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The relationships between somatic constitution, physical fitness, school achievements and fish products consumption in junior male and female high school students

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Abstract. Easily digestible and low-calorie fish products are important components of a proper human diet. The main aim of the study was to assess the relationship between somatic constitution, physical fitness and school grades and the consumption of fish products by junior high school students . The research was carried out at Junior High Schools No. 8 and 9 in Rzeszów, in the school year 2014/2015. The mean age of examined girls was 13.96 ± 0.26, and boys - 13.97 ± 0.31 years. 118 students (58 girls and 60 boys) participated in the study. Basic somatic parameters were measured and tests concerning motor skills from the Eurofit test were performed. A short survey on the consumption of fish products by students was conducted and information on the results of junior high school final exams were obtained. The research showed that boys who have not consumed any fish products or had them rarely in their diet featured a taller body height. The opposite phenomenon was observed in the population of girls. In the group of boys, better exam results in selected subjects were achieved by those consuming fish less often, i.e. once a week or not at all. In the case of the females this phenomenon is only observed in relation to the exam in the school subject called Nature. The analysis of variance carried out in terms of the frequency of fish consumption showed that depending on the amount of fish products in the respondents' diet, the gender significantly differentiates the level of physical fitness of examined girls and boys (except for tapping).

Keywords. fish-eating, physical fitness, somatic constitution, school achievements

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Introduction

One of the main determinants of health, physical and mental fitness is proper nutrition [25, 36]. Eating habits are shaped in childhood and preserved in youth, while in adulthood they are copied and transferred to the next generation. In the case of young people, these habits are especially important because these people are in the period of intensive development. This stage is characterized by an increased demand for nutrients and energy [16, 27, 35]. Studies conducted among children and adolescents indicate basic dietary mistakes. These errors include, among others leaving the house without breakfast, too few meals during the day, irregular consumption of meals, low diversification of meals and snacking on products with low nutritional value [30, 32]. Students who do not eat regularly experience weakness, headaches, worse academic results and worse physical fitness more often [3, 30].

Fish undoubtedly belong to the group of products that are an indispensable element of a proper human diet, as they are easily digestible and low in calories. They are rich in protein, unsaturated fatty acids, vitamins, and mineral salts [2, 15, 31]. These nutrients are indispensable for proper functioning of the body and are beneficial for growth, brain and nervous system; they also have anti-cancer properties [18]. Numerous epidemiological studies have investigated the relationship between consumption of seafood and cardiovascular diseases [11, 17]. Based on Oomen's research [23], it was observed that persons who consumed oily fish featured a 34% reduction in cardiovascular diseases in three cohort studies. Other reports indicate that the daily consumption of 35 g of fish resulted in a reduction in mortality rate due to cardiovascular diseases [5]. Eating fish has many health benefits because it is high in polyunsaturated fatty acids [7, 22].

A dietary deficiency of polyunsaturated fatty acids may consequently lead to neurocognitive deficits, anxiety, aggression and depression [20, 37]. Consumption of these products also plays an important role in the cognitive development of infants [4] or adults [34]. Other reports emphasize a statistically significant relationship between fish consumption and the frequency of physical exercise [1]. On the one hand, fish products provide many health benefits, are an excellent source of protein, and provide omega-3 fatty acids [19, 24, 36]; on the other hand however, they can pose a potential health risk to adults, infants, newborns and developing fetuses. This phenomenon is associated with pollutants such as polychlorinated biphenyls (PCBs) and mercury [9, 12, 28]. Exposure to PCBs is associated with known neurotoxic effects of hypothyroidism on developing organisms, with potential effects including delayed neurological development, decreased intelligence and loss of hearing [26]. Furthermore, too much PCBs in the diet causes changes in the length of the menstrual cycle in women [21]. PCBs exposure can also alter lipid profiles in blood and increase the total levels of blood cholesterol and triglyceride [10]. There are also studies that confirm the relationship between PCBs and the occurrence of breast and lung cancer [33].

Aim of study

The aim of study was to assess the relationship between somatic composition, physical fitness, school grades and the consumption of fish products by junior high school students.

The authors assume that adolescents consuming more fish products will be able to achieve better school achievements. In addition, they will feature a slender body structure and better physical fitness compared to persons whose diet is poorer in fish products.

Material and Methods

Participants

The research group consisted of third grade students of Junior High Schools No. 8 and 9 in Rzeszów (118 persons in total, 58 female and 60 male). The research was carried out in the

school year 2014/2015. The mean age of the examined girls was 13.96 ± 0.26, and of boys 13.97 ± 0.31 years.

Procedures

The research was carried out twice, i.e. at the beginning and end of the school year with the same students and using the same instruments and under the same external conditions. The examinations took place during physical education lessons. All students who were present and received written permission from at least one parent were examined. The research was conducted with the consent of the Bioethics Committee at the University of Rzeszów.

