Amount of Fibre in the Diet with Regard to Excessive Weight and Obesity among Children and Adolescents in Rural Communities

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Summary One component of a correctly balanced diet is dietary fibre. Fibre acts protectively—it improves the functioning of the intestines, regulates the rhythm of bowel movements, inhibits the absorption of sugar and also lowers the level of cholesterol. The aim of the research was to determine the intake of fibre in relation to the occurrence of excessive weight and obesity among children and adolescents living in rural areas. The research was conducted using an authored questionnaire. The study questionnaire was completed by the study participants and their parents over 7 d. The anthropometric measurements were carried out on pupils in their underwear in conditions of privacy. Based on the results obtained, the BMI index was calculated for each pupil and then ranked according to WHO reference values. Among the pupils in the study group, the intake of fibre was at a very low level. The lowest amount of fibre in the diet was found among those with excessive weight and with obesity. Over 39% pupils never consumed wholegrain bread. Fruit and vegetables were consumed most seldom by pupils with excessive body weight. Knowledge about the lifestyles of children and adolescents is of crucial importance in taking multidirectional preventative actions to make changes to such lifestyles.

Key Words children, fibre, fruit, wholegrain bread, vegetables

The awareness of a healthy lifestyle and the related correct dietary habits with regard to children and adolescents in Poland is still insufficient—the belief that a ‘chubby’ child is a ‘healthy’ child is still held in some sections of society (1, 2). It is generally considered that the problem of low awareness concerns rural communities in particular. Children and adolescents living in rural areas have poor dietary habits, and as a result incorrect body mass is more prevalent among this group in comparison to their peers living in urban areas (3, 4).

Research on the effect of eating habits on health has undergone numerous changes and modifications, however, the recommendations of the WHO, as well as the Polish Food and Nutrition Institute, define the conditions that guarantee the preservation of good health until old age. An important element of maintaining good health is a correctly balanced diet containing the appropriate amounts of nutrients (5–9). One component of a correctly balanced diet is dietary fibre, which has a direct effect on the digestive tract, but also has properties that improve health in diseases that are diet-related, in particular colorectal cancer and diabetes (10).

High fibre content can be found in wholegrain and whole wheat bread, which have a lower calorific value than other types of bread. Wholegrain bread is a valuable source of minerals and vitamins, but is unpopular among children and adolescents. Another important source of dietary fibre are fruit and vegetables, which, depending on the time of year, are eaten by children and adolescents on average 3 to 4 times per week (3, 9, 11–16).

In comparison to children with correct BMI values, children with excessive body weight show higher levels of total cholesterol, low-density lipoprotein in the blood serum and secondary hyperinsulinemia. Obesity increases the instance of higher blood pressure (5). In this regard, fibre acts protectively—it improves the functioning of the intestines, regulates the rhythm of bowel movements, inhibits the absorption of sugar and also lowers the level of cholesterol. Research conducted among female students showed an inverse relationship between the consumption of fibre and the occurrence of body fat (17). This is of key importance in the treatment of diet-related diseases (5–9, 18, 19). According to Platty, increasing the amount of dietary fibre in the diet is important in the treatment of diabetes and constipation (13).

According to the WHO, an intake for adults of 25 g of fibre per day ensures correct functioning of the body. In Poland, the Institute of Food and Nutrition recommends a fibre intake of between 16 g (for lower age groups) to 21 g (for adolescents), with the principal source being natural fibres contained in cereals, fruit and vegetables (6, 9, 18, 20–22). Most research to date has only analysed the effect on fibre intake on the occurrence of constipation. However, an interesting question is whether the amount of fibre in the diet has an influence on BMI values among children and adolescents.

The aim of the research was to determine the intake
of fibre in relation to the occurrence of excessive weight and obesity among children and adolescents living in rural areas.

**RESEARCH PARTICIPANTS AND METHODS**

The research was conducted among 1,180 pupils attending one of the schools (primary or secondary) located in a village on the outskirts of Bielsko-Biała ranked in 566th place in terms of affluence among all districts in Poland. This village is one of the largest in Poland in terms of population.

