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RELATIONS BETWEEN SOME ANTHROPOMETRIC PARAMETERS OF KNEE OSTEOARTHRITIC PATIENTS AND SOME INDICATORS OF THE DISEASE

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ABSTRACT

Knee osteoarthritis (OA) is related to the person's gender, weight and age. However, associations between the body types and disease related values are not clear. All the subjects participated in the study of a new mud therapy course in Estonian medical spas and had knee OA. The mean age of the subjects was 61.7 years (62.0 years for women and 61.1 years for men). Based on the 5 SD height-weight classification, devised by the Centre for Physical Anthropology at the University of Tartu, the subjects were divided into five classes (1 – small height and weight; 2 – medium height and weight; 3 – big weight and height; 4 – big weight, small height; 5 – small weight, big height). The results showed that knee OA was more prevalent in women than men. 39.8% of the subjects were obese. Leptomorphic females and males prevailed among the subjects (28.5% and 26.8%, accordingly). Therefore, the height is also one factor which is associated with knee OA. Females had more problems with their knees than males. The group of small females had more problems with both knees, but pycnomorphic females complained more about knee pain in the last month before the study. Therefore, they used more analgesics. In both genders, the more problematic knee was the right knee. The class of medium males also had more problems with both knees. They had the highest values of the morning stiffness of the knee and knees crepitus in active motion.

Keywords: *height-weight classification, knee osteoarthritis, body mass index*

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INTRODUCTION

The main factors associated with knee osteoarthritis (OA) are obesity, previous knee trauma, female gender and older age [4]. To assess obesity, the body mass index (BMI) is used. The mechanism of the association between BMI and knee OA is not only biomechanical, with the excess weight, but it is also related to adipose tissue within the body [5]. Ojoawo et al [9] have found that people suffering from knee OA have significantly higher body weight and BMI values than healthy people. Knee problems are more frequent among women than men and increase with age. Female sex and age over 59 years are strong independent markers for symptomatic knee OA. This may be related to hormonal changes in postmenopausal women. Higher weight is also related to higher pain intensity and functional disability [3]. Wang et al [16] have found that high weight and knee OA are a strong risk factor for primary knee replacement.

BMI is based on a person's weight and height. Actually, it does not measure the percentage of body fat [7, 11]. Ordinarily, it is used to estimate a healthy body weight based on the human's height [11]. BMI characterises only obesity but not different body types, as some body build classes (for example small and leptosomic) may have an almost equal value of BMI, although the body types are very different [10]. To study clinical data, using anthropometric parameters and a height-weight classification for systematisation of the characteristics of the human body as a whole are suggested [15]. The Centre for Physical Anthropology at the University of Tartu has introduced a height-weight classification that consists of five classes: 1 – small (small height, small weight); 2 – medium (medium height, medium weight); 3 – large (big height, big weight); 4 – pycnomorphs (big weight, small height); 5 – leptomorphs (small weight, big height) [8]. This classification can be used in different medical studies even if only the person's body height and weight are available. In addition, it helps to understand if the differences in distinct persons are related to their body type as a whole or not [15].

This study concentrates on knee osteoarthritis and people who suffer from it. The aim of the study was to divide the subjects into five classes according to the height-weight classification and to find associations with the person's height, weight, body mass index, age, gender and some disease-related values.

MATERIAL AND METHODS

All the subjects participated in a study related to the new mud therapy complex in Estonian medical spas. The subjects suffered from knee osteoarthritis, which was confirmed by the American College of Rheumatology criteria [2]. They gave a written consent to participate in the study. The study was approved by the Research Ethics Committee of the University of Tartu, Estonia. At the first clinical examination, the anthropometric data (weight – kg, height – cm) and some medical data were collected in an unidentifiable form; no sensitive personal data was recorded. The weight and height values of the subjects were self-reported.

The subjects were aged from 50 to 83 years. The body mass index (BMI) was calculated using the following standard equation: BMI (kg/m^2) = weight (kg) / height (m^2). The subjects were classified as underweight (< 18.50), normal weight (18.50–24 .99), overweight (25.00–29.99) and obese (≥ 30.00) according to the classification system recommended by the World Health Organization [17].

