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Adolescence as a Critical Period: Gender Differences in Nutrition, Physical Activity and Sedentary Behavior

Suncica Delas-Kalinski
Split University

Borcic Ljubica
Girls' High School of the Congregation of the Sisters of Public Charity in Zagreb

Vesna Babic
Zagreb University

Abstract: The study, conducted with a sample of 177 male students and 89 female students from the final grades of high schools in Zagreb, examined physical activity, sedentary behavior, and dietary habits among adolescents. The results show that the majority of male students (67%) regularly engage in sports, with most having been involved in sports for over five years (44.65%), while the majority of female students (52.27%) are inactive. Among those who participate in sports, a larger percentage of both genders engage in individual sports (39.55% of male athletes and 42.05% of female athletes).Regarding sedentary behavior, both genders spend a similar amount of time using mobile devices and applications (2-3 hours daily), with a higher percentage of male students (37.29%) spending more time playing video games compared to female students (79.55%).In terms of dietary habits, the majority of students from both genders report having prior knowledge of nutrition, with male students being slightly more informed about weight loss and weight gain advice. While they are aware of the importance of proper nutrition, there are noticeable deficiencies in their dietary habits, especially in the consumption of fruits, vegetables, and fish. Females generally consume more fruits and dairy products, while males consume more meat and meat products. The study highlights the need for further educational and health interventions to promote a more balanced diet and greater engagement in physical activity among adolescents.

Keywords: Secondary school students, Physical activity, Eating habits, Nutrition

Introduction

Adolescence is a pivotal period in life, marked by rapid and profound changes across physical, emotional, social, and cognitive domains. It is a time when the foundations for adult habits are established, including behaviors related to nutrition, physical activity, and mental health (National Academies of Sciences, Engineering, and Medicine [NASEM], 2019; Mastorci et al., 2024). This stage, which spans from ages 10 to 19, presents young people with numerous challenges arising from pubertal changes, social pressures, and the drive for independence and identity formation (Steinberg, 2005; Arnett, 2007).

One of the most prominent characteristics of adolescence is the emergence of gender differences, which are evident across various aspects of adolescent life—from biological and physical traits to social roles and psychological needs (De Bolle et al., 2015). Boys and girls often adopt different approaches when it comes to diet, physical activity, sedentary behavior, and mental health (Harter, 2012; Harris & O'Neil, 2017). For instance, boys are generally more likely to engage in high-intensity physical activities and meet recommended physical activity guidelines, while girls more frequently report higher levels of sedentary behavior (Brazo-

Sayavera et al., 2021; Aubert et al., 2018). Similarly, dietary habits also vary significantly between genders. Girls tend to be more concerned with body weight control, which often leads to an increased risk of disordered eating and unhealthy weight-loss strategies (Gibson, Hunt & Sallis, 2016; Mikkilä, Räsänen & Räsänen, 2004). In contrast, boys are more likely to consume larger quantities of fast food and sugary beverages, raising their risk of obesity and related health problems (Harris & O'Neil, 2017; Gibson et al., 2016; Mikkilä et al., 2004). These differences are not superficial—they deeply affect adolescents' physical and mental health and lay the groundwork for potential health issues in adulthood (Berge et al., 2017).

The issue of gender differences in dietary habits and physical activity is also evident in research conducted in Croatia. Peršun (2021), in a study among high school students in Zagreb, found that girls more frequently choose healthier foods and vegetables, while boys consume more processed food, sugary drinks, and fast food. Similar studies conducted in Osijek and Split suggest that girls tend to maintain more balanced diets, whereas boys show a preference for fast food and carbonated drinks (Peršun, 2017). In a study by Uršulin-Trstenjak, Miler & Ferenčak (2016), carried out in secondary schools in Zagreb and Varaždin, a significant gender gap in physical activity levels was highlighted: boys were more involved in high-intensity activities, while girls more often opted for lighter forms of exercise, such as walking or cycling. Similarly, Peršun (2021) analyzed adolescents' dietary habits in Zagreb and found that boys often fail to meet the recommended daily intake of fruits and vegetables.