The research was conducted using an authored questionnaire which contained questions on the daily frequency of intake of selected food products, with particular focus on the frequency that fruit and vegetables were consumed. The questionnaire also contained amount of physical activity, as well as the results of anthropometric measurements for body mass and height conducted on each of the pupils in the study. The body mass and height values were used to calculate the BMI index. Physical activity was calculated in minutes per day, and then added together to obtain the activity in minutes per week.

Before the study began, a meeting was held with the pupils and their parents in order to present the correct method for measuring portions of food products consumed. The size of portions consumed was verified using ‘The Album of Photographs of Food Products and Dishes’ (23).

The study questionnaire was completed by the study participants and their parents over 7 d. If any pupil in the study consumed one of the selected food products less than once per week, they could choose between the options: 2 to 3 times per month, once per month, or I do not eat this product. The study was conducted between October 2017 and March 2018.

**Study inclusion and exclusion criteria.** The criteria for inclusion in the study was the age of study participants between 7 and 18 y old, and that they should attend one of the schools located in the village covered by the study.

The exclusion criteria were consumption by pupils of vitamin supplements, or chronic illnesses (e.g. allergies, in particular food allergies). The study also did not include pupils whose study questionnaires were incomplete.

**Size of study group.** The study questionnaire was completed by 1,243 pupils, of which 1,180 were taken complete. Division of pupils into age groups was done using yearly intervals of calendar age (24).

For statistical purposes, the study participants were divided into three age groups, within which the AI (Adequate Intake) of fibre was the same which for children aged 7–9 y old was 16 g/d, for children aged 10–15 y old—19 g/d, and for adolescents aged 16–18 y old—21 g/d (21). The average daily intake of fibre is presented according to gender, age and BMI index. Table 1 presents details of the study group.

**Data collection and assessment of the results of body mass and height measurements.** The anthropometric measurements were carried out on pupils in their underwear in conditions of privacy. Each measurement was taken three times, with the average of the three then calculated. Based on the results obtained, the BMI index was calculated for each pupil and then ranked according to WHO reference values, assuming correct BMI values between −1 and +1 standard deviation (SD) from the body mass indicator median. Excessive weight if the BMI value was above +1 SD from the body mass indicator median, and obesity above +2 SD, while insufficient body mass was of a BMI below −1 SD of the body mass indicator median (20, 25, 26).

**Collection and assessment of food intake data.** The completeness of the data in the study questionnaires was checked by the study authors, with all data subsequently entered into the DIETA FAO 5.0 software. The DIETA FAO 5.0 software allows for the amounts of nutrients in the diet to be determined, including protein, fats and carbohydrates, as well as the amount of vitamins, minerals, fatty acids and fibre.

**Statistical analysis.** The statistical analysis was conducted using the PQStat computer programme (version 1.6.6).

**Bioethics Committee approval and research funding.** The study was verified by the Bioethics Committee in Bielsko-Biała, and written permission was obtained under the number 2017/06/1/4.

**RESULTS**

Among the children and adolescents living in rural areas, excessive body weight occurred primarily in the younger age groups, with it being a common occurrence among 10 to 15 y-olds. In the oldest group (16–18 y-olds) there were only some cases of excessive weight (9.3%), and no obesity was found. Excessive body weight (being overweight and obesity) affected over 29% of the study participants. Insufficient body mass was recorded in 13% of study participants. Depending on the age group, physical activity was found to be at the level of 200–310 min per week (Table 1).

Among the pupils in the study group, the intake of fibre was at a very low level. The daily intake of fibre at

| BMI       | Age 7–9 y | Age 10–15 y | Age 16–18 y | Total |
|-----------|-----------|-------------|-------------|-------|
| Below −1 SD | 56        | 78          | 19          | 153   |
| −1 SD +1 SD | 176       | 395         | 107         | 678   |
| +1 SD +2 SD | 80        | 188         | 13          | 281   |
| Above +2 SD | 20        | 48          | —           | 68    |
| Total     | 332       | 709         | 139         | 1,180 |

SD: standard deviation.
the level of AI was found mainly among study participants with insufficient or correct body weight. Participants who consumed too little fibre were most often found among those with obesity—the levels were considerably below the daily requirement, and in some groups reached only 76–77% of the daily requirement. The lowest amount of fibre in the diet was found among those with excessive weight (11.39 g/d) and with obesity (12.27 g/d) in the group of boys aged 7 y old. The highest (22.12 g/d) daily intake of fibre was found in 18-y-old boys with insufficient body mass. The differences in the daily intake of fibre among study participants with different BMI values were statistically significant (Table 2).