For dividing the subjects by height and weight, the five SD height-weight classification introduced by the Centre for Physical Anthropology at the University of Tartu was used. This classification consists of five classes: small, medium, large, pycnomorphs and leptomorphs [8].

For all anthropometric variables, the basic statistics (mean values $\bar{x}$, standard deviations SD, minimum and maximum) were calculated. Thus, the five height-weight SD classes were created according to the following rules [10]:

Class 1 (small):

$$weight < \bar{x}_w - 0.5\,SD_w \qquad height < \bar{x}_h - 0.5\,SD_h$$

Class 2 (medium):

$$\bar{x}_w - 0.5\,SD_w \le weight < \bar{x}_w + 0.5\,SD_w$$
$$\bar{x}_h - 0.5\,SD_h \le height < \bar{x}_h + 0.5\,SD_h$$

Class 3 (large):

$$weight \ge \bar{x}_w + 0.5\,SD_w \qquad height \ge \bar{x}_h + 0.5\,SD_h$$

Class 4 (pycnomorphs):

$$weight \ge \bar{x}_w - 0.5\,SD_w \qquad height < \bar{x}_h - 0.5\,SD_h \quad \text{or}$$
$$weight \ge \bar{x}_w + 0.5\,SD_w \qquad height < \bar{x}_h + 0.5\,SD_h$$

Class 5 (leptomorphs):

$$weight < \bar{x}_w - 0.5\,SD_w \qquad height \ge \bar{x}_h - 0.5\,SD_h \quad \text{or}$$
$$weight < \bar{x}_w + 0.5\,SD_w \qquad height < \bar{x}_h + 0.5\,SD_h$$

Statistical analysis was performed using the SPSS program, version 17.0. The connection between different parameters was analysed with Pearson's correlation coefficient. Age-related anthropometric differences were mostly insignificant ($p>0.05$). Therefore, the subjects were analysed as one group, as Kaarma et al [7] also did.

Before the statistical analysis, the subjects' weight and height were standardized to search for outliers. One of the easiest ways to standardize is to use two statistical parameters – empirical average and standard deviation, finding *z*-scores which will give the characteristic of normal distribution $N(0;1)$, which is centralized and standardized and enables to compare characteristics with different content [12]. A *z*-score is a number that indicates how far above or below the mean a given score in the distribution is in the standard deviation units [13] and those subjects whose z-score was outside the limits of the Empirical Rule [14] (mean – 3 SD, mean + 3 SD) of the standardized normal distribution are outliers. There were several outliers in the present study database. The main reason was too big weight (men 142 kg and 155 kg and women 120–134 kg) and body mass index (38.7–47.8). These values were not used in the height-weight classification calculation process but were marked as subjects with big weight or height in the system of the five SD height-weight classification.

RESULTS AND DISCUSSION

The age of the subjects varied from 50 to 83 years (mean 61.7 years). The total number of the subjects was 261; 82 males and 179 females. 39.8% of the subjects were obese, and 75% of those were females. After discarding the six outliers, the descriptive statistic values were calculated (see Table 1). The means and standard deviations of age, height, weight, and body mass index were analysed by gender.

Correlations between body height, weight and BMI were found. Male subjects' height and weight correlation was 0.46 and females' 0.40. Weight and BMI correlation was 0.92 in both males and females. There was no statistically significant correlation between height and BMI. Kaarma et al [7] have also found that BMI is not correlated with body height but is correlated with body weight. BMI is a whole body characteristic, and therefore, for a classification of body measurements, height and weight are more preferable. BMI is a valuable addition to height-weight classes. Abbate et al [1] have compared women with

and without knee OA and found that women with knee OA had significantly higher mean BMI and weight. Mean height was similar in both groups, but height seemed to be independently associated with knee OA.

