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Statistical and Multidimensional Body Composition Parameter Analysis in Young Childhood Cancer Survivors

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Abstract. This article concerns the problem of assessing selected body composition parameters after completion of antitumor therapy and comparing them with the same parameters of healthy children. A high percentage of overweight and obesity, as well as abnormal fat distribution in convalescents with cancer shows a significant adverse effect of therapy on body composition and suggests the need for early intervention in terms of diet and exercise, which would help patients to quickly achieve the proper parameters of body composition. Two main problems will be mentioned during the presented data analysis. Firstly, in each group there was a small number of observations. Because of this, the real differences between examined subgroups may have been omitted. Secondarily, many variables are correlated and are not normally distributed. Therefore, beside the standard statistical tests to compare two groups, principal component analysis was applied to reduce the dimensions of the attribute space and to attempt to classify two groups of patients.

Introduction

With an increase in the curability of cancer, which is currently at about 80%, more and more attention is being paid to the late complications of antineoplastic therapy. Among these complications, primarily overweight and obesity can be distinguished. Overweight and obesity among children treated for cancer are associated with treatment including chemotherapy and especially steroidotherapy, as well as with the lack of physical activity and immobilisation caused by the disease, in addition to prolonged neutropenia, among other causes. Decrease in physical activity during treatment should be transient. However, after completion of the therapy, a lot of

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cancer survivors continue to have a very limited level of physical activity. This can cause effects in adulthood.

Childhood obesity is associated with many serious health problems, including high blood pressure, high cholesterol level, pulmonary and skeletal problems, and an increased risk of developing diabetes and heart disease. Childhood obesity is associated with a 50% higher risk of urothelial or colorectal cancers (Leiba et al., 2012). An elevated BMI in adolescence constitutes a substantial risk factor for obesity-related disorders in midlife. Although the risk of diabetes is mainly associated with increased BMI close to the time of diagnosis, the risk of coronary heart disease is related to an elevated BMI both in adolescence and in adulthood (Tirosh et al., 2011).

The apparent impact of obesity on the incidence of cancer in adulthood should also be mentioned. An American Cancer Society study showed a significant increase in cancer occurrence in people who are the most overweight. This link is stronger in some cancer types, including breast cancer after menopause and cancers of the colon and rectum, pancreas, kidney, esophagus, and endometrium, and can be associated with a major increase in risk (Foxhall, 2013). Obese people are three to four times more likely to develop uterine cancer than people with a normal bodyweight (Bjorge et al., 2007; Reeves et al., 2007). Being overweight doubles the risk of developing esophageal cancer (Kubo et al., 2006). Being obese can triple the risk (Merry et al., 2007). There is more and more evidence that overweight or obesity may have an impact on the level of risk associated with many types of cancer, such as brain, ovarian, liver or prostate cancer.

But not only weight or body mass index can be measured to assess overweight or obesity. Inappropriate body composition, such as fat distribution, can be checked by values of different parameters. More detailed ones, describing the musculoskeletal system (reduced muscle tissue, increased fat mass, etc.), can provide information about possible problems. For instance, waist-to-hip ratio is one of the most well-known values used to estimate abdominal obesity. When BMI is chosen as a body fat measure, the results show a higher risk of bowel cancer only for obese men. But the waist-to-hip ratio measure shows that both women and men have a higher risk of that disease. Thus, fat around the stomach is the problem, at least for women (Dai et al., 2007; Pischon et al., 2006).

The prevention and early detection of such diseases becomes one of the main objectives after hospitalization and particularly relates to young convalescents. Keeping a healthy weight, normal fat distribution and appropriate exercise parameters reduces cancer risk, as may losing weight.

The aim of the study was to assess selected body composition parameters after completion of antitumor therapy and to compare them with the same parameters of healthy children.

Material

The data set used in this study comes from the Department of Pediatric Oncology and Haematology, Medical University of Bialystok. Seventy-two children were described by variables that presented measurements of the musculoskeletal system for two groups of children. The first group – the treatment group – was formed by children treated for cancer. The second group was the control and it was formed by healthy children, who were siblings of treated patients or children hospitalized for reasons other than cancer.

The attributes belonged into one of the two groups. The first group was formed by general measurements. Eleven attributes described each patient: *the indication of the group*, *gender*, *diagnosis*, *bone marrow transplantation*, *taking steroids*, *irradiation of the central nervous system*, *age during research*, *age at diagnosis*, *age at the cancer treatment end*, *weight SDS* and *BMI SDS*. The last two variables have been presented as standard deviation scores (SDS).

The second group of variables consisted of attributes describing body composition parameters chosen by a physician. The musculoskeletal system measurements were made using the professional medical body composition analyzer – InBody 370. It has received FDA approval and its main purpose is to diagnose hidden obesity. Parameters of four different types were measured: water, proteins, fat and minerals. Bone mineral content (BMC) is linked with osteoporosis and can be influenced by antitumor treatment.

Among the seventeen variables, ten were selected for further analysis as being of the doctor's interest: *skeletal muscle mass* (kg), *body fat mass* (%), *degree of abdominal obesity* (waist-hip ratio), *bone mineral content* (kg), *protein mass* (kg), *mineral mass* (kg), *fat free mass* (kg), *degree of obesity*, *visceral fat area* and *intracellular water mass* (l).

