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Research article

Dietary fiber intake, physical fitness, and weight status in 14- to 17-year-old adolescents

Klaus Greier[1,*], Clemens Drenowatz[2], Jozef Dudas[3], Cornelia Decristoforo[4], Gerhard Ruedl[1], Martin Burtscher[1] and Maria do Carmo Greier[3]

[1] Department of Sports Science, University of Innsbruck, Innsbruck 6020, Austria
[2] Division of Sport, Physical Activity and Health, University of Education Upper Austria, Linz 4020, Austria
[3] Department of Otorhinolaryngology, Head and Neck Surgery, Medical University of Innsbruck, Innsbruck 6020, Austria
[4] Department of Pediatrics I, Medical University of Innsbruck, Innsbruck 6020, Austria

* **Correspondence:** Email: nikolaus.greier@uibk.ac.at; Tel: +4351250745851.

Abstract: *Background:* Physical fitness, nutrition, and body weight are important health factors. However, in recent decades, obesity, an unhealthy diet, and declining physical fitness among adolescents have increased. Therefore, the aim of this study was to investigate the relationship between physical fitness and body weight with diet in Austrian adolescents. *Methods:* A total of 410 (54.6% female) adolescents between 14 and 17 of age completed four test items (push-ups, sit-ups, standing long jump, and a 6-minute run) from the German Motor Skills Test (DMT 6–18), which measured cardiorespiratory and muscular endurance as well as muscular power. Body height and body weight were measured and the 18-point questionnaire Fiber-Screen was used to determine the daily fiber intake. *Results:* The average daily fiber intake of the participants was 14.5 ± 6.0 g/day. Spearman correlation analyses showed a significant inverse association between body weight and fiber consumption (rho = −0.198; $p < 0.001$), while high physical fitness positively correlated with fiber intake (rho = 0.304; $p < 0.001$). Non-overweight participants mainly obtained their fiber from fruits, vegetables, and legumes, while overweight/obese students consumed more potatoes and white bread. *Conclusions:* A higher body weight and a lower physical fitness are associated with a low fiber intake in adolescents. The results suggest that not only the amount but also the quality of the fiber sources is associated with weight status and physical fitness.

Keywords: students; motor performance; overweight and obese; nutrition; health

1. Introduction

Against the background of a salutogenetic understanding of health, physical fitness and a balanced diet are understood as important health resources. In line with this, numerous studies support the importance of these behavioral factors in the context of prevention [1–7]. However, diet, physical fitness, and the activity behavior of large population groups have dramatically changed in recent decades in almost all industrialized nations and is increasingly characterized by a lack of exercise, declining performances, and unhealthy diets [8–13]. These factors are often accompanied by an increase in the prevalence of overweightness and obesity [14–16]. Although the prevalence of overweightness among children and adolescents shows a stagnating regional trend according to some studies [17,18], there has been a continuous increase in global overweightness and obesity over the last two decades [19,20], which is often accompanied by a variety of health risks, including metabolic and cardiovascular diseases, as well as psychosocial stress [21,22].

In addition, obesity in childhood and adolescence increases the likelihood of persistent overweightness in adulthood, which is associated with an increased risk of various non-communicable diseases [23,24]. The development of obesity in adolescents is understood as a multifactorial process in which various lifestyle factors are important [25–27]. In addition to genetic factors, exercise, nutritional behaviors, and physical fitness play important roles in this context [28,29]. For example, studies show that overweightness and obesity in childhood and adolescence are often associated with reduced physical fitness, especially in areas of coordination and endurance [11,30,31]. Accordingly, data from the European Youth Heart Survey (EYHS) further showed that children and adolescents with high cardiorespiratory fitnesses had significantly lower total body fat percentages [32]. Furthermore, a British study of 16- to 18-year-old boys found that well-developed muscular fitness (muscle strength) has a positive effect on bone health (e.g., bone mineral density) [33]. Among adults, cardiorespiratory fitness has also been shown to be a more reliable predictor of mortality risk compared to many other risk factors [34]. Taken together, these findings emphasize the importance of age-appropriate, well-developed physical fitness for health and well-being.

On the other hand, low physical fitness can be both a consequence and a potential amplifier of overweightness or obesity. In addition to these factors, nutritional behavior also plays a central role; in particular, the intake of sufficient fiber is associated with various positive health effects [35–38]. Dietary fiber includes indigestible food components of plant origins, which are found in whole grain products, fruits, vegetables, and legumes, among other foods. They contribute to the regulation of the energy balance, promote a longer feeling of satiety, and can have positive effects on glucose and fat metabolism [39]. Additionally, fiber acts as a prebiotic and serves as a primary source of energy for many beneficial bacteria in the gut microbiome, which acts as a central regulator of digestive function, immune defense, and metabolism [40]. Therefore, fiber is not only a passive component of the diet, but also a modulator of human health. Empirical data also suggest that an increased fiber intake is associated with a lower risk of weight gain and obesity [41,42]. In addition, a meta-analysis showed that the intake of sufficient fiber caused a significant reduction in body weight in overweight or obese adults [43]. Despite these proven health benefits, the average fiber intake for much of the population is well below the recommended levels of 25–30 g per day [39,44,45].

