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ORIGINAL PAPER

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Infuence of HbA_{1c}, serum lipids, blood pressure and BMI on Auditory Brainstem Response in diabetic patients

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ABSTRACT

Introduction. Impaired hearing organ function including abnormalities in auditory brainstem response (ABR) are more frequent in diabetic subjects compared to the general population. The aim of our study was to assess the impact of selected modifiable factors on ABR latencies in diabetic subjects.

Material and Methods. 58 patients with type 1 and type 2 diabetes, aged <45 years, with diabetes duration <10 years, and without clinically overt hearing impairment or diabetic neuropathy, were included. In all subjects vital signs and blood samples were obtained, and ABR audiometry was performed.

Results. Significantly delayed latencies in ABR were found in patients with total cholesterol <192 mg/dL, with HDL-cholesterol <49.5 mg/dL, with triglycerides >89 mg/dL, with presence of hypertension, and with systolic and diastolic blood pressure >135 and >78 mm Hg respectively. A linear correlation between triglycerides and wave I and III latencies, and between systolic blood pressure and wave III latency were revealed. A relationship between ABR latencies and HbA_{1c}, LDL-cholesterol or BMI was not found.

Conclusions. Several modifiable factors affect functioning of the retrocochlear part of the auditory pathway. If these results were confirmed in further studies, a vast area of possible therapeutic interventions to preserve hearing function in diabetic patients would become available.

Keywords. auditory brainstem response; diabetes mellitus; serum lipids.

Introduction

The prevalence of hearing impairment in diabetic subjects is roughly doubled compared to the non-diabetic population and along with noise exposure and smoking, diabetes can be counted among risk factors of hearing impairment.[1,2] The negative impact of diabetes on auditory organ function has been studied for years and it was also summarized in recently published reviews and meta-analyses.[3-5] In contrary to the non-diabetic population, the prevalence of hearing impairment in diabetic

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subjects did not decrease during the three decades of observation in the U.S.[6] One of the clinical manifestations of hearing organ impairment seen in diabetic patients is delayed nerve conduction velocity along the auditory pathway. First described by Jewett et al. in 1970 , evaluation of auditory brainstem response (ABR) became the most commonly used non-invasive electrophysiological test to determine function of the retrocochlear part of the auditory pathway, up to the brainstem level.[7,8] Wave I in ABR arises from the distal part of the auditory nerve (first-order neuron of the auditory pathway), a branch of the vestibulocochlear (VIII) cranial nerve. Wave III reflects activation of the second-order neuron at the cochlear nuclei, while wave V likely originates from the lateral lemniscus.[8] The main abnormalities found in ABR in type 1 diabetes are delayed latencies of wave III and V, and prolonged interpeak latencies III-V and I-V.[4] In type 2 diabetic subjects, there were delayed wave III and V latencies (in this review interpeak latencies were not analyzed).[5]

Among factors affecting hearing function in diabetes the role of its metabolic control has been the most extensively studied. These data are divergent and they are discussed in a small review.[9] Data regarding influence of other mediators on auditory organ function in diabetic populations are scarce. In a population drawn from the National Health and Nutrition Examination Survey (NHANES) diabetes, low HDL-cholesterol, higher BMI and higher CRP level were associated with a higher risk of hearing impairment.[10] In one of the studies HDL-cholesterol, triglycerides and BMI were associated with higher hearing threshold and otoacoustic emission (OAE) abnormalities.[11] Relationships between lipid abnormalities and impaired OAE in diabetic subjects were also described by Erdem et al., while Duck et al. found higher hearing threshold in hypertensive patients with diabetes.[12,13]

Since data regarding associations between serum lipids, blood pressure, BMI, and auditory brainstem responses in diabetic subjects are scarce, we decided to perform this interdisciplinary study to assess the impact of these potential mediators of hearing function on waves and interpeak latencies in auditory brainstem response audiometry in a group of young adult subjects with both type 1 and type 2 diabetes mellitus.