All of the musculoskeletal measurements were continuous values with different ranges. The slight inconvenience with these variables is as follows. The norm of each variable changes in time. Thus, for different ages and different gender, the norm is different. Due to that fact, deviations between the original values and the appropriate norms were calculated. These new values were then used for analysis.

Methods

The Stata IC/11.0 and the SAS System were used to perform statistical calculations. For comparisons between groups, the assumption about normal distribution was checked by using the Shapiro-Wilk test. If the assumption was fulfilled, the assumption about variance equality was checked. The t-test was performed to compare two groups. If unequal variances had been shown, the Welch approximation was used. In the case of non-normal distributions, the Kruskal-Wallis test was used.

For normally distributed data, the mean values with standard deviation are presented in the results, while for non-normally distributed data, the median is shown. The difference in proportions has been checked using the Fisher exact test.

Principal component analysis was applied to reduce the multivariate problem for musculoskeletal variables. To classify the objects in a new space, the Weka system was used and the John Platt's sequential minimal optimization algorithm was used for training a support vector classifier.

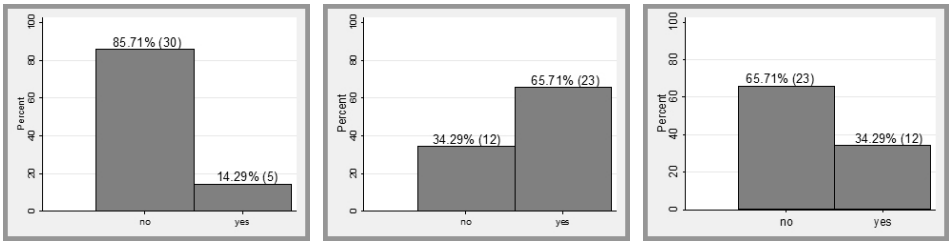
In the tables below, instead of full names of the attributes, abbreviations created from their first letters may be encountered.

Results

In the dataset, among 72 children, there were 48.61% (35 children) in the treatment group and 51.39% (37 children) in the control group. Males constituted 47.22% (34) and females constituted 52.78% (38) in the whole group. There were 18 females and 17 males in the treatment group, and 20 females and 17 males in the control. In the treatment group 42.86% of patients (15 children) suffered from leukemia, 14.28% (5 children) from lymphoma and 42.86% (15 children) had solid tumors. Because of the very small number of lymphoma patients, these children have been attached to the group of leukemia patients.

Out of 35 patients, 85.71% (30) did not have bone marrow transplantation, while 5 patients did (Figure 1a). The percentage of patients that took steroids during treatment was 65.71% (23), while 34.29% (12) did not (Figure 1b). The percentage of patients that received irradiation of the central nervous system was 34.29% (12), while 65.71% (23) did not (Figure 1c).

Upon studying the homogeneity due to age between groups formed by treatment and gender, it was observed that there was no evidence of any difference in age between control and treatment groups ($t = 1.24$, $p = 0.222$).



a) transplantation b) steroids c) RTX

Figure 1. Indications of a) bone marrow transplantation; b) taking steroids; c) irradiation of the central nervous system

There was also no evidence that there was any difference in age between males from control and treatment groups ($t = 1.876$, $p = 0.074$), and the same was true for females ($t = 0.023$, $p = 0.982$).

Upon analyzing the treatment group, there was no difference found between females and males regarding age ($t = 0.888$, $p = 0.381$), age at diagnosis ($t = 0.211$, $p = 0.835$), age at the end of treatment ($t = 0.364$, $p = 0.719$) and time from the end of treatment ($t = 0.674$, $p = 0.507$), see Table 1.

Table 1. Comparison of four variables connected with age in gender groups

	Females $N = 18$				Males $N = 17$				p
	n	$\bar{x}$	sd	*Range*	n	$\bar{x}$	sd	*Range*	
Age (years)	18	14.97	3.73	10–21	17	16.06	3.49	10–22	0.381
Age at diagnosis	17	7.51	5.23	0.32–17	17	7.89	5.09	1.32–17	0.835
Age at the end of treatment	16	9.14	5.41	0.83–18	17	9.81	5.15	2.23–19	0.719
Time from the end of treatment	12	5.05	3.40	1–10	13	5.95	3.22	1–10.25	0.507

Table 2. Comparison of the mean age in groups related with time from treatment end

	Time from end of treatment: from 1 till 5 years $N = 12$				Time from end of treatment: above 5 years $N = 13$				p
	n	$\bar{x}$	sd	*Range*	n	$\bar{x}$	sd	*Range*	
Age (years)	12	14.08	0.93	10–22	13	16.12	1.09	10–22	0.175

There was no evidence that there was any difference in age between the group of patients who had fewer than 5 years from the end of treatment and the group of patients with a longer time from the end of treatment

Table 3. Comparison of four variables connected with age in diagnosis groups

	Leukemia+Lymphomas $N = 35$				Solid tumors $N = 37$				p
	n	$\bar{x}$	sd	*Range*	n	$\bar{x}$	sd	*Range*	
Age (years)	20	14.83	3.42	10–21	15	16.40	3.76	10–22	0.205
Age at diagnosis	19	7.04	4.79	0.39–17	15	8.54	5.49	0.32–17	0.403
Age at the end of treatment	18	9.12	5.07	0.83–19	15	9.92	5.52	2.23–18	0.669
Time from the end of treatment	16	5.41	3.49	1–10.25	9	5.70	3.01	1–10	0.839

($t = -1.4$, $p = 0.175$), see Table 2. The two groups formed by diagnosis were also homogeneous due to age, age at diagnosis, age at the end of treatment and time from the end of treatment (Table 3).

