germany (Oja et al., 2023; Reiß et al., 2024), where girls had more complaints than boys, and the number of complaints increased with age. Similarly to Oja et al. (Oja et al., 2023) and Bianco et

al. (2019), our study also showed that the most frequent health complaints among adolescents were irritability/bad mood and nervousness. At least once a week or more, 51.8% of respondents complained of nervousness and irritability/bad mood. Among somatic complaints, headache was the most common complaint - 35.7% of 12 - 17-year-old schoolchildren had a headache once a week or more. Headache was also the most frequent physical health complaint among Norwegian adolescents (Nilsen et al., 2023). It is well established that health issues can disrupt concentration and learning abilities. Mental health, in particular, has a significant impact on adolescents' academic success (Agnafors et al., 2021).

The inverse relationship between self-assessment of health and health complaints further confirms the reliability of the self-reported questionnaire. Therefore, it can be concluded that if school students perceive more health problems, their health assessments tend to be lower. According to Corell et al. (2022), the main factor causing health complaints is stress, which is associated with psychological complaints more than with somatic ones. But at the same time, Lovis-Schmidt et al. (2022) highlight in their study the fact that negative emotions predict the presence of health complaints more than stress and health behavior. On the other hand, participating in organized sports has been shown to enhance psychological well-being and help prevent mental health issues (Tahira, 2022). This was also confirmed by our correlation analysis, which shows that the frequency of exercise and hours of intensive exercise are more positively related to health assessment than physically active time outdoors. Additionally, the correlation coefficients for the inverse relationships between the total number of health complaints, psychological complaints, and somatic complaints are higher for exercise frequency and hours of intensive exercise compared to time spent being physically active outdoors. Furthermore, psychological complaints did not differ from somatic complaints in terms of the strength of their connection. Although, several authors point out the beneficial effect of intensive exercise on more common mental problems such as anxiety and depression (Neill et al., 2020; Panza et al., 2020; Tahira, 2022). However, Dahlstrand et al. state that any physical activity, regardless of intensity, reduces stress and stress-related mental health problems (Dahlstrand et al., 2021). And according to Cheon (2021), exercise frequency seems to be related to subjective happiness, which in turn contributes to mental well-being.

4.2. Associations with Screen Time and Sleep Duration

In addition to various indicators of physical activity, self-assessment of health and more frequent health complaints were weakly but still statistically significantly related to screen time and sleep duration. Moreover, in the case of the above-mentioned relationships, from the point of view of health, longer sleep duration is more important than shorter screen time. And in both cases, age was shown to have a noticeable effect on the results of this study. This means that as age increases, screen time tends to rise while sleep duration decreases, both of which contribute to more frequent health complaints. Conversely, reducing screen time

and increasing sleep duration can lead to fewer health complaints. These results also coincide with previous studies, which revealed that if adolescents have less screen time, they also have fewer health complaints (Hrafnkelsdottir et al., 2018; Khan et al., 2022; Marques et al., 2019). The inverse relationship between sleep duration and health complaints in this study also coincides with previous studies, where shorter sleep duration was associated with a greater number of health complaints (Paiva et al., 2015; Segura-Jiménez et al., 2015). Bedtime also plays a significant role; the later adolescents go to sleep, the more health problems they experience (Dutil et al., 2022; Gariépy et al., 2019). In addition to health complaints, insufficient sleep was also associated with emotional and behavioral problems (Kosticova et al., 2020). The average required sleep duration for teenagers is 9 h (Matricciani et al., 2013). According to our research, only 13.3% of participants fell into this category. Among boys, the situation was slightly better than among girls, 15.8% and 10.9% of whom sleep 9 - 10 hours a day, respectively. When we also consider whether screen time aligns with the recommendations (WHO suggests no more than 2 hours per day for teenagers), the reality becomes even more concerning. Only 5.1% of students aged 12 - 17 had less than two hours of screen time.