Table 1. Basic characteristics of the study sample

Gender		Age	Height (cm)	Weight (kg)	BMI (kg/m^2)
Male	Mean	61.1	176.2	87.8	28.2
	N	80	80	80	80
	SD	7.9	5.7	14.2	4.1
	Minimum	50	164	60	19.6
	Maximum	83	190	130	40.8
Female	Mean	62.0	163.6	79.1	29.5
	N	177	176	176	175
	SD	7.2	5.9	14.5	5.0
	Minimum	50	150	50	19.1
	Maximum	83	178	115	44.9
Total	Mean	61.7	167.5	81.8	29.1
	N	257	256	256	255
	SD	7.4	8.3	14.9	4.8
	Minimum	50	150	50	19.1
	Maximum	83	190	130	44.9

N – number of subjects, SD – standard deviation

To compare the BMI values of the subjects of the study and of the general population, the study of Health Behavior among Estonian Adult Population was used, which has been conducted each even year since 1990 and forms a part of the Finbalt Health Monitor (Finbalt) co-operative study in which Lithuania, Latvia and Finland participate as well. For comparing the BMI values of the subjects of our study, subjects of the same age group were used as it was in the previous population studies. In the population studies, the suitable age group was 55–64 years. In the knee OA study, this age range covered 41.8 % of all the subjects. BMI was classified according to the system recommended by the World Health Organization [17]. The BMI data of the population study can be found in the Health Statistics and Health Research Database (http://pxweb.tai.ee/esf/pxweb2008/Database_en/Surveys/databasetree.asp). The BMI values of the subjects of another study in the same database (Estonian community based study about health determinants) were also used. This study gives an overview of the health status of Estonian inhabitants in 2011. The age range of 55–70 years was taken for the comparison. This constitutes 65.8% of all the subjects of the present study. The results are given in Table 2.

Table 2. Distribution (%) of subjects of different studies by BMI and gender

Age group	Gender	Study	BMI (kg/m²)			
			<18.5	18.5–24.9	25–29.9	≥30
55–64 years (41.8% of all the subjects of the present study)	Male	HB2000*	0	32.1	48.6	19.3
		HB2002	0	39.0	40.0	21.0
		HB2004	0.5	41.1	34.0	24.4
		HB2006	0.9	28.9	49.6	20.7
		HB2008	1.4	28.4	44.5	25.6
		HB2010	1.3	29.7	44.8	24.1
		HB2012	0.8	32.8	37.8	28.6
		Mean	0.7	33.1	42.8	23.4
		SD	0.6	5.0	5.7	3.2
		Present study	0	17.6	47.1	35.3
	Female	HB2000*	0.6	27.3	40.0	32.1
		HB2002	0.6	29.2	39.0	31.2
		HB2004	0	32.0	38.9	29.1
		HB2006	0.3	29.6	41.1	29.0
		HB2008	0.9	22.8	39.1	37.2
		HB2010	0.3	26.6	41.5	31.6
		HB2012	1.2	29.9	35.5	33.3
		Mean	0.6	28.2	39.3	31.9
		SD	0.4	3.0	2.0	2.8
		Present study	0	19.7	36.8	43.4
55–70 years (65.8% of all the subjects of the present study)	Male	EC2011**	1.3	38.8	38.2	21.7
		Present study	0	18.8	47.9	33.3
	Female	EC2011**	3.5	45.7	28.4	22.5
		Present study	0	19.1	40.0	40.8

*Health Behavior among Estonian Adult Population in Health Statistics and Health Research Database

** Estonian community based study about health determinants in Health Statistics and Health Research Database

From Table 2, it can be calculated that among the 55–64-year-old male subjects in the present study, 47% fewer were with normal weight, 10% more with overweight and 51% more obese than in the Estonian population studies on average. Among the female subjects of the same age in the knee OA study, there were 30% fewer with normal weight, 6% fewer with overweight and 36% more obese than in the population studies. Among the 55–70- year-old male subjects, 52%

fewer were with normal weight, 25% more with overweight and 53% more were obese than in the community-based study. Among female subjects of the same age, 58% fewer had normal weight, 41% more were overweight, and 81% more were obese. There were no underweight subjects in the present study. Previous studies have also shown that knee OA is more frequent in women and obese people [4, 6].