There was also no significant difference in BMISDS between the treatment and control group ($\chi^2 = 2.991$, 1 df, $p = 0.084$).

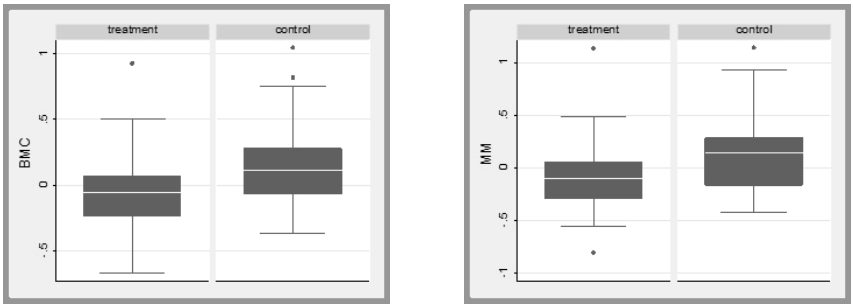
Musculoskeletal System Parameters

By using the Shapiro-Wilk test it was confirmed that none of the body composition variables were normally distributed in the entire treatment group and gender subgroups at the significance level of 0.05.

The results of comparison of musculoskeletal parameters between the treatment and control group are presented in the Table 4. A statistically significant difference can be observed for two parameters: bone mineral content and mineral mass (Figure 2).

Table 4. Comparison of the variables describing the musculoskeletal system between the treatment and control group

	Treatment $N = 35$ *Me*	Control $N = 37$ *Me*	χ^2 (1 df)	p
Skeletal muscle mass	–1.9	–0.3	3.01	0.083
Body fat mass	2.8	4.9	0.16	0.689
Degree of abdominal obesity	–0.02	–0.01	0.78	0.376
Bone mineral content	–0.06	0.11	6.77	0.009
Protein mass	–0.6	–0.1	3.46	0.063
Mineral mass	–0.1	0.14	6.06	0.014
Free fat mass	42.5	47.7	1.59	0.207
Degree of obesity	97.3	106.4	2.86	0.091
Visceral fat area	33.3	40	1.28	0.257
Intracellular water mass	–1.4	–0.2	2.76	0.096



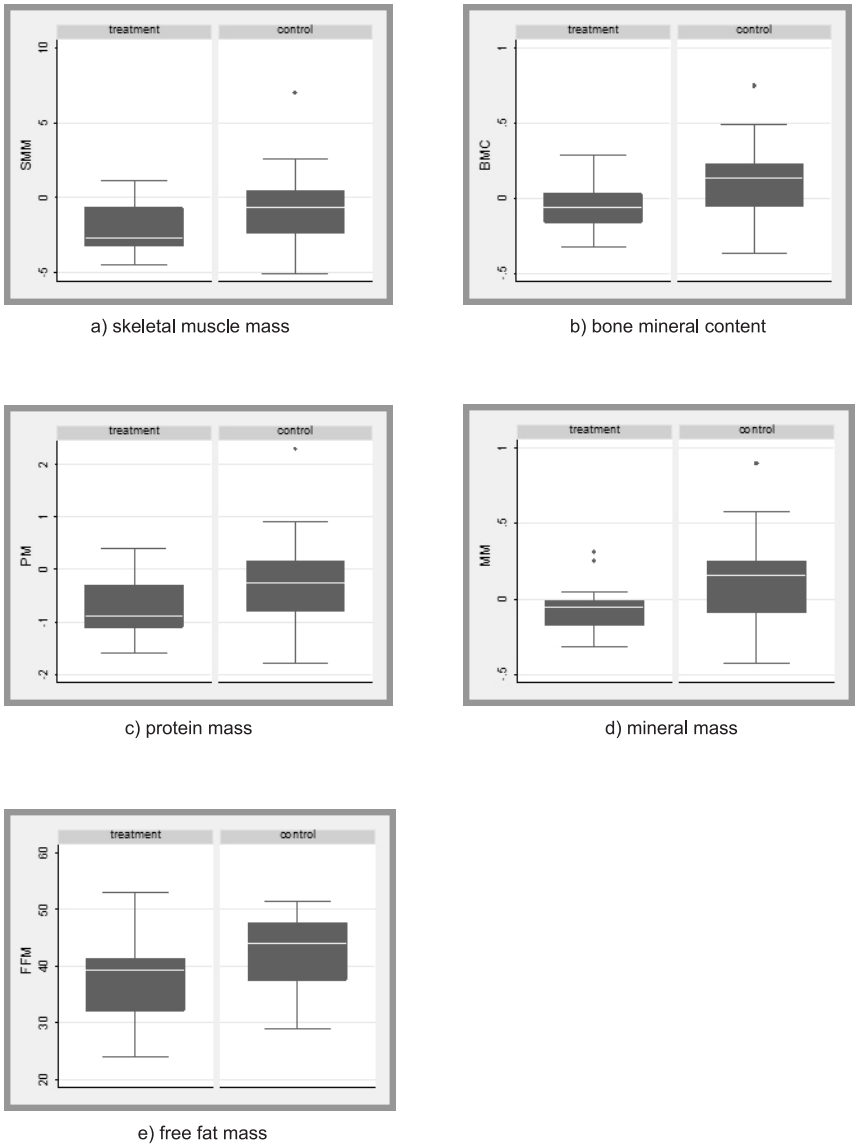
a) bone mineral content b) mineral mass

Figure 2. Box plots for two parameters between the treatment and control group

Examining differences in the mean values of parameters, gender was checked. Treated girls were compared to girls from the control group and for boys an analogical analysis was performed (Table 5). The differences in parameters observed between mixed gender treatment and control groups were caused by the group of girls. Bone mineral content, mineral mass, protein mass and free fat mass were variables with a statistically significant difference between median values. The differences are also presented in Figure 3.

