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Eating Patterns of Elite Adolescent Athletes: Results of a Cross-Sectional Study of 51 Olympic Sports

Ernährung von jugendlichen Leistungssportlern: Ergebnisse einer Querschnittsstudie von 51 olympischen Sportarten

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ZUSAMMENFASSUNG

Problemstellung: Das Betreiben von Leistungssport kann den Energie- und Nährstoffbedarf von Jugendlichen erhöhen. Daher ist es wichtig, mehr über die tägliche Ernährung jugendlicher Leistungssportler zu erfahren, um diese bei einer individuellen, sportlergerechten Ernährung zu unterstützen. Methoden: Basierend auf Daten zu deutschen Nachwuchsleistungssportlern aus 51 olympischen Sportarten (GOAL Study; n = 1,138, 56,1 % männlich; MW = 16,33 Jahre) wurden Zusammenhänge zwischen dem täglichen Konsum bestimmter Lebensmittel und den Charakteristika der Athleten berechnet. Zusätzlich wurde die tägliche Ernährung der jugendlichen Leistungssportler mit der täglichen Ernährung von jugendlichen Nicht-Leistungssportlern verglichen. Ergebnisse: Es ergab sich, dass sowohl sport- als auch ernährungsspezifische Variablen (z.B. Erhalt von Informationen von einem Ernährungsberater, Vorliegen eines Ernährungsplans, Ort der Nahrungsaufnahme) mit der täglichen Ernährung in Verbindung stehen. Verglichen mit Nicht-Leistungssportlern zeigten Leistungssportler einen signifikant höheren Anteil an täglichen Konsumenten von vitamin- und ballaststoffreichen Lebensmitteln (47,9 % vs. 43,2 %), tierischen Produkten (27,7 % vs. 19,6 %) und Süßigkeiten (19,6 % vs. 1,0 %). Diskussion: Da lediglich ein Viertel der Leistungssportler Informationen von einem Ernährungsberater erhält, Ernährungsberatung und -schulung jedoch als wichtiges Korrelat für die Wahl gesunder Lebensmittel identifiziert werden konnten, ist das Anbieten von Informationen zur Ernährung äußerst wichtig. Diese Angebote sollten insbesondere Athleten in niedrigeren Kaderstufen zugänglich gemacht werden. Aber auch Eltern sollten zunehmend bezüglich einer sportlergerechten Ernährung aufgeklärt werden.

Schlüsselwörter: Leistungssport, Gesundheitsverhalten, Food Frequency, physische Aktivität, Essverhalten.

SUMMARY

Purpose: Performance of elite sports can increase adolescents' energy and nutritional requirements. Therefore, the knowledge of daily eating habits is important to adequately support elite adolescent athletes in their nutrition. Methods: Based on data of German elite adolescent athletes in 51 Olympic sports (GOAL Study; n=1,138, 56.1% male; mean=16.33 years), we analyzed associations between the daily consumption of foods and athletes' characteristics. In addition, we compared the daily food consumption of elite athletes with that of non-elite athletes. Results: We found types of sport and nutrition-specific variables (e.g., getting information from nutritionists, having a nutrition plan, place of food intake) to be correlated with daily food intake. Compared to non-elite athletes, elite athletes had a significantly higher daily consumption of vitamin and fiber-rich products (47.9% vs. 43.2%), animal products (27.7% vs. 19.6%) and sweets (19.6% vs. 1.0%). Discussion: As only a quarter of the elite athletes were found to have gotten information from a nutritionist, and since nutritional education and counseling were shown to be important for healthy food choices in this group, offering information and education is absolutely essential. This applies especially for athletes in lower squads. However, their parents and coaches should also be educated in terms of nutrition.

Key Words: Professional sports, health behavior, food frequency, physical activity, eating behavior.

INTRODUCTION

Adequate food intake is important for the physical and mental development of children and adolescents. With the onset of puberty, young people experience a wide range of physiological, psychosocial and cognitive changes (21). Poor nutrition during this crucial stage of development can have long-term health consequences (25) and may lead to chronic diseases such as coronary heart diseases, osteoporosis and type 2 diabetes later in life (5,9). Moreover, an adequate nutrition during adolescence may determine future eating habits because eating practices being established during this period can be carried forward into adulthood (12).