Although the importance of motor performance and nutrition for healthy development in adolescence has been proven in numerous studies [46,47], these factors have often been separately examined. Scientific research on the connection between a high-fiber diet and physical fitness is currently limited and has not yet been comprehensively reviewed [48,49]. However, an integrated approach that takes both physical fitness and specific nutritional factors such as fiber intake into account could provide a better understanding of the determinants of overweightness and obesity in adolescence. Especially in the school context, in which both the promotion of physical fitness and nutrition education are central components of health-promoting measures, a deeper understanding of these relationships is of great relevance. Against this background, the present study aims to investigate the association of fiber intake, physical fitness, and overweightness/obesity in adolescents. A better understanding of the interaction of these contributors to health can help to develop evidence-based prevention and intervention strategies to promote the health of children and adolescents.

2. Materials and methods

The present study is a cross-sectional study that was carried out in the 2024/25 school year in the federal state of Tyrol (Austria). As Tyrol is one of the economically strongest regions in the European Union, the population has access to good health care and enjoys a high life expectancy.

Five schools were randomly selected from a total of 28 high schools (AHS) in Tyrol. These schools were contacted and asked to participate in the study, resulting in 410 eligible participants between 14 and 17 years of age. The inclusion criteria were the lack of cognitive, physical, or motor impairments. The study was approved by the school principals as well as the Review Board of the University of Innsbruck (Certificate of Good Standing, 18/2025). Parental consent was obtained prior to data collection and all study procedures met the ethical standards of the 2008 Declaration of Helsinki.

The questionnaire survey and the sports motor tests took place between May and June 2025 during regular school hours in the schools' gymnasium. First, body height and body weight were measured in sportswear without shoes (barefoot). Body height was measured with an accuracy of 0.1 cm using a mobile stadiometer (SECA® 217, Seca, Hamburg, Germany) and the body weight measurement was carried out with an accuracy of 0.1 kg using a calibrated electronic scale (SECA® 803, Seca, Hamburg, Germany). Based on these values, five weight groups were calculated according to the German (body mass index) BMI reference system [50]. Specifically, adolescents were considered to be of normal weight if their BMI was between the 10th and 90th percentile. Adolescents with values below the 3rd percentile were classified as anorexic, those between the 3rd and below the 10th percentile were classified as underweight. If the BMI was between the 90th and 97th percentile, adolescents are considered overweight, and values above the 97th percentile indicated obesity.

Due to the low number of cases of anorexia, underweight, and obesity, two groups, namely non-overweight (anorexic, underweight and normal weight) and overweight (overweight and obese), were formed. Following the anthropometric measurements, the participants completed the German Motor Skills Test (DMT 6–18), which has been validated for children and adolescents aged 6 to 18 years [48]. Specifically, push-ups, sit-ups, standing long jump, and a 6-minute run were used to measure muscular endurance, muscular power, and cardiorespiratory endurance. Raw performance scores were converted into age- and gender-normalized values (Z-values), with the average of all Z-values serving as an indicator of overall fitness. According to Bös et al. [51], the test results were classified into five performance categories: C1 = well below average (Z-values < 93); C2 = below average (Z-values 93

to <98); C3 = average (Z-values 98 to <103); C4 = above average (Z-values 103 to <109); and C5 = well above average (Z-values ≥ 109).

The dietary fiber intake of the adolescents was assessed using the validated 18-point questionnaire Fiber-Screen according to Rijnaarts et al. [52], which had already been used with Austrian university students [39]. The questionnaire is a validated tool developed in the Netherlands to assess daily fiber intake. The Fiber-Screen covers a wide range of high-fiber food categories, including whole grains, fruits, vegetables, legumes, nuts, and seeds. Both the frequency of consumption (e.g., how many days per week food is usually eaten) and the average amount consumed per day (e.g., number of servings, tablespoons, etc.) were collected. To estimate fiber intake, the participant's responses were converted into daily fiber intake (in grams) using an evaluation algorithm, namely multiplying the reported frequency and amount by specific fiber content factors assigned to each food category [39].