Table 5. Comparison of the variables describing the musculoskeletal system between treatment and control groups according to gender subgroups

	Gender = Male				Gender = Female			
	Treatment $N = 17$ *Me*	Control $N = 17$ *Me*	χ^2 (1 df)	p	Treatment $N = 18$ *Me*	Control $N = 20$ *Me*	χ^2 (1 df)	p
Skeletal muscle mass	–0.9	–0.1	0.57	0.449	–2.7	–0.65	4.01	0.045
Body fat mass	5.0	0.3	0.60	0.438	0.8	5.25	2.05	0.152
Degree of abdominal obesity	–0.01	–0.02	0.01	0.945	–0.025	–0.01	1.73	0.188
Bone mineral content	–0.07	0.07	2.25	0.134	–0.06	0.135	6.18	0.013
Protein mass	–0.3	–0.1	0.50	0.480	–0.9	–0.25	4.62	0.031
Mineral mass	–0.14	0.03	2.30	0.130	–0.06	0.155	4.87	0.027
Free fat mass	52.0	53.9	0.83	0.361	39.25	44.1	4.81	0.028
Degree of obesity	98.2	105.8	0.57	0.449	97.15	107.55	3.50	0.061
Visceral fat area	41.2	58.8	0.157	0.692	31.15	39.6	2.59	0.108
Intracell. water mass	–0.7	–0.1	0.712	0.398	–2.05	–0.55	3.34	0.068



a) skeletal muscle mass

b) bone mineral content

c) protein mass

d) mineral mass

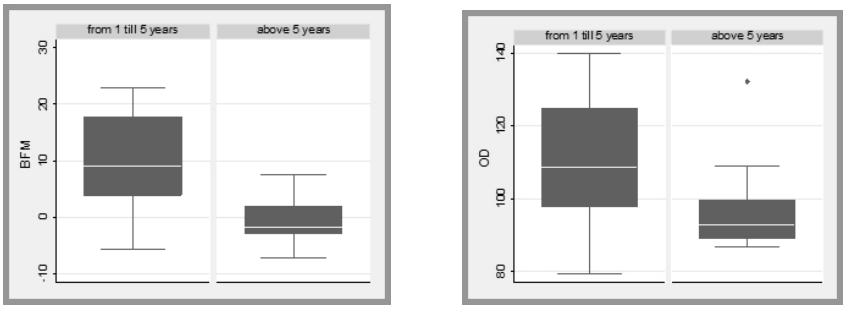
e) free fat mass

Figure 3. Box plots for parameters between the treatment and control group in the female subgroup

In Table 6 and Figure 4, the differences in parameters can be observed due to the amount of time that had passed after the end of treatment. The stabilizing process can be observed by looking at body fat mass and degree of obesity parameters.

Table 6. Comparison of the parameters in groups related with time from end of treatment

	Time from end of treatment: from 1 till 5 years $N = 12$			Time from end of treatment: above 5 years $N = 13$			p
	$\bar{x}$	sd	Me	$\bar{x}$	sd	Me	
Skeletal muscle mass			–1.25			–1.5	0.935
Body fat mass	9.4	9.49		–0.85	4.21		0.004
Degree of abdominal obesity	–0.007	0.05		–0.035	0.03		0.066
Bone mineral content			–0.05			–0.1	0.114
Protein mass			–0.5			–0.5	0.978
Mineral mass			–0.055			–0.1	0.301
Free fat mass	42.05	13.03		49.19	13.37		0.189
Degree of obesity			108.7			92.8	0.033
Visceral fat area			41.45			25.7	0.157
Intracellular water mass			–1.2			–1.2	0.828



a) body fat mass b) degree of obesity

Figure 4. Box plots for two parameters between groups related with time from end of treatment

PCA Analysis

Studying interrelations between chosen variables in the musculoskeletal system, very strong correlations can be noticed between almost all variables. They are presented in Table 7. For instance, the skeletal muscle mass variable is highly correlated with almost all remaining variables apart from the body fat mass variable. The values of correlation range from 0.443 for the degree of abdominal obesity variable, to 0.997 for the protein mass variable.

The body fat mass variable is most highly correlated with the degree of obesity (0.761) and the degree of abdominal obesity (0.745). The situation is similar for almost all remaining variables. This may be an indication that an additional method of analysis, such as Principal Component Analysis, can be performed to try to reduce the multivariate data into a lower dimensional issue, especially when the number of observation are rather small. If PCA is performed, the original data will be reoriented so that the multitude of original variables can be summarized by a couple of new components that capture the maximum possible information – variance – from the original attributes.

Because there were different scales used for variables in the data and the PCA is sensitive to that, the PCA based on the correlation matrix rather than the covariance matrix was calculated.