Among the study participants, over 39% (462 people) never consumed wholegrain bread, of whom half were pupils with excessive weight (186 people) and with obesity (49 people). No cases were found among the study groups of any participants not consuming any fruit and vegetables at all.

In the group of children aged 7–9 y old wholegrain bread was never consumed or it was consumed once a week by 64% of study participants. Wholegrain bread was consumed 4 times a week most often by study participants with insufficient or with correct body mass. Fruits and vegetables were consumed most often in this group (7–9 y-olds) 3 to 4 times a week. Twice a week fruits were consumed by 45.3% of study participants with excessive body weight, while 5 times a week by only 5 participants from this group. The same number of children with insufficient body mass as well as with overweight consumed vegetables 5 times a week (Table 3).

Among pupils aged 10–15 y old wholegrain bread was never consumed or it was consumed only once a week by 63.3% of study participants. The majority of

Table 2. Average daily fibre intake in individual age groups according to BMI values.

| Age       | BMI          | Chi square | p-value | AI g/d |
|-----------|--------------|------------|---------|--------|
|           | Below −1 SD  | −1 SD+1 SD | +1 SD+2 SD | Above +2 SD |
| 7–9 y     | 18.36        | 15.73      | 14.54    | 13.90  | 20.159 | 0.001 | 16    |
| 10–15 y   | 20.01        | 17.63      | 16.87    | 17.38  | 20.025 | 0.015 | 19    |
| 16–18 y   | 21.12        | 20.49      | 19.41    | 18.4   | 10.257 | 0.022 | 21    |

SD: standard deviation.

Table 3. Frequency of consumption of wholegrain bread, fruit and vegetables by age group 7–9 y.

| Analyzed variable              | BMI          | p-value |
|--------------------------------|--------------|---------|
| Wholegrain bread               |              |         |
| Does not eat this product      | n 14         | 85      | 43      | 9      |
| % 9.3%                        | 56.3%        | 28.5%   | 5.9%    |
| Once a week or less often      | n 12         | 21      | 20      | 8      |
| % 19.7%                       | 34.4%        | 32.8%   | 13.1%   |
| 2–3 times a week               | n 24         | 42      | 17      | 3      |
| % 27.9%                       | 48.8%        | 19.8%   | 3.5%    |
| 4 times a week or more often   | n 6          | 28      | 0       | 0      |
| % 17.6%                       | 82.4%        | 0%      | 0%      |

SD: standard deviation.
**Table 4. Frequency of consumption of wholegrain bread, fruit and vegetables by age group 10–15 y.**

| Analyzed variable | BMI | p-value |
|-------------------|-----|---------|
|                   | Below -1 SD | -1 SD +1 SD | +1 SD +2 SD | Above +2 SD |
| Wholegrain bread  |  |  |  |  |
| Does not eat this product | 5 | 103 | 132 | 40 | 1.8% | 36.8% | 47.1% | 14.3% | 0% |
| Once a week or less often | 18 | 151 | 42 | 0 | 8.5% | 71.6% | 19.9% | 0% | 0% |
| 2–3 times a week | 30 | 72 | 10 | 0 | 26.8% | 64.3% | 8.9% | 0% | 0% |
| 4 times a week or more often | 25 | 69 | 4 | 8 |  | 23.6% | 65.1% | 3.8% | 7.5% |
| Fruit |  |  |  |  |
| 2 times a week or less often | 11 | 76 | 87 | 31 | 5.4% | 37.1% | 42.4% | 15.1% | 0% |
| 3–4 times a week | 24 | 187 | 89 | 17 | 7.6% | 59% | 28.1% | 5.3% | 0% |
| 5 times a week or more often | 43 | 132 | 12 | 0 | 23% | 70.6% | 6.4% | 0% | 0% |
| Vegetable |  |  |  |  |
| 2 times a week or less often | 10 | 61 | 103 | 29 | 5% | 30% | 50.7% | 14.3% | 0% |
| 3–4 times a week | 32 | 252 | 79 | 14 | 8.5% | 66.8% | 21% | 3.7% | 0% |
| 5 times a week or more often | 36 | 82 | 6 | 5 |  | 27.9% | 63.6% | 4.6% | 3.9% |

SD: standard deviation.