Statistical analyses: Descriptive statistics are presented as means with standard deviations (SD) for continuous variables and prevalence rates for categorical variables. Frequency differences were examined using chi-square tests. Due to the lack of normal distribution, nonparametric tests and Spearman correlation analyses were used to investigate differences or relationships between the values of daily fiber intake, physical fitness, and weight status. Group comparisons (fitness quintiles) were performed using the Kruskal Wallis test for independent samples with a Bonferroni correction. In addition, a linear multiple regression was performed to evaluate the association of daily fiber intake with physical fitness and weight status. The dependent variable was fiber intake/day and the independent variables were BMI-Percentile and physical fitness. All statistical analyses were performed for the whole sample as well as separately for boys and girls using SPSS 30.0 (IBM, Armonk, NY, USA), with statistical significance set at $p < 0.05$. The figures and tables were graphically displayed using GraphPad Prism 10 (GraphPad Software, San Diego, CA, USA).

3. Results

A total of 410 adolescents (54.6% female) with an average age of 15.7 ± 0.9 years provided complete data. There was no significant difference in age between girls and boys ($p > 0.05$). However, boys were taller and heavier and had a higher BMI percentile (Table 1). The proportion of overweight/obese adolescents was 11.7%, with no significant sex difference.

The mean Z scores for overall fitness and standing long jump of the entire sample indicate the average fitness scores. The mean for push-ups was above average, while the mean for the 6-minute run and sit-ups was below average. The male students performed significantly better than their female peers in the push-up and long jump tests, while the girls achieved significantly higher scores in the 6-minute run. There was no significant sex-difference for sit-ups (Table 1).

3.1. Fiber intake

Overall, the average daily fiber intake was 14.49 ± 6.01 g/day, and there was no difference between male (14.41 ± 6.24 g/day) and female (14.56 ± 5.83 g/day) adolescents ($p = 0.348$; Figure 1A). The data further show that 92.9% (n = 381) of adolescents consumed less than 25 g of fiber per day, and only 7.1% (n = 29) met the minimum recommended intake of ≥25 g of fiber per day (Figure 1B). 93.8% of girls (n = 210) and 91.9% of boys (n = 171) did not meet the current fiber intake recommendations.

Table 1. Anthropometric characteristics and physical fitness for the total sample and separately for girls and boys. Values are means with SD.

	Total sample (N = 410)	Girls (N =224)	Boys (N = 186)
Age (years)	15.72 ± 0.97	15.64 ± 0.91	15.82 ± 01.03
Body height (cm)**	170.04 ± 9.19	164.79 ± 5.97	177.18 ± 07.07
Body weight (kg)**	61.87 ± 10.73	57.86 ± 08.94	66.68 ± 10.76
BMI percentile *	51.9 ± 26.29	49.5 ± 27.70	54.8 ± 24.24
Push ups (Z)**	106.63 ± 13.08	105.59 ± 11.87	107.88 ± 14.34
Sit ups (Z)	91.91 ± 10.15	91.24 ± 10.21	92.72 ± 10.03
Longjump (Z)*	102.22 ± 10.97	101.03 ± 11.07	103. 66 ± 10.70
6 min run (Z)*	96.40 ± 10.47	97.93 ± 11.06	94.55 ± 9.41
Total fitness (Z)*	99.49 ± 8.27	98.94 ± 8.86	100.16 ± 7.47

Note: *significant sex difference at $p \leq 0.05$; **significant sex difference at $p \leq 0.01$.