In recent years, global research has revealed alarming trends in sedentary behavior and low levels of physical activity among adolescents worldwide (Guthold et al., 2019; van Sluijs et al., 2021). Global studies consistently show that only a minority of adolescents meet WHO physical activity guidelines—over 80 % globally fall short of the 60-minute daily recommendation (Guthold et al., 2019), with only around 20 % achieving daily physical activity even in large multi-country samples (Pengpid & Peltzer, 2020). Simultaneously, increased technology use and screen time have become serious concerns, contributing to negative mental health outcomes and obesity (Carson et al., 2016; Poitras et al., 2016). These trends underscore the need for further research to better understand the specific needs of boys and girls and to support the development of targeted interventions aimed at reducing these negative outcomes (Aubert et al., 2018). In Croatia, according to Mikulić et al. (2018), the majority of adolescents do not meet the recommended levels of physical activity, and a significant number spend most of their day sitting, which can lead to adverse health consequences. Similarly, research by Vranić et al. (2019) shows that Croatian adolescents spend a high percentage of their time being sedentary—up to 8 to 9 hours a day—mostly on mobile phones and computers.

This paper aims to explore gender differences in dietary habits, physical activity, and sedentary behavior among Croatian adolescents. Understanding these differences is crucial for designing specific programs and policies aimed at improving young people's health, taking into account the unique needs of both boys and girls (Berge et al., 2017; Harris & O'Neil, 2017).

Method

Sample of Respondents

The sample consisted of students from the 3rd and 4th grades of the I. Technical School Tesla in Zagreb (n = 177), aged 16 to 19 (M = 17.59), and female students from the All-Girls General Gymnasium of the Sisters of Mercy (F = 89), aged 16 to 19 (M = 17.41). All participants were informed about the purpose of the study and were made aware that participation was voluntary and they could withdraw at any time.

Variables Sampled

An online questionnaire was created using Google Forms, consisting of 51 questions related to daily activity, sedentary behavior, and dietary habits (Questionnaire link). Each nominal variable (i.e., the response options for a given question) was coded from 1 to 6, depending on the number of answers offered.

Data Analysis Methods

Descriptive statistical analyses were performed. Mode and mode frequency were calculated using the Statistica software, version 14.0 (StatSoft, Inc., Tulsa, USA).

Data Collection

Physical and health education teachers distributed the questionnaire link to students during class time.

Results and Discussion

Table 1 presents the values of descriptive parameters for indicators of activity, sedentary behavior, and dietary habits among upper secondary school students.

Table 1. Descriptive indicators of physical activity, sedentary behavior, and dietary habits among upper secondary school students

	Boys (n=177)			Girls (n=89)		
Question	Mode	Freq	%	Mode	Freq.	%
How old are you?	18	88	49.7%	17	48	53.9%
Highest level of education completed	4	75	42.3%	3	50	56.8%
When you are alone, do you get bored?	3	91	51.4%	1	60	68.1%
Do you play any sports?	1 (Yes)	119	67.2%	3 (No)	46	52.2%
If you play sports, which sport group does your sport belong to?	2	70	39.5%	5	37	42.0%
How many years have you been playing sports?	6	79	44.6%	3	42	47.7%
How many days per week do you train?	Multiple (varied)	44	24.8%	6	24	27.2%
Do you earn any income from playing sports?	2 (No)	152	85.8%	8 (No)	75	85.2%
How many hours per day do you watch TV?	1	100	56.5%	0	48	54.5%
How many hours per day do you play computer games?	1	66	37.2%	9	70	79.5%
How many hours per day do you spend browsing social media/apps?	3	93	52.5%	4	37	42.0%
How many times per week do you do other leisure activities (foreign language, music, hobbies, etc.)?	3	67	37.8%	5	33	37.5%
Do you have prior knowledge about nutrition?	1 (Yes)	141	79.6%	6 (Yes)	64	72.7%
Have you ever received advice about nutrition to lose/gain weight?	1 (Yes)	112	63.2%	8 (Yes)	62	70.4%
Do you work with a nutritionist?	2 (No)	164	92.6%	6 (No)	83	94.3%
Are you currently on a special diet?	2 (No)	155	87.5%	7 (No)	73	82.9%
Most often I eat when:	1	112	63.2%	8	57	64.7%
Usually when I eat:	1	119	67.2%	3	57	64.7%
To what extent does the statement apply: I eat standing up	2	61	34.4%	6	35	39.7%
To what extent does the statement apply: I eat from a bowl	3	76	42.9%	4	36	40.9%
To what extent does the statement apply: I eat while watching TV, reading, or working	3	60	33.9%	0	36	40.9%
To what extent does the statement apply: I eat when I'm bored	3	60	33.9%	0	34	38.6%
To what extent does the statement apply: I eat when I'm angry or in a bad mood	1	93	52.5%	4	26	29.5%
To what extent does the statement apply: I eat unorganized between meals	3	58	32.7%	7	28	3