**Table 5. Frequency of consumption of wholegrain bread, fruit and vegetables by age group 16–18 y.**

| Analyzed variable | BMI | p-value |
|-------------------|-----|---------|
|                   | Below -1 SD | -1 SD +1 SD | +1 SD +2 SD |
| Wholegrain bread  |  |  |  |  |
| Does not eat this product | 0 | 20 | 11 | 0% | 64.5% | 35.5% |
| Once a week or less often | 3 | 26 | 2 | 9.7% | 83.9% | 6.4% | 0% |
| 2–3 times a week | 3 | 33 | 0 | 8.3% | 91.7% | 0% | 0% |
| 4 times a week or more often | 13 | 28 | 0 | 31.7% | 68.3% | 0% | 0% |
| Fruit |  |  |  |  |
| 2 times a week or less often | 0 | 8 | 6 | 0% | 57.2% | 42.8% | 0% |
| 3–4 times a week | 2 | 50 | 7 | 3.4% | 84.7% | 11.9% | 0% |
| 5 times a week or more often | 17 | 49 | 0 | 25.8% | 74.2% | 0% | 0% |
| Vegetable |  |  |  |  |
| 2 times a week or less often | 0 | 13 | 8 | 0% | 61.9% | 38.1% | 0% |
| 3–4 times a week | 3 | 60 | 5 | 4.4% | 88.2% | 7.4% | 0% |
| 5 times a week or more often | 16 | 34 | 0 | 32% | 68% | 0% | 0% |

SD: standard deviation.
children (70.5%) with insufficient body mass as well as 35.7% of children with correct body weight consumed wholegrain bread 2 to 3 times a week or even 4 times a week. In this age group fruits and vegetables were consumed most often 3 to 4 times a week. The large group of children with correct body weight (33.4%) consumed fruits 5 times a week. Vegetables were consumed most seldom by pupils with excessive body weight (55.9% of study participants) (Table 4).

Among pupils aged 16–18 y old with overweight, wholegrain bread was not consumed more than once a week, while in the group of participants with insufficient body mass no case of a person not consuming this type of bread at all was found. After the analysis of the fruits and vegetables consumption in this age group, it was concluded that the higher body mass, the less frequent consumption of them. Adolescents with correct body mass consumed fruits and vegetables most often 3 to 4 times a week (Table 5).

Fruit and vegetables were consumed most seldom by pupils with excessive body weight. The differences in the frequency of consumption of fruit and vegetables in each age group were statistically significant (Tables 3–5).

**DISCUSSION**

The study showed that among children and adolescents living in rural areas, incorrect body mass affected every fourth pupil involved in the study, however, this was more frequently excessive body mass than insufficient body mass. The study participants too infrequently consumed fruit and vegetables, with this affecting the daily intake of fibre, which very seldom covered the AI requirement.

Inadequate intake of calories does not only result in insufficient body mass, but also bears the risk of a shortage of nutrients, which in the case of children and adolescents can lead to development disorders. According to Marcinkowska et al., the insufficient body mass that occurs in younger children reduces with age to become correct body mass or even excessive body mass (11). Our study has shown that insufficient body mass diminished with age, however, no notable increase in the number of people with excessive weight or obesity was found. This may be due to the increase with age in physical activity. According to WHO guidelines, children and adolescents should spend 60 min a day on physical activity (18).

Excessive body weight, in particular obesity caused by a long-term energy imbalance, where the daily intake of energy exceeds its use, is a problem both in developed countries as well as in developing nations. One of the causes of excessive amounts of energy in the diet is the replacement of plant-based products (including fruit and vegetables) with products rich in fats and carbohydrates (21, 27–29).

It is considered that obesity affects above all children and adolescents living in rural areas. Research by Stankiewicz et al. showed that excessive weight affected 9% of study participants aged 6–18 y old living in small towns and villages, while for obesity the figure was 5.1% (2). Our research has shown a similar prevalence of obesity (5.7%), while excessive weight affected as much as 23.8% of study participants. In Poland, the prevalence of excessive body weight among children and adolescents living in rural areas is also high. Analysis of body mass among children and adolescents in Gdańsk showed a rising trend of the prevalence of excessive body mass up to around 12 y of age, with this trend then normalising. However, excessive weight was seen in as much as 18% of 7-y-olds, and obesity in 7.2%. Among 9-y-olds the figures were respectively 23.6% for excessive weight, and 8.6% for obesity (30).