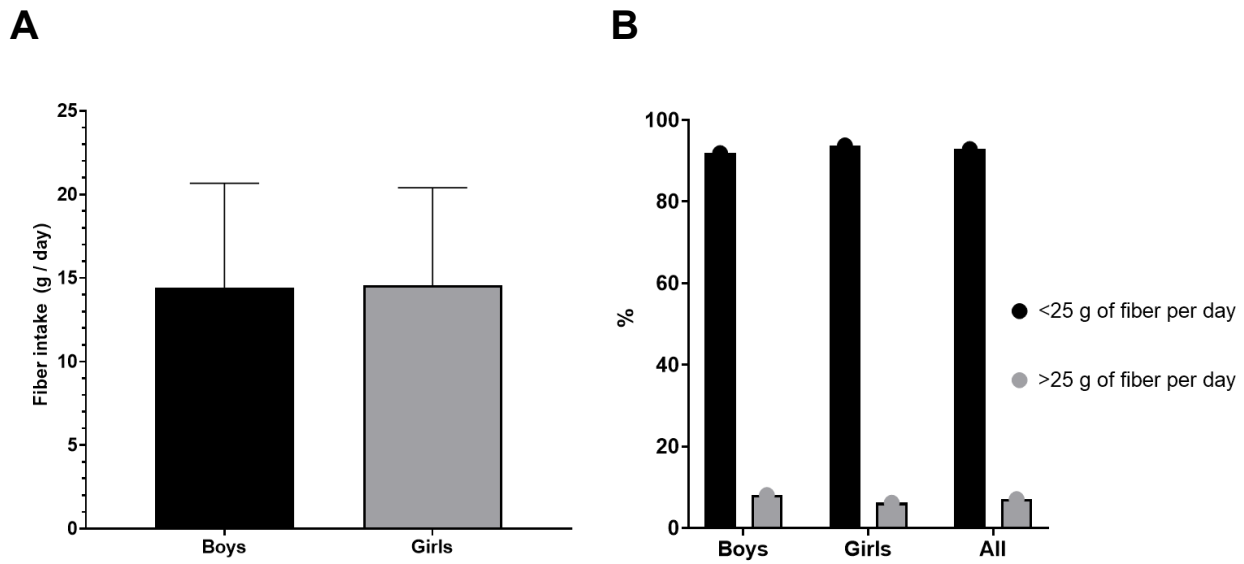


Figure 1. (A) Mean daily fiber intakes of boys and girls (p = 0.348; error bars: SD); (B) Daily fiber intake in categories <25 g/day vs. >25 g/day.

Most adolescents consumed their dietary fiber from vegetables (2.39 ± 1.18 g), followed by legumes (1.71 ± 2.03 g), fruits (1.36 ± 1.01 g), and potatoes (1.35 ± 0.87 g). The lowest fiber intake was achieved by muesli bars (0.22 ± 0.35 g) and dried fruits (0.20 ± 0.24 g). Examining specific foods, it was shown that girls consumed significantly more fiber from dried fruits, vegetables, and legumes than boys, while the fiber intake from white bread was significantly higher in boys than in girls (Figure 2). The main sources of fiber in girls were vegetables (2.52 ± 1.24 g), legumes (1.97 ± 2.26 g), and fruits (1.43 ± 0.97 g), and in boys were vegetables (2.23 ± 1.10 g), legumes (1.40 ± 1.67 g), and potatoes (1.37 ± 0.85 g).

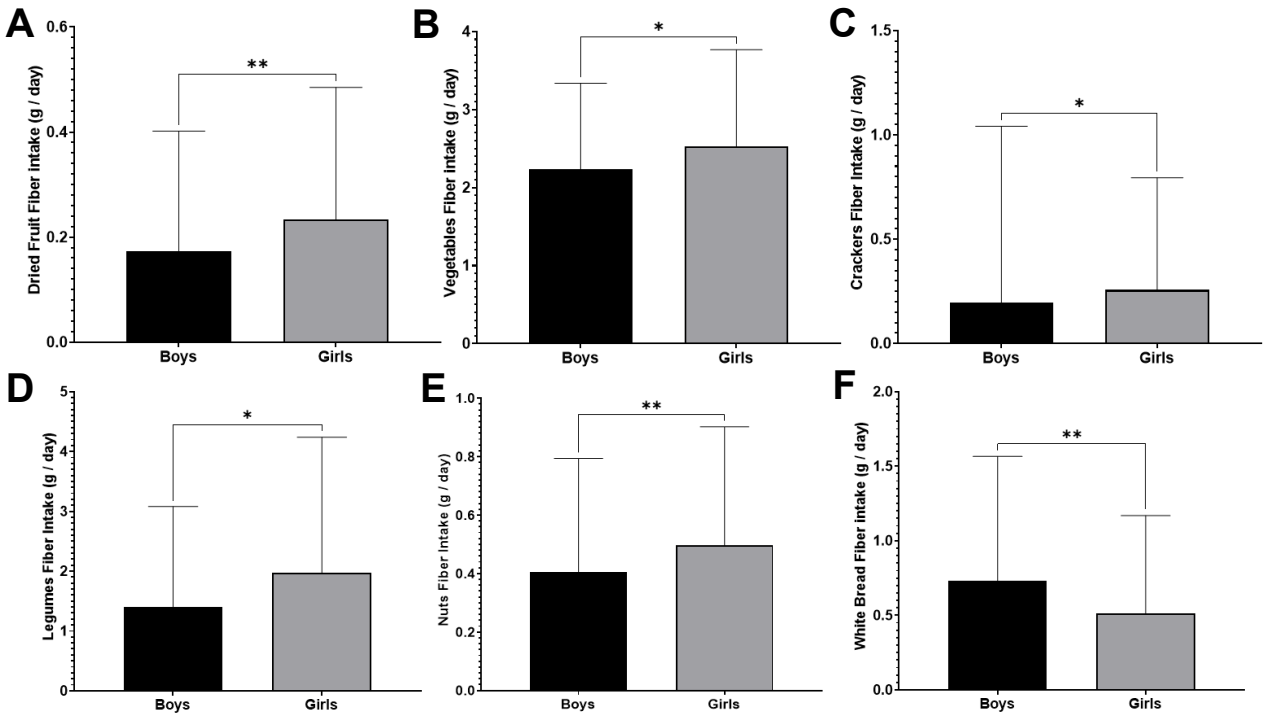


Figure 2. Fiber intake differences between boys and girls sourcing from dried fruit (A), vegetables (B), crackers (C), legumes (D), nuts (E), and white bread (F). In all cases: boys N = 186; girls N = 224.