Based on the results obtained, it is evident that the majority of male students engage in sports (67%), while the majority of female students do not (52.27%). Among both genders, those who engage in sports predominantly participate in individual sports (such as athletics, gymnastics, boxing, etc.; 39.55% of male athletes and 42.05% of female athletes). This result contradicts the findings of Ivković, Hordov and Miodrag (2021), which show that Croatian high school students most often participate in team sports (football, basketball, volleyball), followed by individual sports (athletics, swimming, boxing, and rowing). Similar patterns were observed in

other populations: in an Israeli sample, gymnastics, athletics, and tennis were among the most frequent individual sports, while basketball, football, and volleyball were dominant team sports (Lidor et al., 2022). U.S. data likewise demonstrate that athletics and other individual sports rank among the most common extracurricular activities among adolescents, in some cases even surpassing team sports such as football and basketball (National Federation of State High School Associations [NFHS], 2019; Pate et al., 2000).

Regarding the length of time spent practicing sports, it was found that the majority of male athletes have been practicing sports for more than five years (44.65%), while female athletes predominantly selected the option "I do not engage in sports" (47.73%), which resulted in the data on the duration of female athletes' involvement in sports not being recorded as dominant. The number of training days per week among male athletes is highly variable (ranging from 1-2 times a week to 6 times a week), while female athletes predominantly train 3 times a week (27.27%). Male and female athletes alike report no income from their sports activities (85.88% of male athletes and 85.23% of female athletes). The level of sports activity among the participants in this study is significantly higher than the results from Ivković et al. (2021), where only 40.05% of Croatian high school students engage in sports regularly, as well as compared to data from the Global Matrix 4.0 report (Pedišić et al., 2023), which shows that only 30% of high school students participate in organized sports activities.

In terms of time spent watching TV and (presumably) using mobile devices, the data from both genders are quite similar: both genders predominantly do not spend time watching television (56.60% of male athletes and 54.55% of female athletes), but they mostly spend 2-3 hours a day browsing content on various applications (52.54% of male athletes and 42.05% of female athletes). The time spent browsing different applications corresponds with the findings in the study by Jokić et al. (2024), also with global research findings which indicate that a significant portion of adolescents engage in extensive screen time, particularly through mobile devices (Dai & Ouyang, 2025). Such trends reflect the growing role of digital media in adolescents' daily lives and highlight the importance of monitoring screen exposure in this population.

While both genders predominantly chose the response "I do not spend time playing computer games" to the question, "How many hours a day do you spend playing video games?", the percentage of male athletes giving this response (37.29%) is significantly lower than that of female athletes (79.55%). This data aligns with numerous studies that confirm adolescents, especially boys, spend significantly more time playing video games than girls (Desai et al., 2010; Gómez-Gonzalvo et al. 2020; Leonhardt & Overå, 2021). Despite the inability to determine statistical significance for these differences, the result indicates notable gender differences in video game-related behavior among adolescents.

Aside from sports, the majority of both male students (37.85%) and female students (37.50%) engage in other activities during their free time (such as learning a foreign language, music, or hobbies like art) 2-3 times a week. This percentage aligns with the findings of Jokić et al. (2022), who reported that 71.7% of third-year high school students in Croatia do not participate in any extracurricular activities other than sports. Recent international studies confirm that extracurricular activities positively impact adolescent development. Participation in sports, arts, and other activities enhances physical activity (Nagata et al., 2025), improves mental health by reducing depression and anxiety (O'Flaherty et al., 2022), and promotes healthier behaviors and risk awareness (Szapary et al., 2025). Together with the current study, these findings highlight the important role of extracurricular engagement in supporting social, cognitive, and emotional growth, as well as healthy lifestyle habits.