Table 7. Correlation matrix of ten musculoskeletal parameters

	smm	bfm	aod	bmc	pm	mm	ffm	od	vfa	iwm
smm	1.000									
bfm	0.059	1.000								
aod	0.443	0.745	1.000							
bmc	0.768	0.466	0.376	1.000						
pm	0.997	0.068	0.448	0.773	1.000					
mm	0.836	0.318	0.467	0.984	0.837	1.000				
ffm	0.722	–0.076	0.240	0.592	0.732	0.631	1.000			
od	0.656	0.761	0.840	0.769	0.661	0.768	0.400	1.000		
vfa	0.563	0.654	0.831	0.601	0.568	0.628	0.485	0.833	1.000	
iwm	0.979	0.042	0.433	0.726	0.977	0.814	0.703	0.633	0.607	1.000

The results are presented in Table 8. The first eigenvalue equals 6.65, thus the first principal component explains 66.5% of the total sample variance (6.65/10). The first two principal components, collectively, explain 87.2% of the total sample variance. The first three principal components explain, respectively, 92.9% of the total sample variance. Consequently, sample variation is summarized very well by two principal components. The reduction in the data from 72 observations on 10 variables to 72 observations on 2 principal components is reasonable.

The scree plot of eigenvalues with an added line across the y-axis at 1 and heteroskedastic bootstrap confidence intervals, which is presented in Figure 5, was used to decide how many principal components should be selected for further analysis.

Table 8. Contribution of eigenvalues and principal components in total sample variance division

Principal component no.	Eigenvalue	Difference	Proportion	Cumulative
1	**6.65436**	4.5855	0.6654	**0.6654**
2	**2.06883**	1.5041	0.2069	**0.8723**
3	0.56470	0.1583	0.0565	0.9288
4	0.40644	0.2591	0.0406	0.9694
5	0.14736	0.0346	0.0147	0.9842
6	0.11281	0.0869	0.0113	0.9954
7	0.02587	0.0128	0.0026	0.9980
8	0.01310	0.0090	0.0013	0.9993
9	0.00409	0.0017	0.0004	0.9998
10	0.00244	.	0.0002	1.0000

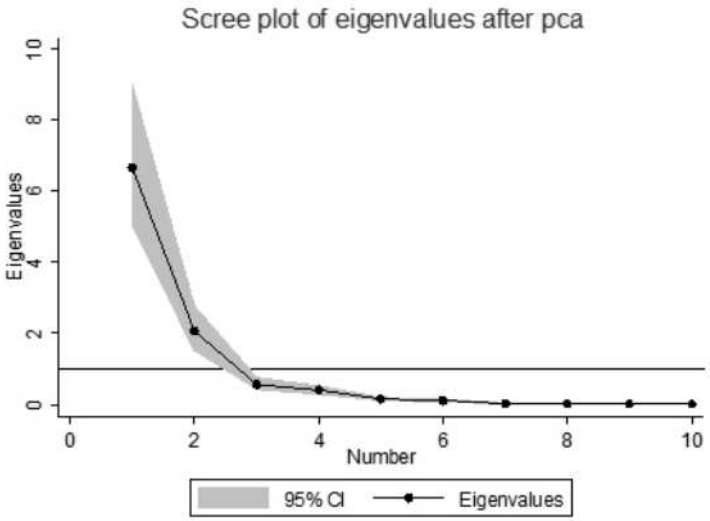


Figure 5. The scree plot of the eigenvalues

On the basis of Kaiser's rule we should retain only components with eigenvalues that exceed unity. This means that the component accounts for at least as much variation as the original variable. Two principal components should be chosen regarding this rule. Studying the scree plot in the Figure 5, a "break" in the plot can be observed between the second and the third principal component. This may be used to confirm the results obtained by

the previous method. Finally, three principal components were chosen for further analysis, to enlarge the amount of explained sample variance.

The factor loadings obtained from the analyses and final forms of the principal components' equations are shown in Table 9 and below. The factor loadings are the correlations between the original variables and principal components. By rule of thumb, only absolute values larger than 0.3 were considered.

Table 9. Factor loadings for three principal components

Variable	Comp 1	Comp 2	Comp 3	Unexplained
smm	**0.349**	–0.259	0.086	0.046
bfm	0.168	**0.602**	–0.179	0.044
aod	0.270	**0.415**	**0.376**	0.079
bmc	**0.344**	–0.045	**–0.568**	0.028
pm	**0.351**	–0.255	0.088	0.042
mm	**0.356**	–0.092	**–0.460**	0.018
ffm	0.269	**–0.312**	**0.328**	0.256
od	**0.343**	0.288	–0.096	0.038
vfa	**0.316**	0.278	**0.365**	0.102
iwm	**0.344**	–0.256	0.165	0.061

The first three principal components are as follows:

$$Comp1_i = 0.349 \cdot smm_i + 0.344 \cdot bmc_i + 0.351 \cdot pm_i + 0.356 \cdot mm_i + 0.343 \cdot od_i + 0.316 \cdot vfa_i + 0.344 \cdot iwm_i$$

$$Comp2_i = 0.602 \cdot bfm_i + 0.415 \cdot aod_i - 0.321 \cdot ffm_i$$

$$Comp3_i = 0.376 \cdot aod_i - 0.568 \cdot bmc_i - 0.460 \cdot mm_i + 0.328 \cdot ffm_i + 0.365 \cdot vfa_i$$