Material and methods

58 diabetic subjects of Caucasian ethnicity, among them 31 patients with type 1 diabetes and 27 with type 2 diabetes, with no history of noise exposure and/or ototoxic medication use, were included. The other inclusion criteria were: age below 45 years, a diabetes history of no longer than 10 years (to avoid advanced diabetic complications), and no clinically overt diabetic neuropathy or hearing impairment present. Among study participants 10 subjects had an early background retinopathy, 2 patients had microalbuminuria, 28 were hypertensive, 17 patients were overweight and 14 were obese. The detailed characteristics of the study group are presented in Table 1.

Table 1. Characteristics of the study participants

Parameter	*Value ± SD*
Gender (n)	
women	21 (36.2%)
men	37 (64.8%)
Age (years)	33.7 ± 7.9
Retinopathy (n)	
normal eye fundus	49
background retinopathy	5
not examined	4
Nephropathy (n)	
normoalbuminuria	49
microalbuminuria	02
not examined	07
Albuminuria (mg/l)	09.9 ± 7.6
BMI (kg/m^2)	26.9 ± 6.7
Lipid profile (mg/dl)	
total cholesterol	182.1 ± 35.6
LDL cholesterol (calculated)	107.2 ± 32.6
HDL cholesterol	052.6 ± 14.6
triglycerides	108.0 ± 69.3
Creatinine (mg/dl)	0.77 ± 0.18
Glycated hemoglobin HbA_{1C} (%)	7.16 ± 1.56
Hypertension (n)	28 (48.3%)
Blood pressure (mm Hg)	
systolic	137.4 ± 17.9
diastolic	081.3 ± 12.1

SD – standard deviation

Study was approved by the Bioethics Committee at Regional Medical Chamber in Rzeszów; Poland. After an informed consent was obtained, in all patients weight, height and blood pressure were measured, and BMI was calculated. Blood samples for fasting serum lipids were obtained in 54 subjects (4 patients were not fasting). Total cholesterol, HDL-cholesterol and triglycerides were measured, while LDL-cholesterol level was calculated using the Friedewald formula.[14] Morning urine samples were analyzed for microalbuminuria in 51 subjects. After vital signs and blood samples were obtained, patients were referred to the Department of Otorhinolaryngology at the Provincial Specialist Hospital in Rzeszów, Poland, where a detailed ear examination by an ENT (Ear-Nose-Throat) specialist was performed to exclude abnormalities of the external and middle ear. Then auditory brainstem response evaluation was carried out in all study participants by trained audiological technicians.

Auditory brainstem response audiometry was performed using a Centor-C analyzer (Racia-Alvar, Paris, France) with a click stimulus of 100 μs duration,

a repetition rate of 19.1 Hz, and intensity of 70 dB. The electrodes were placed on the forehead (positive), the ipsilateral mastoid (negative), and chin (ground). The results were presented as a waveform graph and also in a tabular form where the latencies of particular waves and interpeak latencies were presented. Waves I, III and V were identified in 49 (97 ears), 47 (92 ears) and 57 patients (114 ears) respectively. Interpeak latencies I-III, I-V and III-V were assessed in 45 (90 ears), 49 (97 ears) and 47 subjects (92 ears) respectively. For comparisons between 2 or 3 groups, data from all ears were taken, whereas for linear correlation analysis between ABR latencies and different variables, mean values for each wave and interpeak latency in particular patients were used.

The blood lipids were assessed using an Architect c8000 analyser (Abbott Laboratories, Irving, TX, USA) at the Medical Diagnostic Center "Medicor", Rzeszow, Poland.

Glycated hemoglobin (HbA_{1c}) was measured from capillary blood using a DCA 2000®+ analyzer (Siemens, Elkhart, IN, USA) with the monoclonal antibody method. Also microalbuminuria, determined by the albumin concentration and albumin/creatinine ratio from a morning sample of urine, was assessed using the same analyzer.