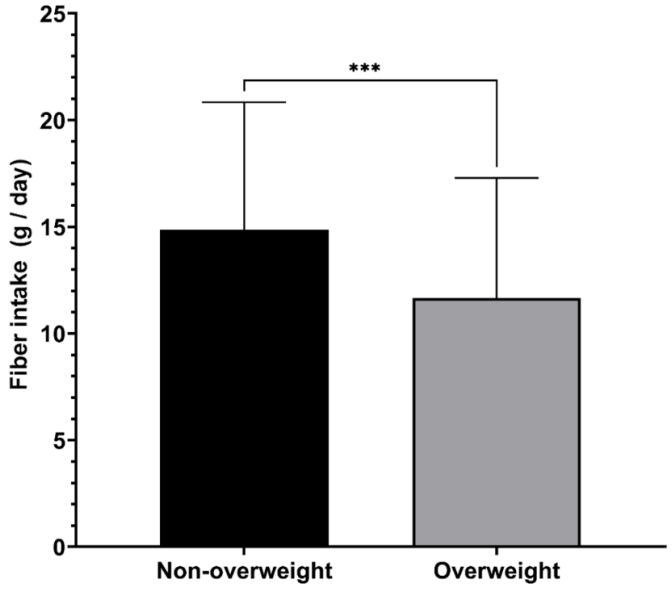


Figure 3. Mean fiber intakes (g/day) of non-overweight and overweight/obese participants (Error bars: SD; *** $p < 0.001$).

3.2. Fiber intake and weight status

The overweight/obese participants consumed significantly less fiber (11.67 ± 5.61 g/day) than their non-overweight peers (14.87 ± 5.97 g/day; $p < 0.001$) (Figure 3). Sex-specific analyses also showed that non-overweight boys and girls (boys: 14.62 ± 6.15g/d; girls: 15.08 ± 5.82g/d) consumed significantly more fiber than overweight/obese boys (12.78 ± 6.89g; $p \leq 0.05$) and girls (10.81 ± 4.32g; $p < 0.01$). These results suggest that the negative association between weight status and fiber intake was consistent within each sex group. In addition, correlation analyses between the BMI-Percentile and the daily fiber intake showed a significant inverse relationship in the overall sample (Spearman's rho = −0232; $p < 0.001$), as well as in girls (Spearman's rho = −0.269; $p < 0.001$) and boys (Spearman's rho = −0.168; $p = 0.022$).

Subgroup analyses between the weight groups on the fiber quality showed clear patterns. The non-overweight participants consumed significantly more fiber from the food groups fruits, dried fruits, vegetables, wholegrain bread, and legumes than those with overweightness/obesity ($p < 0.05$). On the other hand, overweightness/obesity was associated with a higher fiber intake from white bread ($p < 0.05$) (Table 2).

Table 2. Fiber intake for the total sample and separately for non-overweight and overweight/obese. Values are mean with SD.

Fiber intake from	Total sample (N = 410)	Non overweight (N = 362)	Overweight/obese (N = 48)
Fruits (g/d)*	1.36 ± 1.01	1.40 ± 1.02	1.09 ± 0.87
Dried fruits (g/d)*	0.20 ± 0.24	0.21 ± 0.23	0.17 ± 0.27
Brown bread (g/d)	0.84 ± 1.19	0.86 ± 1.22	0.67 ± 0.89
Wholegrain bread (g/d)*	0.82 ± 1.16	0.86 ± 1.19	0.52 ± 0.84
White bread (g/d)*	0.61 ± 0.74	0.57 ± 0.71	0.87 ± 0.95
Vegetables (g/d)*	2.39 ± 1.18	2.44 ± 1.20	2.00 ± 1.01
Legumes (g/d)**	1.71 ± 2.03	1.89 ± 2.00	0.36 ± 0.97
Wholegrain pasta (g/d)*	0.68 ± 1.00	0.71 ± 1.01	0.45 ± 0.90
White pasta (g/d)	0.73 ± 0.43	0.72 ± 0.43	0.75 ± 0.47
Potatoes (g/d)	1.35 ± 0.87	1.36 ± 0.87	1.30 ± 0.88
Cereal (g/d)	1.17 ± 1.34	1.20 ± 1.32	0.97 ± 1.51
Nuts (g/d)	0.45 ± 0.39	0.46 ± 0.39	0.39 ± 0.45
Crackers (g/d)	0.23 ± 0.69	0.24 ± 0.72	0.14 ± 0.31
Bran (g/d)	0.99 ± 2.00	0.98 ± 2.04	1.01 ± 1.88
Muesli bars (g/d)	0.22 ± 0.35	0.23 ± 0.37	0.13 ± 0.22
Total fiber (g/d)**	14.49 ± 6.01	14.87 ± 5.97	11.67 ± 5.61