The first principal component (*Comp1*) is most influenced by skeletal muscle mass, bone mineral mass, protein mass, mineral mass, degree of obesity, visceral fat area and intracellular water. These variables form the pattern of general health and body composition. If someone is fit and healthy, they will have an appropriate skeletal muscle mass, bone mineral mass, protein mass, degree of obesity, and visceral fat area. If the muscles are in good condition, the amount of intracellular water mass will also be large enough. The second principal component (*Comp2*) is associated with fat – three variables have an influence on that component. They are body fat mass, degree of abdominal obesity (describing the waist-hip ratio) and free fat mass. This component differentiates body fat mass and fat located around the stomach from the free fat mass. The last component (*Comp3*)

differentiates mineral variables (bone mineral mass and mineral mass) from variables associated with abnormal fat distribution.

The unexplained variances in all variables are of a similar order. The average unexplained variance is equal to the overall unexplained variance of 4%, apart from the free fat mass variable, for which the unexplained variance is about 25%. The component loadings are presented in Figure 6.

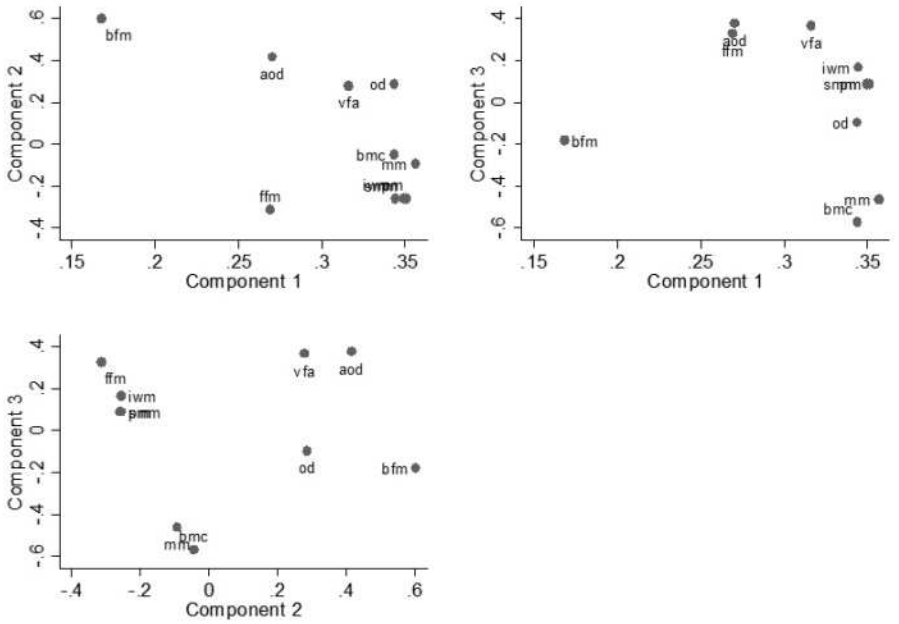


Figure 6. Component loadings

Bartlett's test of sphericity was performed to check if the analysis was reasonable. The hypothesis that the correlation matrix is an identity matrix was tested. At the significance level of 0.05 we reject the null hypothesis ($\chi^2 = 1500.321$, $p < 0.001$) and can conclude that there are correlations in the data that are appropriate for principal component analysis. The value of the overall Kaiser-Meyer-Olkin Measure of Sampling Adequacy for this set of variables is 0.767, which would be labeled as 'middling'. Since the KMO Measure of Sampling Adequacy meets the minimum criteria, we do not have a problem that requires us to examine the correlation matrix and the reasonable usage of principal component analysis in this case has been confirmed. For every variable, the value of KMO is also larger than 0.5. Thus, all variables may be included in the principal components building process.

In Figure 7, there are three two-dimensional plots of principal components with observations from treatment (circles) and control groups (squares). In all cases the groups are not separable, which provides confirmation for the results obtained with the statistical tests.

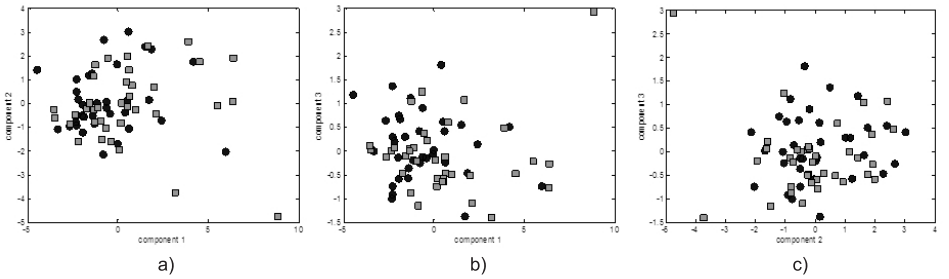


Figure 7. Observations divided into treatment and control groups on principal component axes

In Figure 8, shapes represent groups with time from treatment end. The circles signify observations for which the time from end of treatment is less than 5 years, while squares signify observations with time after treatment equal to or greater than 5 years. What is very interesting here is that in Figures 8a and 8c, all the square observations have values less than zero for component 2. This means that patients with longer time after treatment have smaller values of fat parameters.