Especially for youths who are engaged in elite sports, sport-adequate nutrition is essential to stay healthy and to be successful in their sports (2,6,15). Total nutrient needs are higher during adolescence anyway (4,6) and performing elite sports can further increase energy and nutritional requirements (6,10) because training

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	Proportion of the sample (in %)	Products high in vitamin and fiber [Factor 1] (in %)	p-value	Animal products [Factor 3] (in %)	p-value
		47.8		29.6	
Biological variables					
Sex			< .001		< .001
Male	56.1	40.9		36.1	
Female	43.9	56.6		21.4	
BMI					.029
Severe underweight	0.5			0.0	
Underweight	2.6			27.6	
Normal weight	90.5			28.7	
Overweight	5.5			43.5	
Obesity	0.9			50.0	
Sociodemographic variables					
School (attending or finished)			< .001		
Secondary General School	2.1	34.8			
Comprehensive Schools	10.9	39.8			
Intermediate Secondary School	16.6	37.8			
Grammar Schools	70.4	52.4			
Boarding school					.031
Yes	24.4			34.7	
No	75.6			27.8	

Table 1: Daily consumption of different food groups and biological and sociodemographic characteristics of elite adolescent athletes (n = 1,138).

Legend: Classification of food groups is based on preliminary considerations and factor analysis; p-values describe the significance of the statistical connection between the daily consumption of the food groups and the independent variables; only significant results are reported.

and competition are demanding for the athletes. A sport-specific diet helps to optimize energy production, control, and efficiency (7,11,26).

The knowledge of daily eating habits is therefore essential for an adequate support of elite adolescent athletes. Up to now, the current state of research in this field is lacking comprehensive results in terms of eating behavior. Although there do exist analyses concerning the nutrition and dieting behavior of adolescent athletes, they focus mainly on individual types of sports using smaller sample sizes (26) or on recreational athletes (23). With our study of elite adolescent athletes from 51 Olympic sports, it was possible to describe eating habits in the unique group of elite adolescent athletes using a wide range of individual sport-specific and nutrition-specific variables. In a second step, we compared the data of elite adolescent athletes with that from a sample of adolescent non-elite athletes to identify potential differences in their daily food intake.

METHODS

We used the quantitative data of the cross-sectional GOAL Study (German Young Olympic Athletes' Lifestyle and Health Management Study), which was initiated, coordinated, and investigated by the authors. Approval of the ethics committee of the Medical Faculty of Tübingen was obtained (222/2009BO1). All individuals gave their informed consent prior to their inclusion in the study.

The GOAL Study is a nationwide study of German elite adolescent athletes, meeting the following criteria: (1) participating in one sport of the Winter Olympics 2010 or the Summer Olympics 2012; (2) competing at the four highest national squads (in Germany A to D/C squad); (3) born between the years 1992 and 1995. Overall, we asked 1,843 athletes from 51 sports to answer a self-administered questionnaire between February 2010 and January 2011. The response rate was 61.75% (n = 1.138; 56.1% male; aged 14-18, mean 16.33). A more detailed description of the study design was recently published elsewhere (24).

We used an established food frequency scale (5-point-scale, "never" to "several times a day") based on the German Health Interview and Examination Survey for Children and Adolescents (KiGGS), a representative survey that included recreational athletes and non-athletes (14). To group these different foods, an explorative factor analysis was conducted. Since it is not recommended to use ordinal variables with unequal distances for factor analyses, and as our main focus lies on the daily nutrition anyway, we recoded them into binary variables ("daily consumption" vs. "non-daily consumption") for the classification of food groups. In accordance with theoretical preliminary considerations based on literature and on the so called food pyramid for athletes (18), the factor analysis resulted in three factors (Kaiser-Meyer-Olkin-Measure = 0.698; Bartlett-Test $p < 0.001$): Factor 1 (labeled as "Products rich in vitamin and fiber"), Factor 2 ("Snacks and sweets"), and Factor 3 ("Animal products"). All analyses of this manuscript are based on these three food groups.