Note: * significant sex difference at $p < 0.05$; ** significant sex difference at $p < 0.01$.

3.3. Fiber intake and physical fitness

Analyzing the results of the fitness test, it was shown that the average amount of daily fiber intake increases with an increasing performance. For example, a significant difference in daily fiber intake

between the lowest and highest physical fitness category was found in the overall sample and sex-specific analyses (Table 3).

Table 3. Mean daily fiber intake (g/day) depending on physical fitness for the total sample and separately for girls and boys. Values are mean with SD along with [median].

Physical fitness categories	C1 N = 80	C2 N = 94	C3 N = 82	C4 N = 87	C5 N = 67
Total sample ** a,b,c,d,e,f fiber intake (g/day)	11.74 ± 4.96 [11.11]	14.19 ± 6.05 [13.29]	14.24 ± 5.25 [13.54]	15.19 ± 5.83 [13.90]	17.58 ± 6.71 [16.41]
Girls ** a,b,c,d,e fiber intake (g/day)	11.44 ± 5.28 [10.32]	14.09 ± 5.16 [14.27]	14.67 ± 4.76 [14.19]	15.99 ± 5.83 [14.77]	17.97 ± 6.40 [16.78]
Boys * d fiber intake (g/day)	12.26 ± 4.39 [11.68]	14.50 ± 7.38 [12.48]	13.76 ± 5.68 [12.31]	14.61 ± 5.82 [13.45]	17.07 ± 7.17 [15.29]

Note: * $p \leq 0.05$; ** $p \leq 0.01$. Category: C1 = Well below average; C2 = Below average; C3 = Average; C4 = Above average; C5 = Well above average; a (C1–C2; $p \leq 0.05$); b (C1–C3; $p \leq 0.05$); (C1–C4; $p \leq 0.01$); d (C1–C5; $p \leq 0.01$); e (C2–C5; $p \leq 0.05$); f (C3–C5; $p \leq 0.05$).

Correlation analyses between physical fitness and daily fiber intake further showed a significant positive association (Spearman's rho = 0.304; $p < 0.001$). In particular, fruits, vegetables, nuts, whole grain products, and muesli bars showed significant positive associations with physical fitness, with the associations being stronger in girls than in boys (Table 4).

Table 4. Association between physical fitness and Fiber intake from various foods for the total sample and separately for boys and girls. Values are Spearman rho.

	Physical fitness		
Fiber intake from	Total sample	Girls	Boys
Fruits (g/d)	0.217**	0.277**	0.167*
Dried fruits (g/d)	0.130**	0.136*	0.167*
Brown bread (g/d)	0.091	0.062	0.102
Wholegrain bread (g/d)	0.147**	0.217**	0.061
White bread (g/d)	−0.028	−0.081	0.003
Vegetables (g/d)	0.226**	0.326**	0.104
Legumes (g/d)	0.147**	0.233**	0.054
Wholegrain pasta (g/d)	0.161**	0.150*	0.197*
White pasta (g/d)	−0.024	−0.014	−0.058
Potatoes (g/d)	0.018	0.106	−0.093
Cereal (g/d)	0.149**	0.210**	0.087
Nuts (g/d)	0.248**	0.255**	0.280**
Crackers (g/d)	0.090	0.119	0.085
Bran (g/d)	0.031	0.086	−0.015
Muesli bars (g/d)	0.193**	0.199**	0.170*

3.4. Association of Fiber intake and physical fitness with body weight

The multiple linear regression analysis also revealed significant associations of physical fitness and BMI Percentile with fiber intake/d, both variables explaining 10.5% of the variability in fiber intake. Specifically, a higher fiber intake was associated with higher physical fitness and a lower BMI-Percentile. The results were comparable in girls, while among boys, only fitness was significantly associated with fiber intake and the explanatory value of the regression model dropped to 5% (Table 5).

Table 5. Results of the multiple linear regression analysis with the dependent variable "Fiber intake/d" for the total sample and separately for girls and boys.