Measurements

The following anthropometric measurements were carried out: body height measured with an anthropometer, body weight measured with the Tanita body composition analyzer, BMI based on the measured body weight and height, body fat content, muscle mass, fat free mass and bone tissue mass measured with the Tanita body composition analyzer (Tanita MC-180) using the bioelectrical impedance technique. The physical fitness levels were tested in the gym. The measurements were preceded by a warm-up lasting several minutes and carried out in the appropriate order. Selected samples from the Eurofit test battery (1989) were used to assess the level of motor skills development. With regard to motor components, the following factors were measured:

- balance - maintaining balance for as long as possible, standing on one selected leg on a beam, along the longitudinal axis - grip at the back by the foot of the free leg, bent at the knee. Before the main test, the students could lean on their partner's shoulder in order to take the right position. The test begins when the partner's arm is released. The adopted position should be maintained for 1 min. The attempt is halted after each loss of balance – and then it is repeated.
- speed of movements with the upper extremity (tapping) - position in a light stride in front of the table - placing the palm of the less-efficient hand on the rectangular middle plate, the palm of the more efficient hand placed on the opposite disk - moving the more efficient hand from one disk to the other, above the hand in the middle as fast, as possible. Each time each disc is to be touched. On the "ready start" command, the student carries out 25 back and forth movements (50 touches in total) as quick as he/she can and pauses after the "stop" command. During the test, each cycle should be counted out loudly. The test is carried out twice.
- static strength of the forearm and hand muscles - tested in a small spread, the dynamometer tightly adheres to the fingers of the hand, arm lowered along the torso so that the hand does not touch the body - the dynamometer is squeezed shortly and with maximum strength, the other arm is lowered freely
- strength of the torso muscles - lying on the back, legs bent at the knees at an angle of 90 degrees, feet spread 30 cm apart, hands clasped with fingers and placed under the head - the partner in kneeling position between the feet of a lying person presses them to the mattress – on the signal the lying person takes sitting position, touches the knees with his/her elbows and immediately returns to lying position so that the interlocked fingers can touch the ground and takes sitting position again without pushing with his elbows away from the mattress.
- running endurance - from position in a light forward stance sprinting to the second line and back after the "start" command. A total of 10 sections of 5 m each are carried out.

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Each time the distance marking line should be crossed with both feet. The test is carried out once.

In addition, a short survey on consumption of fish products and results obtained in junior high school exams was carried out.

Statistical analysis

The collected data was subjected to detailed statistical analyzes by calculating: mean values, standard deviations and coefficients of variation. The normality of the distribution was assessed by the Shapiro-Wilk test. The significance of the differentiation of the studied variables in the context of the factors present was analyzed using the ANOVA test and the post-hoc NIR test (this statistic compares all pairs of the independent variable with the student's t-test).

Results

Table 1 presents the somatic parameters of the male and female students studied in terms of consumption of fish products.

Table 1. Statistical characteristics of somatic parameters in terms of fish consumption

Variable	Boys						Girls					
	1 N = 48			2 N = 12			1 N = 43			2 N = 15		
	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%
Body height (cm)	177,1	6,37	3,60	175,0	7,59	4,34	163,1	7,70	4,72	165,1	8,59	5,20
Body mass (kg)	65,1	9,39	14,41	64,6	9,05	14,02	55,2	7,43	13,46	53,5	5,70	10,65
BMI	20,8	2,84	13,66	21,1	2,41	11,46	20,7	2,19	10,56	19,6	1,62	8,26
FM (kg)	11,1	4,61	41,58	11,1	4,50	40,53	14,5	3,89	26,85	12,8	2,32	18,19
FFM (kg)	54,2	6,44	11,87	53,5	5,88	10,99	40,8	5,10	12,51	40,8	4,92	12,06
Muscle mass (kg)	51,9	5,92	11,41	50,8	5,56	10,94	38,7	4,92	12,71	38,7	4,71	12,16
Bone tissue mass (kg)	2,8	0,28	10,17	2,7	0,26	9,66	2,1	0,25	12,01	2,1	0,25	11,90

Note: 1-not at all or once a week, 2-twice or 3 times a week, N-number of surveyed people

The analysis of somatic parameters of the examined boys and girls depending on the frequency of fish consumption, shows that among men, persons who eat fish less often (not at all or once a week) are characterized by a greater body height compared to persons consuming fish twice or 3 times a week. The reverse phenomenon is observed in the female participants. The respondents who consumed more fish were taller (165.1 cm) than their female peers whose meals contained low amount of fish products (163.1 cm). In the case of body weight, both in the group of girls and boys, higher values of the researched parameter were recorded among persons who consumed less fish. When analyzing the body fat content, it is noted that in the male group the values of this parameter are the same (11.9 kg). On the other hand, among girls, more fat tissue was found in persons whose diet did not contain much fish. The values of the next two parameters, i.e. muscle and bone mass, in the group of examined men are similar depending on the frequency of fish consumption, with a slight dominance of persons who consumed less fish per week. A similar phenomenon is observed in the group of girls. The females whose diet was rich in fish products are characterized by a lower content of muscle and bone tissue in the body (Table 1).