Regarding nutrition knowledge, an exceptionally high percentage of male students (79.66%) and female students (72.73%) reported having prior knowledge of nutrition and having received advice on nutrition (such as how to lose or gain weight: 63.28% of male students and 70.45% of female students). However, male (92.66%) and female students (94.32%) do not collaborate with a nutritionist, nor are they following any special diet regime (87.57% of male students and 82.95% of female students). These results regarding the participants' knowledge of nutrition are consistent with the findings from studies conducted on high school seniors at the Medical School in Rijeka (Gudeljević & Jovanović, 2021) and at the Health School in Split (Kendeš, 2021). These studies showed that students have a positive attitude and relatively good knowledge about nutrition and are aware of the importance of a healthy diet for maintaining good health. Among students who reported following a specific diet, protein- and carbohydrate-rich diets were most frequently mentioned, while female students primarily mentioned attempts to follow a healthier diet and a calorie-deficit diet.

International studies confirm these gender-specific dietary patterns. Girls are more likely to consume fruit, vegetables, and healthy foods, while boys prefer fast food and meat (Askovic & Kirchengast, 2012). Girls also more often engage in dieting due to body-image concerns, as supported by a systematic review (Deslippe et al.,

2023). Similar findings in Costa Rica show girls linked to nutritious foods, while boys favor energy-dense meals (Salazar et al., 2014).

The eating habits of the students show that, in most cases, they eat when they are hungry and it is time for a meal (63.28% of male students and 64.77% of female students), and when they have requested and received food (67.23% of male students and 64.77% of female students). Gender differences are observed in responses related to the ways and places of meal consumption. Male students almost never eat standing up (34%), while female students do so occasionally (39.77%); male students occasionally eat from a bowl (42.94%), while female students do so frequently (40.91%); male students occasionally eat while watching TV, reading, or working (33.90%), while female students do so frequently (40.91%); and both male students (33.90%) and female students (38.64%) occasionally eat when they are bored (34%). Male students never eat when they are angry or in a bad mood (52.54%), while a dominant percentage of female students do so frequently (29.55%). The dynamics, organization, and locations of student meals show that the highest frequency of responses is recorded for "I sometimes eat unorganized meals between meals" (32.77% of male students and 31.82% of female students). Both genders sometimes eat late in the evening or at night (35.59% of male students and 34.09% of female students). Gender differences are present in the frequency of meals outside the dining room: male students sometimes eat in the living or working room (28.81%), while female students do so frequently (32.95%). Male students sometimes eat in the bedroom (30.51%), while female students do so frequently (28.41%). Both genders only sometimes take a second serving of food (36.72% of male students and 45.45% of female students). The findings of this study regarding adolescents' eating habits are consistent with international research. Female students were more likely than males to eat in response to emotions or while multitasking, such as watching TV or reading, whereas male students showed more structured eating patterns (Herle et al., 2017; Lombardo, Giusti & Fabbri, 2024). These results highlight that emotional states and meal contexts significantly influence adolescents' eating behaviors. Compared to their generation, the majority of male students (49.72%) and female students (56.82%) believe they eat at an average speed. Once or twice a week, they participate in a family meal with the majority of family members present (40.68% of male students and 47.73% of female students), and their families eat in a restaurant or order fast food less than once a month (63.28% of male students and 62.50% of female students).