The daily consumption of each food group was defined using the binary food variables. The mean of all foods in one group (Factor 1, Factor 2, and Factor 3) was calculated. If the result was greater

Table 2: Daily consumption of different food groups and sport- and nutrition-specific characteristics of elite adolescent athletes (n = 1,138).

Legend: Classification of food groups is based on preliminary considerations and factor analysis; p-values describe the significance of the statistical connection between the daily consumption of the food groups and the independent variables; only significant results are reported.

	Proportion of the sample (in %)	Products high in vitamin and fiber [Factor 1] (in %)	p-value	Sweets and Snacks [Factor 2] (in %)	p-value
		47.8		14.0	
Sport-specific variables					
Type of sport			.017		
Technical sport	16.2	42.4			
Endurance sport	28.9	55.2			
Aesthetic sport	4.1	45.7			
Weight dependent sport	8.6	37.8			
Ball game	35.9	46.2			
Strength sport	6.3	49.3			
Nutrition-specific variables					
Having a nutrition plan			.002		
Yes	14.0	59.5			
No	86.0	46.0			
Having been on a diet during last year					< .001
Yes	20.5			6.5	
No	79.5			16.0	
Information from nutritionist			.002		
Yes	25.0	55.6			
No	75.0	45.2			

than three (three meaning here "consumption 1 to 6 times a week", four meaning here "consumption at least once a day"), we assumed a daily consumption of the respective food group. Afterwards, associations between the daily consumption of these food groups and different biological, sociodemographic, and sport-specific characteristics of the athletes were calculated conducting bivariate analyses (chi²-tests). We chose the independent variables for these analyses based on previous studies (16,20). Following the classification of Sundgot-Borgen and Larson (1993), we categorized elite athletes in different types of sports, namely technical sports (e.g., horseback riding and alpine skiing), endurance sports (e.g., swimming and cycling), aesthetic sports (e.g., figure skating and rhythmic gymnastics), weight dependent sports (e.g., wrestling and weight lifting), ball games (e.g., tennis and soccer), and power sports (e.g., javelin and shot put). BMI was calculated following Kromeyer-Hauschild et al. (13) which accounts for age and sex. In addition, we took into consideration typical places of food intake (e.g., at school cafeteria), being on a diet during the last year, and having a nutrition plan.

To compare the daily food intake of elite athletes and non-elite athletes of the same age, we conducted a random 1:1-matching by age, sex, and education with data of the KiGGS (14). The KiGGS is the only existing comprehensive, nationwide, and representative study on children and adolescents for Germany. It includes data on 17,641 children and adolescents aged 0 to 17 years. For the subanalyses of this manuscript, 942 pairs could be matched because we had to exclude n = 158 athletes aged 18 and n = 38 athletes without information on education. In addition to chi²-tests, we used conditional logistic regressions for comparison. Daily food intake was defined as consuming a food at least once a day.

All p-values were two-tailed at a predefined level of significance of $p < .05$. The data analysis was conducted using SPSS 20 Statistics (IBM Corporation, Somers, NY 10589, USA) and STATA 10.1 MP2 (StataCorp LP, College Station, TX 77845, USA).

RESULTS

The sample included 1,138 elite adolescent athletes (56.1% male, Table 1) aged 14 to 18 years (mean = 16.33). The athletes performed either ball games (35.9%), endurance sports (28.9%), technical sports (16.2%), weight-dependent sports (8.6%), strength sports (6.3%), or aesthetic sports (4.1%) (22). Overall, 14.0% of the athletes had a nutrition plan, 20.5% had been on a diet during the last year, and 25.0% got information from a nutritionist (Table 2). At least once a month, 48.2% had a meal at the school cafeteria, 54.7% at a snack bar, and 46.4% had a meal on the way (Table 3).

Overall, 61.9% of the athletes ate fresh fruits and 43.9% brown bread at least once a day. Chocolate and other sweets like gummy bears were consumed by 21.8% on a daily basis and 4.8% consumed them several times a day. While 6.4% of the athletes refrained from eating fast food, 1.6% consumed fast food on a daily basis. Among the athletes, 2.2% had never consumed meat in the last weeks (Figure 1).