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Table 2. Evaluation of the diversity of average values of the examined parameters in terms of fish consumption frequency - analysis of variance

Feature	Gender		Eating fish		Gender×eating fish		Probabilities for post-hoc tests, NIR test, p value			
	F	p	F	p	F	p	B 1–2	G 1–2	B–G 1	B–G 2
Age	0,00	0,9344	0,70	0,3944	0,10	0,7354	0,7253	0,6594	0,8844	0,3824
Body height (cm)	55,32	**0,0000**	0,00	0,9671	1,58	0,2119	0,3780	**0,0000**	**0,0006**	0,3744
Body mass (kg)	32,97	**0,0000**	0,36	0,5479	0,10	0,7552	0,8434	**0,0000**	**0,0008**	0,5028
BMI	1,79	0,1834	0,52	0,4709	1,60	0,2085	0,7125	0,9384	0,1415	0,1469
FM (kg)	7,83	**0,0060**	0,89	0,3475	0,90	0,3440	0,9963	**0,0001**	0,2956	0,1669
FFM (kg)	107,01	**0,0000**	0,08	0,7726	0,08	0,7735	0,6939	**0,0000**	**0,0000**	0,9994
Muscle mass (kg)	113,36	**0,0000**	0,21	0,6445	0,19	0,6644	0,5413	**0,0000**	**0,0000**	0,9838
Bone tissue mass (kg)	123,80	**0,0000**	0,12	0,7356	0,09	0,7617	0,6618	**0,0000**	**0,0000**	0,9798
Balance (falldowns)	7,04	**0,0091**	1,63	0,2038	0,33	0,5681	0,6310	**0,0311**	**0,0691**	0,1767
Tapping (s)	0,50	**0,4791**	2,91	0,0905	0,06	0,8080	0,1857	**0,3192**	**0,7912**	0,2846
Flexibility (cm)	15,54	**0,0001**	1,06	0,3061	0,29	0,5893	0,7404	**0,0005**	**0,0121**	0,2514
Jumping ability (cm)	22,16	**0,0000**	0,02	0,8959	3,40	0,0680	0,2452	**0,0000**	**0,1060**	0,1498
Static strength (kg)	38,47	**0,0000**	0,02	0,8783	0,20	0,6536	0,8400	**0,0000**	**0,0002**	0,6584
Trunk muscles strength (pow.)	19,97	**0,0000**	1,76	0,1876	0,12	0,7286	0,5059	**0,0000**	**0,0208**	0,2215
Functional strength (s)	18,77	**0,0000**	0,11	0,7425	0,22	0,6404	0,5872	**0,0000**	**0,0300**	0,9188
Running endurance (s)	13,55	**0,0004**	1,40	0,2385	0,53	0,4693	0,1948	**0,0024**	**0,0136**	0,7366
Polish	13,22	**0,0004**	0,02	0,8970	2,01	0,1591	0,2932	**0,0217**	**0,0048**	0,3462
English-basic level	2,72	**0,1017**	0,03	0,8696	0,25	0,6159	0,6495	**0,2314**	**0,2233**	0,8041
English-advanced level	2,16	**0,1446**	0,00	0,9845	0,61	0,4359	0,5855	**0,4724**	**0,2030**	0,5765
Nature	0,28	**0,6009**	0,98	0,3245	0,59	0,4459	0,2337	**0,8014**	**0,4648**	0,8693
Mathematics	0,15	**0,7039**	0,06	0,8092	1,22	0,2711	0,3595	**0,1215**	**0,6809**	0,5270

Note: 1-not at all or once a week, 2-twice or 3 times a week, B-boys, G-girls, F-empirical value of the Anova test, p-probability

The analysis of variance showed that depending on the frequency of fish consumption, the gender significantly differentiates within all parameters except BMI (Table 2).
The analysis of variance carried out in terms of fish consumption frequency showed that depending on the amount of fish in the respondents' diet, the gender significantly differentiates the level of physical fitness of the examined girls and boys (except for tapping) (Table 2).