Variable	*ß*	*p*	R^2
Total sample			0.105
Fitness (Z total)	0.266	<0.001	
BMI percentile	−0.134	0.005	
Girls			0.166
Fitness (Z total)	0.319	<0.001	
BMI percentile	−0.181	0.005	
Boys			0.048
Fitness (Z total)	0.197	0.008	
BMI percentile	−0.068	0.356	

Note: *ß:* standardized regression coefficient; *p* values in bold indicate significant coefficients.

4. Discussion

The aim of this cross-sectional study was to determine the daily fiber intake of 14- to 17-year-old students and to investigate its relationship with physical fitness and weight status. The data is based on a survey of 410 adolescents from five high schools in Tyrol (Austria).

4.1. Fiber intake in 14- to 17-year-old students

A key finding of the study was the low average fiber intake of the participating students at 14.5 g/day. These amounts of fiber are well below the 25–30 g/day recommended by international institutions [44,45]. Only 7% of the participants reached the recommended minimum amount. These data are in line with the results of another study in Austrian College students [39]. Possible reasons for the low fiber intake are a high consumption of ultra-processed foods, sweetened beverages, and refined carbohydrates [36,53,54]. Since the low fiber consumption could be observed in both girls and boys, it can be assumed that this is a cross-sex phenomenon, which has also been shown in several international studies [45,55].

When assessing fiber intake, the quality of the food is a decisive factor in addition to the quantity. The present study showed that fiber was mainly supplied through vegetables, legumes, fruit, potatoes, and bread, but girls consumed significantly more fruit, vegetables, and legumes than boys. On the other hand, in male students, a higher consumption of potatoes and bread could be observed. These sex

differences in the consumption of certain food groups have also been observed in other studies [55,56], which could indicate possible trends in adolescent dietary habits.

4.2. Fiber intake and weight status

Of the participating adolescents, 88.3% (N = 363) were considered non-overweight and 11.7% (N = 48) were classified as overweight/obese based on the German BMI-reference system according to Kromeyer-Hauschild et al. [50]. The analyses showed that non-overweight participants consumed significantly more fiber than overweight/obese participants, in both boys and girls. Correlation analyses between the daily fiber intake and the BMI Percentiles showed a significant inverse relationship in the total sample and sex-specific analyses. The results of the present study are in line with other studies that also observed an inverse association between fiber intake and BMI [39,42,57]. Additionally, a meta-analysis that included 185 prospective studies showed that individuals with a higher dietary fiber intake had significantly lower body weights and lower systolic blood pressures than those with a low dietary fiber intake [58]. Although the absolute difference in fiber intake between the two weight-categories was small at 3.2 g/day, this could still be an indicator of overall diet quality. It can be assumed that higher fiber consumption likely reflects a healthier dietary pattern, which is reflected by a higher consumption of vegetables, fruits, and whole grains. In this study, non-overweight students consumed significantly more fiber from the food groups fruits, vegetables, wholegrain bread, and legumes than students who were considered to be overweight/obese ($p < 0.05$). Similar dietary patterns have been observed in other international studies [39,59]. In addition, an increased fiber intake has been shown to positively affect weight management via reducing the risk of fat gain [60] and supporting weight loss [61].

4.3. Fiber intake and physical fitness

Looking at the overall fitness according to the criteria of Bös et al. [51], it was shown that 42% (N = 174) of the participating adolescents had a physical fitness below the age- and sex-adjusted average values and thus showed poor performance. When considering the four test items individually, boys displayed better performances at push-ups (upper extremities/shoulder girdle), sit-ups (core strength), and long jump (explosive strength of the lower extremities) tests than the girls. These data are consistent with recent studies of 16- to 18-year-old Polish adolescents [62] and Italian middle school students [63]. Moreover, these studies reported better cardiorespiratory endurance in boys, which was not confirmed in the present study, as girls achieved significantly higher scores than the boys in the 6-minute run. However, it should be considered that in the present study, both boys and girls displayed below average performances on the 6-minute run based on the criteria of Bös et al. [51], which is particularly concerning, as cardiorespiratory fitness, in particular, has been shown to be an important indicator of health and well-being [34,52,64].

Higher physical fitness was also associated with a higher average amount of daily fiber intake. Thus, both in the overall sample and within the sexes, a highly significant difference in daily fiber intake was found between the lowest and highest physical fitness category. A correlation analysis between physical fitness and total daily fiber intake showed a significant, medium positive association (Spearman's rho = 0.296; $p < 0.001$). Regression analyses further showed that physical fitness is associated with fiber intake independent of body weight.