The daily consumption of products high in vitamin and fiber was significantly higher for females ($p < .001$), while males consumed more often animal products on a daily basis ($p < .001$, Table 1). We found the highest proportion of consumers of vitamin and fiber-rich foods among athletes in endurance sports and the lo-

	Proportion of the sample (in %)	Products high in vitamin and fiber [Factor 1] (in %)	p-value	Sweets and Snacks [Factor 2] (in %)	p-value	Animal products [Factor 3] (in %)	p-value
		47.8		14.0		29.6	
Meals at the school cafeteria							<.001
Several times a day	5.7					52.4	
Daily	16.6					37.0	
1 to 6 times per week	16.8					27.4	
1 to 3 times per month	9.1					21.8	
Never	51.8					26.5	
Meals at a snack bar					<.001		.016
Several times a day	0.2			50.0		50.0	
Daily	0.4			50.0		50.0	
1 to 6 times per week	11.7			22.9		39.7	
1 to 3 times per month	42.4			15.7		30.4	
Never	45.3			9.3		25.3	
Meals on the way			.038		.002		.021
Several times a day	0.0	-		-		-	
Daily	1.8	70.0		20.0		45.0	
1 to 6 times per week	10.3	46.5		22.8		35.1	
1 to 3 times per month	34.4	51.3		16.0		32.5	
Never	53.6	44.5		10.6		25.7	
Meals at the training center's cafeteria							.001
Several times a day	4.9					50.0	
Daily	7.9					39.1	
1 to 6 times per week	2.8					19.4	
1 to 3 times per month	8.0					26.1	
Never	76.4					27.7	

Table 3: Daily consumption of different food groups and place of food intake among elite adolescent athletes (n = 1,138).

Legend: Classification of food groups is based on preliminary considerations and factor analysis; p-values describe the significance of the statistical connection between the daily consumption of the food groups and the independent variables; only significant results are reported.

west among athletes in weight-dependent sports (55.2 vs. 37.8%, p = .017). Having a nutrition plan and getting information from a nutritionist were associated with a higher proportion of consumers of foods rich in vitamin and fiber (59.5% vs. 46.0%, p = .002 and 55.6% vs. 45.2%, p = .002, respectively). In addition, we found associations between the place of food intake and the daily consumption of the different food groups (Table 1,2 and 3).

In a further step, we compared eating habits of elite adolescent athletes with those of adolescents of the same age not being elite athletes (Table 4). Overall, elite athletes were significantly more likely to eat products rich in vitamin and fiber on a daily basis than non-elite athletes (OR = 1.88, p < .001). In more detail, they showed a higher proportion of consumers of brown bread (42.9% vs. 35.1%, p = .001), fresh fruits (63.2% vs. 43.1%, p < .001), salads and raw vegetables (30.1% vs. 20.5%, p < .001), cooked vegetables (20.3% vs. 6.4%, p < .001), as well as frozen and canned vegetables (3.4% vs. 0.7%, p < .001). Being an elite athlete was also significantly associated with a higher consumption of animal products (OR = 1.57, p < .001). Compared to non-elite athletic adolescents, there was a significantly higher proportion of daily consumers of meat (22.9% vs. 9.9%, p < .001), poultry (11.3% vs. 0.5% p < .001), and eggs (3.7% vs. 0.7%, p < .001). Similar outcomes could be identified concerning the daily consumption of sweets and snacks (OR = 1.63, p < .001) since significantly more athletes ate cake, pastry and cookies (11.1% vs. 6.3%, p < .001) as well as snacks (4.9% vs. 1.0%; p < .001) on a daily basis. No significant differences were found concerning the daily consumption of chocolate (26.9% vs. 23.7%, p = .110).

DISCUSSION

These are the first nationwide results in terms of frequency of food consumption in the unique group of elite adolescent athletes covering 51 Olympic sports. The aim of this paper was to describe eating habits of elite adolescent athletes and to compare their nutrition behavior with that of adolescents not being elite athletes. The results will contribute to the development of prevention and education programs helping athletes to eat healthy and sport-oriented at the same time. This is important because a balanced intake of nutrients is crucial to be successful in their respective sports (2,6).