Blood pressure was measured using an automatic Omron 705 IT blood pressure monitor (Omron Healthcare Europe BV, Hoofddorp, The Netherlands). Hypertension was diagnosed if measured values were ≥140/90 mm Hg or if the patient was using anti-hypertensive medications.

Body weight and height were measured using the legalized electronic medical scales WPT 150.0 (Radwag, Radom, Poland), and then the BMI was calculated.

To assess the presence of retinopathy in all but four subjects, eye fundus examination by an ophthalmologist was performed within a three-months window from the ABR evaluations.

Statistical analysis of the data was performed using SigmaPlot for Windows version 12.5 (Systat Software Inc., San Jose, CA, USA). If not mentioned otherwise, the data were expressed as mean and SD (standard deviation). The data comparing two groups of patients were analyzed using a two-tail Student's t-test for independent variables or a Mann-Whitney rank sum test where appropriate. The data comparing three groups of patients were analyzed using one way ANOVA or Kruskal-Wallis ANOVA on ranks where appropriate. The linear correlations between ABR latencies and HbA_{1c} level, blood pressure values, lipid parameters or BMI due to its non-parametric distribution, were analyzed using a Spearman rank order correlation test. A P value <0.05 was considered statistically significant.

Results

HbA_{1c}

HbA_{1c} level ≤7.0% (53.0 mmol/mol) is recommended by Polish Diabetes Association (PTD) as a general treatment target in diabetes.[15] Such value was measured in 28 patients. No significant differences in the ABR latencies between this group and subjects with HbA_{1c} >7.0 % was found. Also no linear correlations between HbA_{1c} and ABR latencies were revealed.

Serum lipids

Due to a large disproportion between number of patients fulfilling and not-fulfilling blood lipids concentration criteria recommended by the Polish Diabetes Association [23] (e.g. only 14 patients had trigliceride levels exceeding 150 mg/dl), we decided to divide patients into groups below and above median values of each lipid parameter.

Median total cholesterol concentration was 192 mg/dL (5.0 mmol/L). Surprisingly, patients with higher cholesterol level had shorter interpeak I-III latency. No other significant differences were revealed (Table 2).

Median LDL-cholesterol concentration was 110.1 mg/dL (2.85 mmol/L). No significant differences in ABR latencies between groups below and above median were found (Table 2).

Median HDL-cholesterol concentration was 49.5 mg/dL (1.3 mmol/L). Patients with lower HDL-cholesterol values had a delayed wave V and also delayed interpeak I-V latency compared to the group with higher HDL-cholesterol level (Table 2).

Median triglycerides concentration was 89 mg/dL (1.0 mmol/L). Higher triglycerides level was associated with significantly longer wave I and wave V latencies compared to the remaining group (Table 2).

Positive linear correlation between triglycerides level and latencies of waves I and III was found (coefficient R=0.442, p=0.003, and R=0.306, p=0.046 respectively) (Figure 1). For other blood lipids no linear correlations were revealed.

Blood pressure

Among the study participants 28 patients had diagnosed hypertension. In comparison with the remaining 30 subjects, patients with hypertension demonstrated significantly delayed wave I and wave III latencies (Table 2). Also patients with systolic and diastolic blood pressure above median had significantly longer wave III latency (Table 2). Moreover, linear association between SBP and wave III latency has been found (coefficient R=0.308, p=0.036) (Figure 2).