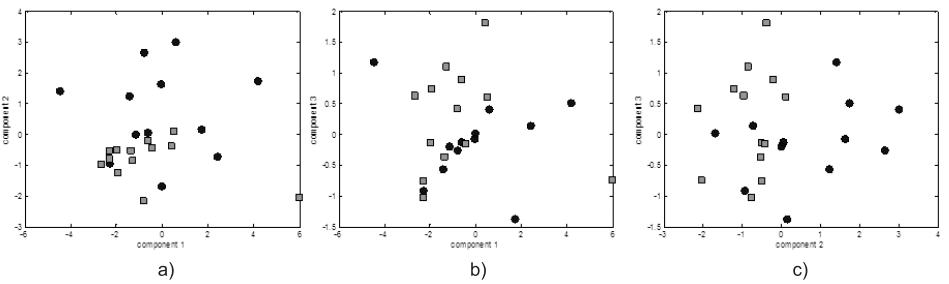


Figure 8. Observations from treatment group divided into groups of time from end of treatment on principal component axes

Only 5 patients had bone marrow transplantation; thus, the pattern obtained in Figure 9 may be accidental and the inference that was made on that basis may be a mistake.

In Figure 10, circles denote patients who were treated without steroids versus squares, which denote patients who took steroids during treatment. We can observe that general body composition condition (first principal

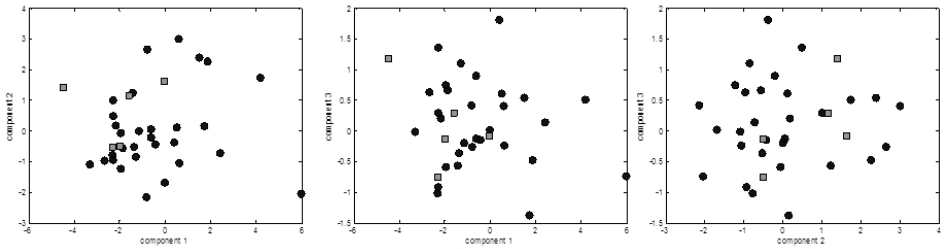


Figure 9. Observations from treatment group divided into groups of transplantation indication on principal component axes

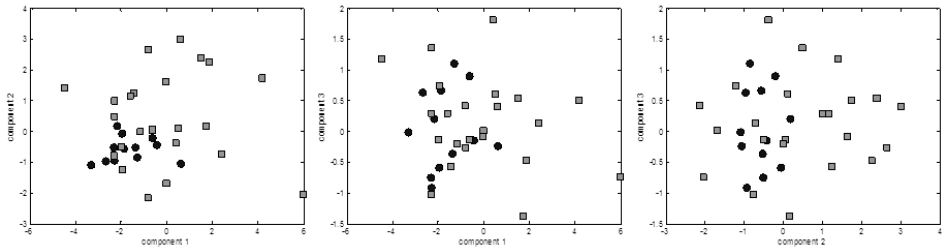


Figure 10. Observations from treatment group divided into groups of steroid treatment on principal component axes

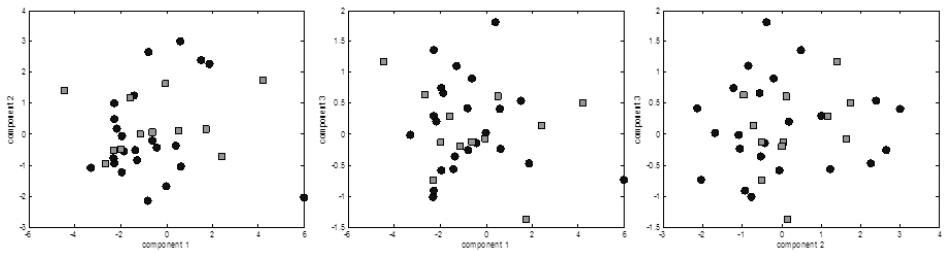


Figure 11. Observations from treatment group divided into groups of irradiation of central nervous system indication on principal component axes

component) and fat parameters (second principal component) are better for the patients cured without steroids. This may be confirmation that steroids have an influence on body composition parameters and could be the cause of higher weight and fat parameters.

For the group treated with irradiation of the central nervous system, there is no difference between parameters formed by principal components when comparing these patients to the patients without irradiation (Figure 11).

The next step, after the reduction of dimensionality in the attribute space, was the attempt to classify objects from different groups. Six analyses were performed to classify treated patients versus healthy children, treated patients versus healthy females, treated patients versus healthy males, and in the treatment group: patients with time after end of treatment from 1 to 5 years versus above 5 years, those taking steroids versus no steroids and finally patients who had irradiation of the central nervous system versus no rtx. The SMO algorithm was chosen and presented due to the best obtained results. The parameters had values as follows: complexity 10.0 and tolerance 0.01. As for a kernel function, the polynomial kernel with exponent parameter equal to 1.0 was applied. For evaluation, 10-fold cross-validation was used. The quality of classification (Q) was calculated as a percent of correctly classified instances. The area under the ROC curve and F-Measure are presented as additional measurements to confirm the classification results, which are in Table 10.