The subjects were classified into five classes of the SD height-weight classification (Table 3). Most male subjects were marked as with medium weight (40.2%) or medium height (39%). The female subjects were divided almost equally between three classes, but the number of woman with light weight and medium height was a few percentage points bigger than the other two groups. There are some other differences by gender in the division into five SD height-weight classes. There are 1.7 times more medium males than females and 15% more leptomorphs among females than among males. The height may influence knee OA, and therefore, taller females have higher odds of knee OA [1]. The same may concern males, but there are no literature data about it. The groups of small, pycnomorphic and large subjects were almost even in both genders.

Table 4 shows the mean values in five SD height-weight classes. The youngest group was large males and females whose BMI value was expectedly high (> 34 kg/m^2). Therefore, the subjects of this group were obese. There was only one group with higher BMI values (35.4 kg/m^2) – pycnomorphic females. The oldest male subjects (63.1 years) were from the medium and females (63.8 years) from the small classes. By BMI values, there was only one group with normal weight, and these were leptomorphic male subjects (24.9 kg/m^2). Leptomorphic females and small subjects of both genders were barely overweight (BMI 25.3–25.9 kg/m^2). Medium males and females were also overweight but nearly obese (BMI 28.5 kg/m^2 and 29.5 kg/m^2, accordingly). All the pycnomorphic subjects in the knee OA study were obese. This was similar to the results of Peterson et al [10] who demonstrated that pycnomorphs and the large class had higher BMI values than others did. However, their study concerned 13–17- year-old students, but in present study, the 50–83-year-old subjects had much higher BMI values.

Table 3. Weight and height classification by gender

Gender	Height class		Weight class			Total
			Light	Medium	Heavy	
Male	Short	Count	15	7	2	24
		% of total	18.3%	8.5%	2.4%	29.3%
	Medium	Count	8	17	7	32
		% of total	9.8%	20.7%	8.5%	39.0%
	Tall	Count	5	9	12	26
		% of total	6.1%	11.0%	14.6%	31.7%
	Total	Count	28	33	21	82
		% of total	34.1%	40.2%	25.6%	100.0%
Female	Short	Count	34	17	8	59
		% of total	19.0%	9.5%	4,5%	33,0%
	Medium	Count	21	22	19	62
		% of total	11.7%	12.3%	10.6%	34.6%
	Tall	Count	9	21	28	58
		% of total	5.0%	11.7%	15.6%	32.4%
	Total	Count	64	60	55	179
		% of total	35.8%	33.5%	30.7%	100.0%

Small, Medium, Large, Pycnomorphs, Leptomorphs

Table 4. Mean values in different height-weight classes

Somatotype		Age		Height		Weight		BMI	
		M	F	M	F	M	F	M	F
Small	Mean	61.0	63.8	168.7	156.7	72.1	63.7	25.4	25.9
	N	15	34	15	34	15	34	15	34
	SD	7.9	7.2	2.3	2.9	5.7	4.9	2.1	1.7
	Minimum	51	51	164	150	62	53	22.0	22.4
	Maximum	78	83	172	160	80	71	29.7	28.4
Medium	Mean	63.1	63.2	176.5	163.8	88.8	79.0	28.5	29.5
	N	17	22	17	22	17	22	17	22
	SD	8.2	8.2	2.0	1.4	3.7	4.2	1.4	1.8
	Minimum	52	50	174	162	82	72	26.5	26.1
	Maximum	79	75	179	166	95	85	31.4	32.4