Results show that the eating habits of young athletes are associated with different variables. Compared to female athletes, male athletes had a higher proportion of consumers of animal products but a lower proportion of consumers of vitamin and fiber-rich products

on a daily basis. However, this difference may be partly explained by the gender-specificity of sports and the sports' demands on weight and muscle mass. This is also reflected in the BMI which is not a meaningful indicator in elite athletes since this is a highly homogenous group with over 90% having a normal weight. Furthermore, being overweight in this specific group usually does not mean to have too much body fat but is primarily associated with an increased mass of muscles. Getting nutrition-specific information from a nutritionist and having a nutrition plan were positively associated with eating products high in vitamin and fiber on a daily basis. In addition, the place of food intake also appeared to be relevant for eating habits. Taking meals in the school cafeteria was associated with a higher consumption of animal products, but also with a more frequent consumption of vitamin- and fiber-rich food. In contrast, eating at snack bars and on the way was connected with a lower daily consumption of the abovementioned products. All these aspects seem to point to a way of nutritional control (i.e., nutrition plan, advice from nutritionist, meals at cafeteria) that could be helpful for a balanced diet.

Consistent with previous research, athletes more frequently consumed dairy products and fruits on a daily basis (1,19,23). Although existing studies indicated no differences in snack consumption between athletes and non-athletes (4,8), elite athletes in our sample were more likely to snack. This may reflect the intention of elite athletes to fill their energy depots with high-carbohydrate products after intensive training (3).

Despite the uniqueness of these analyses, we acknowledge some shortcomings. First, as the GOAL Study focused on a wide range of different aspects concerning elite sports, only a small part of the questionnaire focused on nutrition. This is why we could not take into consideration all the aspects of the food pyramid suggested by Mettler et al. (18) and we could not collect information on the number of food portions. Additionally, we were not able to distinguish between nutrition during competition period and nutrition during training period. However, we could use a lot of the nutrition-specific information of the athletes as independent variables that revealed useful results. Second, due to the cross-sectional design of this study, we cannot establish causal relationships. However, our aim was to describe the status quo in the daily nutrition which was possible with our data. Third, as all information is self-reported, a social desirability bias may exist. To reduce this potential bias, different precautions were taken: (1) each athlete filled in the questionnaire on his/her own; (2) each athlete put his/her questionnaire into a prepaid self-addressed envelope to avoid anyone else seeing the answers; (3) the sealed envelope was sent straight to the study center (Heidelberg University). Fourth, the used food frequency questionnaire is established for inactive up to recreational active children and adolescents. Since young elite athletes have higher energy expenditure and nutrient needs, it is unclear, how well this questionnaire fits to this specific group (17). However, this approach allowed for comparison analysis. Fifth, the field time lasting from February 2010 until January 2011 may represent a possible limitation. However, this relatively expanded time span enabled us to include all Olympic sports. Beside these potential weaknesses, the results build a base for future research and underline that further education is needed among young elite athletes.

It could be shown that different kinds of nutrition counseling (i.e. guidance and support from a nutritionist and provision of nutrition plan) seem to be successful. However, in this sample, only 25% received information from a nutritionist. If nutrition counseling and contact to nutritionists were available to all elite athletes and not only to athletes in high squads, it would be possible that more athletes eat sport-adequate products on a daily basis and that more athletes would choose products due to sport- and performance-specific reasons. Furthermore, education should not only be directed at young athletes but also at coaches and parents as they are often important persons of contact.