Table 10. Classification results; Q – accuracy; AUC – area under ROC curve; F–measure

	Q (%)	AUC	F-Measure
treatment vs. control group	62.50	0.627	0.622
treated females vs. healthy females	68.42	0.686	0.684
treated males vs. healthy males	41.18	0.412	0.393
time from treatment end groups: 1–5 years vs. $>$ 5 years	64.00	0.604	0.633
taking steroids vs. not taking steroids	71.43	0.683	0.714
rtx vs. no rtx	65.71	0.5	0.521

As might be expected, in all cases of classification the accuracy was not satisfactory and was at the level of approximately 60–70%. Only for boys was the value drastically smaller. In trying to separate treated and healthy children on the basis of cumulated information about musculoskeletal parameters, only 62.5% accuracy was obtained. The AUC was 0.627, while the F-measure equaled 0.662. The best results were for the separation between children taking steroids and treated children without the need to take this kind of medication. The accuracy was at the level of 71.43%, the area under the curve equaled 0.683, while F-Measure was 0.714.

All of these achievements confirm the results from the previous paragraph, where only selected singular variables were statistically different between analyzed groups. This effect was masked by other attributes.

Conclusions

Optimal body composition and a sufficient amount of exercise are key elements in preventing the development of diseases and staying healthy for years. Overweight and obesity can be particularly dangerous because of their proven influence on many diseases, including tumors. Not only well-known parameters such as body mass index can describe this problem. There are also a lot of different parameters that may show the hidden problem with body composition or cardiovascular problems in our organisms.

A lack of protein implies a lack of muscle or poor nutrition. Mineral mass is closely related to soft lean mass. If a person has more lean mass, the weight of bones strengthens, which, in turn, increases the bone mineral mass. Body fat mass can be stored under the skin, as well as in the abdomen. When a person's body fat mass is higher than the standard range, they are clinically obese. One-hundred percent normal skeletal muscle mass refers to the ideal quantity of skeletal muscle mass for a person's standard weight. One-hundred percent normal body fat mass refers to the body fat mass that a person should maintain for his/her standard weight. Visceral fat is the fat potentially stored around a person's abdominal organs and a high level of visceral fat over a long period of time puts a person at a greater risk of developing cardiovascular disease, type II diabetes, high lipid levels and hypertension. It is related to high percentage of body fat and high waist – hip ratios.

The main problem with the presented data is the small number of observations made in each group. The real differences between examined subgroups may have been omitted because of that limitation. The second problem is the number of variables of physicians' interest. Many variables are correlated and that is the problem in this case. One of the ideas might be correcting standard errors by the usage of a multivariate normal model, but our data are not normally distributed here. Therefore, principal component analysis can be applied, and was applied in the case of our research, to reduce the dimension of the attribute space. New variables provide independence, but detailed information about particular differences might be lost.

The study has shown that there can be a problem among treated children with normal values of musculoskeletal parameters. Abnormal values for fat distribution are the sign to start prophylaxis and to prevent excessive weight gain among children. A high percentage of overweight and obesity as well as abnormal fat distribution in convalescents with cancer shows a significant adverse effect of therapy on body composition and suggests the need

for early intervention of diet and exercise, which would help the patient to quickly achieve the proper parameters of body composition.

The results suggest the need for education and intervention in the treated group as well as the necessity of collecting a greater number of observations to confirm the real differences.

REFERENCES

Bjorge, T., Engeland, A., Tretli, S., & Weiderpass, E. (2007). Body size in relation to cancer of the uterine corpus in 1 million Norwegian women. *Int J Cancer*, 15, 120(2), 378–83.

Dai, Z., Xu, Y. C., & Niu, L. (2007). Obesity and colorectal cancer risk: A meta-analysis of cohort studies. *World J Gastroenterol*, 13(31), 4199–4206.

Foxhall, L. E. (2013). *The obesity-cancer connection, and what we can do about it.* Retrieved from American Cancer Society website: http://www.cancer.org/cancer/news/expertvoices/post/2013/02/28/the-obesity-cancer-connection-and-what-we-can-do-about-it.aspx.

Kubo, A., & Corley, D. A. (2006). Body Mass Index and Adenocarcinomas of the Esophagus or Gastric Cardia: A Systematic Review and Meta-analysis. *Cancer Epidemiol Biomarkers Prev*, 15(5), 872–878.

Leiba, A., Kark, J. D., Afek, A., Levi, Z., Barchana, M., Tzur, D., Derazne, E., et al. (2012). Overweight in Adolescence Is Related to Increased Risk of Future Urothelial Cancer, *Obesity*, 20(12), 2445–2450.

Merry, A. H., Schouten, L. J., Goldbohm, R. A., & van den Brandt, P. A. (2007). Body Mass Index, height and risk of adenocarcinoma of the oesophagus and gastric cardia: a prospective cohort study. *Gut*, 56(11), 1503–11.

Pischon, T., Lahmann, P. H., Boeing, H., Friedenreich, C., Norat, T., Tjonneland, A., Halkjaer, J., et al. (2006). Body size and risk of colon and rectal cancer in the European Prospective Investigation into Cancer and Nutrition (EPIC). *J Natl Cancer Inst*, 98(13), 920–931.

Reeves, G. K., Pirie, K., Beral, V., Green, J., Spencer, E., & Bull, D. (2007). Cancer incidence and mortality in relation to body mass index in the Million Women Study: cohort study. *BMJ*, 335(7630), 1134.

Tirosh, A., Shai, I., Afek, A., Dubnov-Raz, G., Ayalon, N., Gordon, B., Derazne, E., et al. (2011). Adolescent BMI trajectory and risk of diabetes versus coronary disease. *N Engl J Med*, 364, 1315–1325.