In the homes of male students (69.93%) and female students (71.59%), snacks and sweets are easily accessible, and the most common types found include 2-3 types of savory snacks (44.63% of male students and 39.77% of female students), 2-3 types of nuts (51.95% of male students and 45.45% of female students), 1 type of chocolate (48.59% of male students and 53.41% of female students), and no types of chocolate bars (44.63% of male students and 53.41% of female students). Gender differences are visible in the number of types of candy and carbonated drinks in students' homes: male students predominantly have 1 type of candy (40.68%), while female students have none (37.50%); male students predominantly have 1 type of carbonated drink (36.72%), while female students have none (39.77%). In both genders' homes, the same situation exists for dry cookies and filled cookies (usually 1 type is available), while ice creams and lollipops are mostly unavailable. Most male (47.46%) and female students (48.86%) do not consume additional snacks and sweets over the weekend compared to the week. These findings indicate that both male and female students have easy access to various types of snacks and sweets at home, with gender differences in the types and quantities available. This is consistent with the study by Savige et al. (2007), which found that adolescent snacking behaviors, often occurring after school or while watching TV, are influenced by gender and household context, highlighting the role of home availability in shaping eating habits.

Male and female students consume similar amounts of cereals, legumes, fresh vegetables, fish and seafood, and olive oil: the majority consume 1 portion of cereals and cereal products daily (54.24% of male students and 70.45% of female students), 1 portion of legumes weekly (46.89% of male students and 48.86% of female students), 1-2.5 portions of fresh vegetables daily (49.15% of male students and 54.55% of female students), less than 1 portion of fish and seafood weekly (48.59% of male students and 54.55% of female students), and occasionally consume olive oil (less than 5 tablespoons per day; 54.24% of male students and 57.95% of female students). Gender differences are observed in the consumption of fresh fruit, milk and dairy products, and meat and meat products. Male students consume less than 1 serving of fresh fruit daily (39.55%), while female students consume 1-2 servings of fresh fruit daily (50.00%). Male students consume less than 1 serving of milk and dairy products daily (39.95%), while female students consume 1-1.5 servings of milk and dairy products daily (43.18%). Male students consume more than 1.5 servings of meat and meat products daily (44.63%), while female students consume 1-1.5 servings of meat and meat products daily (52.27%). As previously noted, these results are consistent with the findings of Nagata et al. (2025), which found that among the early adolescent population in the United States, the male sex was associated with lower intake of fruits, vegetables, and whole

grains, but higher consumption of meat, added sugars, and fats — all indicating poorer dietary quality compared to girls.

Conclusion

This study examined gender differences in physical activity, sedentary behavior, and dietary habits among Croatian high school students. The results indicate that the majority of male students actively participate in sports, mostly in individual disciplines, while female students are less involved in organized sports. Male students show more variable training frequency and intensity, whereas female students tend to have more structured, moderate activity patterns. Both genders spend limited time watching TV or playing video games, but boys engage in gaming significantly more than girls. Meanwhile, both genders spend 2–3 hours daily browsing social media or other digital applications, reflecting the increasing role of technology in adolescents' daily routines.

Although students demonstrated high levels of nutritional knowledge, this did not consistently translate into healthy eating behaviors. Female students consumed more fruits, vegetables, and dairy products, while male students consumed more meat, fast food, and high-calorie snacks. Special diets were more common among females and generally aimed at calorie restriction, whereas males followed protein-focused diets. Eating contexts and behaviors also differed by gender: female students were more likely to eat in response to emotions or while multitasking, whereas male students maintained more structured eating patterns.

The study also highlighted the home food environment, showing that snacks and sweets are easily accessible to both genders, but both genders do not show a frequent consumption of these items. Overall, the findings reveal a gap between knowledge and practice regarding healthy lifestyles, underlining the importance of targeted interventions to improve physical activity engagement, limit excessive screen time, and foster healthier dietary behaviors. Gender-specific strategies may be particularly beneficial, addressing the unique needs, habits, and preferences of boys and girls to promote lifelong healthy habits.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of this article published in EPESS journal belongs to the authors.

* Ethics committee permission no. 2181-205-02-05-25-008 of University of Split Faculty of Kinesiology.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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Author(s) Information

Sunčica Delas-Kalinski
Split University
Teslina ul. 6, 21000 Split, Croatia
Contact e-mail: *suncica@kifst.hr*

Borcic Ljubica
Girls' High School of the Congregation of the Sisters of Public Charity in Zagreb
Gundulićeva ul. 12, 10000,Zagreb, Croatia

Vesna Babic
Zagreb University
Horvaćanski zavoj 15. 1000 Zagreb, Croatia

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