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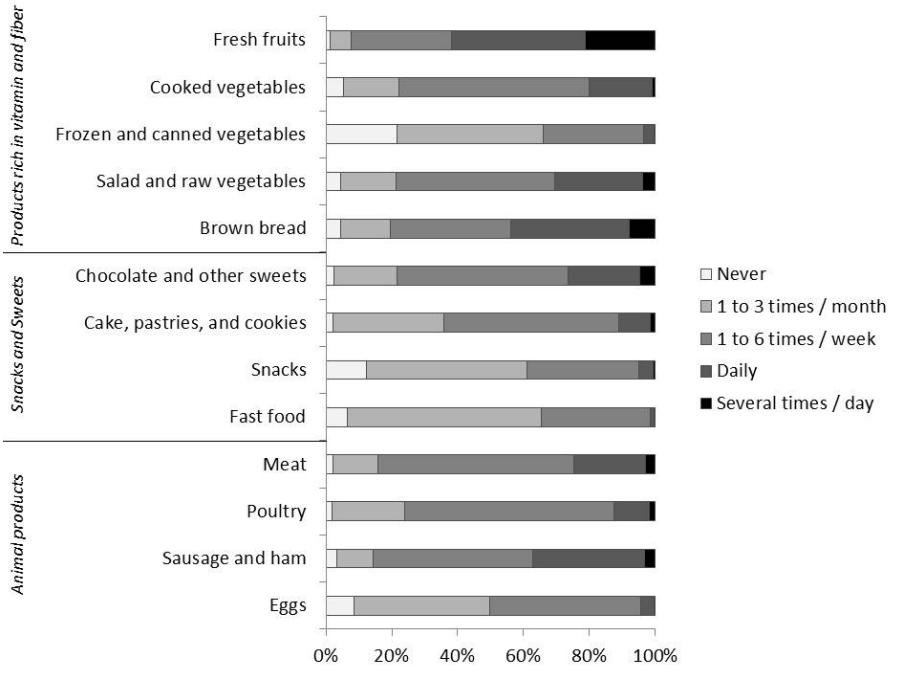

Figure 1: Consumption of different foods among elite adolescent athletes (n = 1,138).