Table 3. Statistical characteristics of junior high school exams results in terms of fish consumption frequency

Subject	Boys						Girls					
	1 N = 48			2 N = 12			1 N = 43			2 N = 15		
	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%	Mean	SD	CV%
Polish	67,6	12,01	17,77	63,2	14,50	22,93	73,7	12,27	16,64	77,3	14,24	18,42
English - basic level	81,0	19,74	24,37	78,3	21,50	27,45	85,6	14,86	17,37	86,9	18,53	21,32
English - advanced level	64,1	25,72	40,14	59,4	31,89	53,67	68,1	24,41	35,87	72,5	28,88	39,85
Nature	65,4	17,82	27,23	58,0	23,14	39,90	64,4	19,21	29,82	63,5	20,56	32,39
Mathematics	67,7	18,27	26,98	61,4	23,85	38,83	60,8	23,23	38,22	64,8	21,70	33,48

Note: 1-not at all or once a week, 2-twice or 3 times a week, N-number of surveyed people

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In Table 3, the characteristic of junior high school examinations results depending on the frequency of fish consumption is presented. The conducted research showed that in the group of men better exams results in selected subjects were achieved by boys consuming less fish - once a week or none at all. In the case of girls, this phenomenon is only observed in relation to the exam in Nature. In the remaining subjects, i.e. Polish, English (basic and advanced level), and mathematics, girls whose diet was rich in fish products achieved better results (Table 3). The analysis of variance showed that depending on the frequency of fish consumption, the gender significantly differentiates the junior high school exams results only in Polish (Table 2).

Discussion

The research on fish consumption by junior high school students conducted in this work focused, among others, on demonstrating the relationship between the frequency of fish consumption, the constitution and composition of young persons' bodies. Statistical characteristics of somatic parameters and body composition of junior high school students from Rzeszów considered in terms of fish consumption frequency showed that persons consuming smaller amounts of such products are characterized, in most cases, by higher values within the scope of examined parameters. This situation is observed among both men (except BMI and birth weight) and women (except body height and birth weight). At the same time, the analysis showed a significant relationship between the fish consumption frequency and examined parameters (except for BMI and birth weight). Siniarska [29] presented similar results in her study. According to her research, the frequency of eating fish and seafood was not significantly related to body height, BMI or body fat. On the other hand, larger body width dimensions and the state of health show a positive relationship with this nutritional factor.

It is also noted that regardless of the frequency of fish consumption by boys and girls from Rzeszów schools, the BMI values of the examined group of young persons were within the normal range. Similar results were recorded by Głębocka and Kęska [8]. According to their research, 52% of girls and 54% of boys from Warsaw and 63% of girls and 62% of boys from Zamość declared fish consumption twice a week. While analyzing the BMI values obtained by the participants of the above research, it was found out that among both girls and boys prevailed persons whose values of that factor were within the normal range [8]. Another phenomenon was observed among academic youth of the University of Zielona Góra. The research performed there showed that only 8% of men and 4% of women declared their consumption of fish to be 3 times a week. In this group of students, an increase in body fat and a tendency to overweight and obesity, mainly in men, were observed [13].

A diet rich in fish and fish products plays an important role in ontogenesis. Consumption of those products will affect not only somatic features or body composition, but also the school achievements of children and adolescents. This phenomenon is confirmed by research carried out by Kim et. al. [14]. According to the authors, higher school grades were achieved by persons who consumed fish once a week compared to people who consumed these products with a frequency less than once a week. The results of that research are reflected in the study by Åberg et. al. [1]. A positive relationship between the number of fish meals consumed weekly by 15-year-old adolescents and cognitive results measured 3 years later was observed. The consumption of fish more often than once a week compared to the frequency lower than once a week was associated with higher intelligence test results. Similar research was conducted on a group of 700 Dutch high school students aged 12-18. The collected data concerned fish consumption, final grades, results from the Amsterdam Vocabulary Test and the results of The YouthSelf-Report (a screening tool regarding behavioral and emotional problems in children and adolescents). Higher fish consumption was associated with more advanced vocabulary and

higher final grades. However, consumption of more fish than the described norm did not seem beneficial [6].

The research results of this study do not fully confirm the above relationships. The conducted analysis indicates that better results in junior high school exams in selected subjects were obtained by men consuming fish once a week or in general compared to the group of junior high school students whose diet was richer in fish products. In the case of the female participants, the opposite phenomenon is noted. Better results in Polish, English and mathematics were achieved by women who declared eating fish twice or three times a week. At the same time, it was observed that (depending on the frequency of fish consumption), only in Polish the gender significantly differentiates the results of junior high school exams.

The main limitations of this study

The main limitation of this study is the lack of detailed information about the diet. Fish consumption is regarded only as a frequency of total fish consumption. In addition, there was no information about the size of portions as well as the type of consumed fish (lean or oily). Restrictions also concerned the lack of information on other dietary components, what means that we were unable to adjust to the total energy consumption, as well as other features of a healthy diet, such as fruit, vegetable and supplement consumption.

Conclusions

Consumption of more fish products by junior high school students was not associated with their better school achievements. At the same time, it was not found that the body structure and composition as well as physical fitness were significantly related to the consumption of fish products.

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