It appears that if adolescents participated in more exercise or spent more time being active outdoors, their screen time would likely decrease, their sleep duration would improve, the frequency of health complaints would diminish, and their overall health assessment would improve. This is exactly what the multifaceted correlative relationships of this study exposed. There is significant room for improvement in this age group, as only 8.4% of study participants engage in daily exercise, and just 12.6% of 12 - 17-year-old students meet the WHO recommendation of 7 hours of moderate and vigorous intensity activities per week (WHO, 2024). In this study, boys performed better than girls on both indicators.

Previous research also supports our statement. Xu et al. (2019) confirm that adolescents whose screen time and physical activity meet WHO recommendations had better sleep quality and quantity. Sufficient sleep and sufficient physical activity in turn had a positive effect on mental health (Wilhite et al., 2023). And if all three indicators, i.e. physical activity, sleep duration and screen time, meet the recommendations, the incidence of depression symptoms among adolescents also tends to decrease (Sampasa-Kanyinga et al., 2020). Therefore, the entire combination of physical activity, screen time, and sleep duration plays a crucial role in adolescents' self-reported health assessments and the frequency of their health complaints. This impact is equally significant for both psychological and somatic health complaints. It is also noteworthy that the most important physical activity indicators are exercise frequency and the duration of intensive exercise, while time spent being physically active outdoors is less influential.

4.3. Strengths and Limitations

4.3.1. Strengths

Sample size: With 1881 participants, the study represents a relatively large

sample, enhancing the statistical reliability and generalizability of the findings to a broader population of Estonian adolescents.

Age range: The study includes adolescents aged 12 to 17, encompassing a crucial developmental period during which health behaviors are established.

Scope: The research conducted is thematically diverse, examining several key variables known to impact adolescent health: self-assessment of health, health complaints, physical activity, screen time and sleep duration. Such a comprehensive approach provides a thorough understanding of adolescent health.

Focus on health complaints: By focusing on the most common health complaints, the study addressed an important and practical aspect of adolescent well-being which can have both immediate and long-term effects.

Practical value for the design of healthcare strategies: The results of the study provide valuable information for public health interventions targeting the health behaviors of adolescents in Estonia or similar population groups.

4.3.2. Limitations

Self-reported data: Using self-reported data to generalize about health, physical activity, screen time, and sleep duration can lead to misinterpretation and individual-based bias. Adolescents may overestimate positive behaviors (e.g. physical activity) or underestimate them (e.g. screen time).

Lack of objective measures: Lack of objective measures (such as the use of wearable devices to monitor physical activity and sleep) may limit the accuracy and reliability of the data. In other words, a subjective assessment may not be generalizable.

Cross-sectional study:

This study can only detect correlations between variables, not causation. For example, in the case of the relationship between screen time and health complaints, we cannot determine whether increased screen time causes more health complaints or vice versa.

The data provide an overview of adolescent health at a limited point in time, which may not reflect changes or trends over a longer period of time.

Cultural and contextual constraints:

Limited generalizability: Although the study is valuable for understanding the health behavior of Estonian adolescents, the findings may not be generalizable to adolescents living in other countries or cultural contexts without additional validation studies.

Contextual factors: The study does not take into account broader social, economic and environmental factors that could influence the health behaviors and outcomes of the adolescents studied.

Developmental differences: Adolescents between the ages of 12 and 17 are at different stages of physical, cognitive, and emotional development. The study may not account for these differences, which may affect the relationship between the variables studied.

Uncontrolled variables: The relationships between health, physical activity, screen time, and sleep duration are also influenced by other important factors (eg, diet, socioeconomic status, mental health) that the study does not control for, which may affect the results.

5. Conclusion

Among the various indicators of physical activity, exercise frequency and the duration of intensive exercise were more significant for better self-assessments of health and fewer health complaints than the time spent being physically active outdoors.

Longer sleep duration had a greater impact than reduced screen time on improving self-assessment of health and was also associated with a reduction in the frequency of health complaints.

More frequent exercise, longer time of moderate and vigorous intensity exercise, shorter screen time and longer sleep duration were found to be equally important for reducing both somatic and psychological health complaints.

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Conflicts of Interest

The authors declare no conflicts of interest regarding the publication of this paper.

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