LITERATURE

1. **Baumert PW Jr, Henderson JM, Thompson NJ:** Health risk behaviors of adolescent participants in organized sports. J Adolesc Health 22 (1998) 460-465. doi:10.1016/S1054-139X(97)00242-5.
2. **Berning JR, Troup JP, VanHandel PJ, Daniels J, Daniels N:** The nutritional habits of young adolescent swimmers. Int J Sport Nutr 1 (1991) 240-248.
3. **Burke LM, Kiens B, Ivy JL:** Carbohydrates and fat for training and recovery. J Sports Sci 22 (2004) 15-30. doi:10.1080/02640410310001405 27.
4. **Cavadini C, Decarli B, Grin J, Narring F, Michaud PA:** Food habits and sport activity during adolescence: differences between athletic and non-athletic teenagers in Switzerland. Eur J Clin Nutr 54 (2000) (Suppl 1) S16-S20. doi:10.1038/sj.ejcn.1600979.
5. **Croll JK, Neumark-Sztainer D, Story M:** Healthy eating: what does it mean to adolescents? J Nutr Educ 33 (2001) 193-198. doi:10.1016/S1499-4046(06)60031-6.
6. **Croll JK, Neumark-Sztainer D, Story M, Wall M, Perry C, Harnack L:** Adolescents involved in weight-related and power team sports have better eating patterns and nutrient intakes than non-sport-involved adolescents. J Am Diet Assoc 106 (2006) 709-717. doi:10.1016/j.jada.2006.02.010.
7. **Eichner ER:** Overtraining: consequences and prevention. J Sports Sci 13 (1995) (Spec No) S41-S48. doi:10.1080/02640419508732276.
8. **French SA, Perry CL, Leon GR, Fulkerson JA:** Food preferences, eating patterns, and physical activity among adolescents: correlates of eating disorders symptoms. J Adolesc Health 15 (1994) 286-294. doi:10.1016/1054-139X(94)90601-7.
9. **Government of Alberta:** Alberta Nutrition Guidelines for Children and Youth 2011. [cited 27 February 2012 Available from: http://www.healthyalberta.com/Documents/FINAL_Nutrition-Guidelines-AB-2011.pdf].
10. **Hoch AZ, Goossen K, Kretschmer T:** Nutritional requirements of the child and teenage athlete. Phys Med Rehabil Clin N Am 19 (2008) 373-398. doi:10.1016/j.pmr.2007.12.001.
11. **Kirkendall DT:** Effects of nutrition on performance in soccer. Med Sci Sports Exerc 25 (1993) 1370-1374. doi:10.1249/00005768-199312000-00009.
12. **Krebs-Smith SM, Heimendinger J, Patterson BH, Subar AF, Kessler R, Pivonka E:** Psychosocial factors associated with fruit and vegetable consumption. Am J Health Promot 10 (1995) 98-104. doi:10.4278/0890-1171-10.2.98.
13. **Kromeyer-Hauschild K, Wabitsch M, Kunze D, Geller F, Geiss HC, Hesse V, von Hippel A, Jaeger U, Johnson D, Korte W, Menner K, Müller G, Müller JM, Niemann-Pilatus A, Remer T, Schaefer F, Wittchen HU, Zabransky S, Zellner K, Ziegler A, Hebebrand J:** Perzentile für den Body-mass-Index für das Kindes- und Jugendalter unter Heranziehung verschiedener deutscher Stichproben. Monatsschr Kinderheilkd 149 (2001) 807-818. doi:10.1007/s001120170107.
14. **Kurth BM, Kamtsiuris P, Holling H, Schlaud M, Dolle R, Ellert U, Kahl H, Knopf H, Lange M, Mensink GB, Neuhauser H, Rosario AS, Scheidt-Nave C, Schenk L, Schlack R, Stolzenberg H, Thamm M, Thierfelder W, Wolf U:** The challenge of comprehensively mapping children's health in a nation-wide health survey: design of the German KiGGS-Study. BMC Public Health 8 (2008) 196. doi:10.1186/1471-2458-8-196.
15. **Lindholm C, Hagenfeldt K, Hagman U:** A nutrition study in juvenile elite gymnasts. Acta Paediatr 84 (1995) 273-277. doi:10.1111/j.1651-2227.1995.tb13628.x.
16. **Lorente FO, Souville M, Griffet J, Grelot L:** Participation in sports and alcohol consumption among French adolescents. Addict Behav 29 (2004) 941-946. doi:10.1016/j.addbeh.2004.02.039.
17. **Magkos F, Yannakoulia M:** Methodology of dietary assessment in athletes: concepts and pitfalls. Curr Opin Clin Nutr Metab Care 6 (2003) 539-549. doi:10.1097/00075197-200309000-00007.
18. **Mettler S, Mannhart C, Colombani PC:** Development and validation of a food pyramid for Swiss athletes. Int J Sport Nutr Exerc Metab 19 (2009) 504-518.
19. **Papaioannou A, Karastogiannidou C, Theodorakis Y:** Sport involvement, sport violence and health behaviours of Greek adolescents. Eur J Public Health 14 (2004) 168-172. doi:10.1093/eurpub/14.2.168.
20. **Peretti-Watel P, Guagliardo V, Verger P, Pruvost J, Mignon P, Obadia Y:** Sporting activity and drug use: Alcohol, cigarette and cannabis use among elite student athletes. Addiction 98 (2003) 1249-1256. doi:10.1046/j.1360-0443.2003.00490.x.
21. **Stang J, Story M:** Adolescent growth and development, in Stang J and Story M: Guidelines for adolescent nutrition services. Center for Leadership, Education and Training in Maternal and Child Nutrition, Division of Epidemiology and Community Health, School of Public Health, University of Minnesota, Minneapolis, 2005, 1-8.
22. **Sundgot-Borgen J, Larsen S:** Pathogenic weight-control methods and self-reported eating disorders in female elite athletes and controls. Scand J Med Sci Sports 3 (1993) 150-155. doi:10.1111/j.1600-0838.1993.tb00379.x.
23. **Taliaferro LA, Rienzo BA, Donovan KA:** Relationships between youth sport participation and selected health risk behaviors from 1999 to 2007. J Sch Health 80 (2010) 399-410. doi:10.1111/j.1746-1561.2010.00520.x.
24. **Thiel A, Diehl K, Giel KE, Schnell A, Schubring AM, Mayer J, Zipfel S, Schneider S:** The German Young Olympic Athletes' Lifestyle and Health Management Study (GOAL Study): design of a mixed-method study. BMC Public Health 11 (2011) 410. doi:10.1186/1471-2458-11-410.
25. **Wahl R:** Nutrition in the adolescent. Pediatr Ann 28 (1999) 107-111.
26. **Ziegler PJ, Nelson JA, Jonnalagadda SS:** Nutritional and physiological status of U.S. national figure skaters. Int J Sport Nutr 9 (1999) 345-360.

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