The lack of differences in the prevalence of incorrect body mass among children and adolescents living in various areas may be caused by a lack of differences in affluence resulting from an improvement in overall economic status, as well as an awareness of a ‘healthy’ lifestyle, visible in similar dietary habits and levels of physical activity. Polish villages are undergoing macroeconomic migration, which leads to the blurring of differences between communities living in different areas (10, 21, 31).

American guidelines indicate that fibre is a very important component of the diet. In spite of this, among children and adolescents in the USA, the amount of fibre in the diet covers only half the Dietary Reference Intake, with 31–38 g/d for boys, depending on age, and 26 g/d for girls. Similar recommendations for the intake of fibre were issued in Canada (3, 32–34). In France, the recommended fibre intake is 30 g per day for men and women, in Japan it is 25 g for women and 30 g for men. The lowest recommended fibre intake is in The United Kingdom—18 g per day (3). In Poland it is at a similar level to that in the United Kingdom (6). In Poland, the main source of dietary fibre are grain products (principally bread) (41.5%), vegetables (26.4%), potatoes (11.8%) and fruit (9.4%) (15).

This study, conducted among the young rural population, showed that the daily intake of fibre covered 68.8–117.8% of the Adequate Intake. The higher intakes of fibre covering 100% of the daily requirement were found more frequently in groups of participants with insufficient or correct body mass than in groups of participants with excessive weight or obesity. This was related to the fact that children and adolescents with excessive body mass less frequently consumed fruit and vegetables, while children with insufficient or correct body mass very often consumed fruit and vegetables five times a week. However, this frequency is insufficient, as according to WHO recommendations, 5 portions of fruit and vegetables (400 g) should be consumed every day, with there being more vegetables in the diet than fruit (16, 18).

Vegetables, and in particular fruit, contain carbohydrates—glucose can be found in grapes and the green parts of vegetables, fructose and saccharose are found in beetroot, carrots, pineapple and dates. Too high amounts of fruit in the diet is therefore not recommended. The higher sugar content in fruit gives them a
higher glycaemic index than vegetables. Consumption of fruits with a high glycaemic index, which additionally are more calorific than vegetables, promotes the deposition of glucose in the adipose tissue (35, 36).

Research conducted in several European countries has not shown statistically significant differences between urban and rural dwellers in terms of the frequency of consumption of fruit and vegetables. However, the financial situation of the families of children included in the research had a statistically significant influence on dietary choices (31).

Research by Calyniuk et al. including analysis of dietary habits among 10 to 13 y-olds living in urban and rural areas showed that 23.7% of children living in cities and 24.7% of those from villages did not consume wholegrain bread (12).

Our research has shown that as many as 39% of pupils living in rural areas never consumed wholegrain bread, with this most commonly seen in people with excessive body mass. Research by foreign authors has shown that improper dietary habits occur irrespective of place of living (21, 25, 28, 29, 31). Analysis of data from the Main Statistical Office shows that consumption of fruit, vegetables and grain products followed a downward trend in the years 2000–2009. The daily intake of dietary fibre decreased.

One factor that has a negative impact on the amount of fibre in the diet is technological advances related to the processing of foodstuffs, resulting in the depletion of all biologically active substances in food products (15).

While analyzing teenagers’ eating habits most of the researchers were examining a group of respondents of a certain age, without the division based on body weight, which could have affected the research results. It may happen that, despite the fact that diet includes all nutrients necessary for the body, it is not properly balanced.

The limitation in the study, was participants and their parents used their own containers (devices) for measuring the amount of food products consumed, which could affect the precision of determining the size of portions.

CONCLUSIONS

1. Research has confirmed the influence of fibre intake on the prevalence of eating disorders.

2. The frequency of consumption of wholegrain bread, fruit and vegetables had an impact on BMI values.

3. Knowledge about the lifestyles of children and adolescents is of crucial importance in taking multidirectional preventative actions to make changes to such lifestyles.

Disclosure of state of COI
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