In addition, studies have shown that limited physical fitness often promotes overweightness and obesity and can thus trigger a vicious circle [65,66]. This is significant because maintaining sufficient physical fitness in childhood and adolescence is considered essential for sustainable health [30], especially since a low fitness level often persists into adulthood [67] and can thus negatively affect physical activity later in life [68].

4.4. Future recommendations

The current results show that a large proportion of adolescents do not consume enough fiber and that an increased BMI percentile and low physical fitness are associated with low fiber intake. However, not only is the amount of fiber important, but also the type of food from which it comes and the frequency of its consumption. In addition, considering broader dietary patterns, including consumption of ultra-processed foods, sweets, and soft drinks, is important to consider along with their combined effect on weight retention and performance [39].

Although nutritional behavior can play an important role in physical fitness and the development of obesity in adolescents, it must be pointed out that these are multifactorial processes in which various lifestyle factors are important [26,27]. In addition to nutritional behavior, genetic factors, socio-demographic characteristics, and leisurely behaviors (e.g. active vs. passive) play an important role [16,29]. In line with other studies, the present results confirmed that overweight and obese adolescents have low physical fitness [69–71]. Therefore, in addition to nutrition, physical fitness plays an important role in the prevention of overweightness and obesity in children and adolescents. Thus, the connections between specific dietary patterns, physical fitness, and body weight increasingly illustrate the close link between these important health factors.

Against this backdrop, the data collected on physical fitness must be critically evaluated, as more than 40% of the adolescents achieved below-average performance scores. Of particular concern are the below-average performance scores in the assessments of core strength (sit-ups) and aerobic endurance (6-minute run). The poor performance may be attributed to the lifestyle of young people, which is characterized by high amounts of sedentary behaviors, such as heavy media use [31,72].

These data underline the need for early and sufficient exercise opportunities and comprehensive nutrition education. The school setting is ideal for this. For example, school-based interventions in close cooperation with parents, school doctors, and sports clubs can effectively intervene in the prevention of lack of exercise, nutritional errors, and obesity in children and adolescents [73,74]. Projects such as “Creating a healthy snack”, more exercise units in everyday school life through “active breaks”, and additional sports lessons [75–77] could have positive and lasting effects on a healthy lifestyle at an early school age.

However, some limitations of the present study should be considered when interpreting the results. Due to the cross-sectional nature of the study, no causal relationships can be established. Despite the use of a validated and detailed questionnaire on fiber intake, possible measurement errors due to recall bias or social desirability cannot be ruled out. For example, the students surveyed might forget what they ate or might report different eating habits than they actually have. Although the 18-item “FiberScreen” questionnaire is a quick and validated tool to estimate dietary fiber intake, it does not provide a complete picture of a person’s diet. It does not account for total calorie intake or other nutrients that could influence body weight or physical fitness, such as the intake of fat, sugar, or protein. Other factors that could influence the results—such as family environment, physical activity, sleep, or

stress—were also not measured. Therefore, the observed associations between dietary fiber intake, physical fitness, and BMI should be interpreted as correlations rather than causal relationships.

In addition, this study was limited to a few schools in one province in Austria, so that the sample is not fully representative of all young people in Austria. The large sample size with more than 400 subjects, the use of the validated Fiber Screen questionnaire, the objective assessment of body weight and height, and the assessment of physical fitness using a validated and commonly implemented test procedure (DMT 6–18) are significant strengths of this study.

5. Conclusions

The results highlight a significant deficiency in the fiber intake of adolescents and show a connection between fiber intake, physical fitness, and weight status. While physically fit students consumed more fiber than physically less fit students, a significant inverse relationship was found between body weight and daily fiber intake. These results are aligned with existing findings and support the recommendation to promote exercise and healthy nutritional behavior of adolescents with fiber as a central component of a healthy diet. As many adolescents exhibit unhealthy behaviors, continuous monitoring of physical fitness, dietary habits, and body composition is needed in order to develop appropriate preventive measures for future health and well-being.

Use of AI tools declaration

The authors declare they have not used Artificial Intelligence (AI) tools in the creation of this article.

Authors' contributions

Conceptualization, K.G. and MC.G.; methodology, K.G. Cl.D. and J.D.; formal analysis, K.G., M.B. and Cl.D; writing - original draft preparation, K.G.; writing - review and editing, MC.G., M.B., Co.D., G.R., Cl.D and J.D.; project administration, K.G., G.R. Co.D. All authors have read and agreed to the published version of the manuscript.

Conflict of interest

Klaus Greier is a guest editor for special issue of AIMS Public Health and was not involved in the editorial review or the decision to publish this article. Clemens Drenowatz and Martin Burtscher are editorial board members for AIMS Public Health and were not involved in the editorial review or the decision to publish this article. All authors declare that there are no competing interests.

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