Somatotype		Age		Height		Weight		BMI	
		M	F	M	F	M	F	M	F
Large	Mean	56.1	58.9	183.8	170.9		100.1	34.4	34.3
	N	12	28	12	28	12	28	12	28
	SD	4.5	8.1	3.6	3.4	17.5	10.5	4.7	3.7
	Minimum	50	50	180	167	100	87	29.9	27.5
	Maximum	63	79	190	178	155	120	45.3	42.5
Pycnomorphs	Mean	60.7	62.9	173.4	160.2	97.2	90.9	32.3	35.4
	N	16	44	16	44	16	44	16	44
	SD	7.5	5.9	3.4	3.3	10.7	12.6	3.5	4.3
	Minimum	51	50	168	150	83	72	28.1	28.8
	Maximum	74	76	179	166	125	130	40.8	47.8
Leptomorphs	Mean	61.9	61.3	180.2	167.4	81.0	71.0	24.9	25.3
	N	22	51	22	51	22	51	22	51
	SD	9.0	6.9	4.1	4.1	9.2	8.6	2.2	2.6
	Minimum	50	50	174	161	60	50	19.6	19.1
	Maximum	83	75	186	178	95	86	28.1	30.1
Total	Mean	60.9	62.1	176.5	163.7	89.3	80.0	28.6	29.8
	N	82	179	82	179	82	179	82	179
	SD	7.9	7.2	5.9	5.9	16.9	15.8	4.6	5.4
	Minimum	50	50	164	150	60	50	19.6	19.1
	Maximum	83	83	190	178	155	130	45.3	47.7

M – male, F – female, BMI – body mass index

Females had more problems with their knees than males (Table 5). The group of small females had more problems with both knees than the group of medium females. Although the small females group complained more about knee problems, they were not physically very active in their daily life. Still, participation in physical exercises only need not help. Leptomorphic females attended more different physical exercise groups, but their number of different complaints was also high. The same was found about the class of medium males. It needs further study why movement therapy in the last six months had not been effective in diminishing of knee problems.

Table 5. Frequencies of occurrence (%) of knee OA problems according to somatotypes

Variables	Gender	Height-weight classes				
		Small	Medium	Large	Pycnomorphs	Leptomorphs
Left knee	F	59%	51%	55%	58%	59%
	M	27%	33%	28%	22%	25%
Right knee	F	63%	54%	60%	62%	60%
	M	24%	38%	25%	22%	22%
Knee pain on most days of the last month	F	55%	44%	58%	67%	56%
	M	24%	23%	18%	18%	21%
Morning stiffness in knees < 30 min	F	59%	56%	68%	65%	63%
	M	22%	41%	23%	22%	26%
Crepitus on active motion	F	59%	51%	60%	58%	60%
	M	22%	33%	23%	23%	27%
Analgesics	F	12%	3%	13%	17%	10%
	M	0%	8%	5%	2%	1%
NSAID	F	51%	46%	55%	55%	49%
	M	20%	31%	23%	20%	16%
Corticosteroids	F	8%	10%	3%	5%	0%
	M	2%	0%	0%	0%	0%
Hyaluronic acid injection	F	2%	0%	5%	3%	1%
	M	0%	0%	0%	2%	1%
Movement therapy	F	8%	23%	25%	20%	26%
	M	0%	13%	3%	10%	1%

NSAID – non-steroidal anti-inflammatory drug, F – female, M – male

The group of medium males also had problems in both knees, but the more problematic knee in both genders was the right knee. In the last month before the study, pycnomorphic females complained more about knee pain on most days than the females of the medium class (67% and 44%, accordingly). Therefore, they used more analgesics and NSAIDs (17% and 55%, accordingly). The medium female class also used more NSAIDs than analgesics to diminish their pain problems. As this group felt much better in the last month before study, they also had the lowest values of morning stiffness and knee crepitus in active motion.

CONCLUSIONS

Classification by height and weight of knee OA patients who participated in the new mud therapy complex study showed that knee problems were more prevalent in females. Their BMI was mostly high; therefore, there were too many overweight and obese people among them. 28% of the subjects were leptomorphs, which means that height has an influence on knee OA, and taller people with normal weight have higher odds of knee OA. Females had more complaints about knee problems. They used more analgesics than males and attended more movement therapy in the last six weeks. However, in both gender groups, the physical activity had no positive effect on knee problems. This aspect will need further studies and may be related to only this research. The next step will be to analyse the influence of selected anthropometric variables on the functioning of patients and pain intensity. It would also be interesting to find how different somatotypes respond to the mud therapy course.

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