Body mass index (BMI)

Among study participants 27 subjects had normal weight (BMI <25 kg/m^2), 17 were overweighted (BMI

Table 2. Impact of analyzed variables on ABR latencies (significant differences in bold)

Parameter		*Latency (ms) (mean ± SD)*					
		Wave I	*Wave III*	*Wave V*	*Interpeak I-III*	*Interpeak III-V*	*Interpeak I-V*
HbA_{1c} (%)	≤7	1.76±0.13	3.93±0.21	5.85±0.25	2.17±0.16	1.90±0.21	4.08±0.20
	>7	1.76±0.13	3.93±0.19	5.78±0.26	2.17±0.16	1.83±0.15	4.01±0.19
Total cholesterol (mg/dL)	<192	1.75±0.13	3.95±0.21	5.83±0.28	**2.21±0.14**	1.86±0.16	4.06±0.21
	≥192	1.77±0.13	3.91±0.19	5.80±0.25	**2.11±0.17**†	1.87±0.21	4.02±0.20
LDL-cholesterol (mg/dL)	≤110	1.75±0.13	3.94±0.22	5.83±0.27	2.19±0.15	1.86±0.16	4.06±0.20
	>110	1.77±0.14	3.92±0.19	5.80±0.26	2.13±0.18	1.87±0.20	4.02±0.21
HDL-cholesterol (mg/dL)	≥50	1.76±0.13	3.92±0.20	**5.77±0.27**	2.15±0.16	1.88±0.19	**4.01±0.21**
	<50	**1.76±0.14**	**3.94±0.21**	**5.87±0.25***	2.18±0.17	1.90±0.20	**4.09±0.18***
Triglycerides (mg/dL)	<89	**1.72±0.12**	3.89±0.19	**5.77±0.25**	2.17±0.16	1.85±0.17	4.04±0.21
	≥89	**1.81±0.13**†	3.97±0.22	**5.87±0.27***	2.15±0.17	1.88±0.20	4.05±0.20
Hypertension	No	**1.74±0.13**	**3.89±0.19**	5.82±0.29	2.16±0.16	1.87±0.18	4.05±0.22
	Yes	**1.79±0.12***	**3.96±0.20***	5.82±0.22	2.17±0.17	1.86±0.19	4.04±0.17
SBP (mm Hg)	≤135	1.74±0.13	**3.87±0.18**	5.81±0.28	2.13±0.15	1.88±0.20	4.03±0.21
	>135	1.78±0.12	**3.97±0.20**†	5.83±0.24	2.19±0.17	1.86±0.17	4.05±0.18
DBP (mm Hg)	≤78	1.74±0.11	**3.88±0.18**	5.80±0.27	2.15±0.16	1.87±0.19	4.04±0.21
	>78	1.78±0.14	**3.97±0.22***	5.84±0.25	2.18±0.17	1.86±0.18	4.05±0.18
BMI (kg/m^2)	<25	1.74±0.12	3.90±0.20	5.80±0.26	2.17±0.16	1.87±0.15	4.06±0.21
	25-29.9	1.78±0.14	3.93±0.18	5.79±0.24	2.17±0.14	1.85±0.18	4.01±0.19
	≥30	1.80±0.12	3.99±0.22	5.88±0.27	2.16±0.20	1.86±0.25	4.04±0.19

SD – standard deviation; *p<0.05, †p<0.01

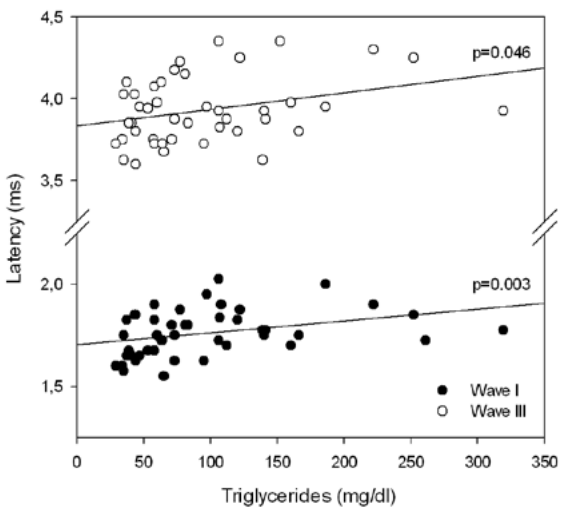

Figure 1. Linear correlation between triglycerides and waves I and III latencies (scatter plot and regression line)

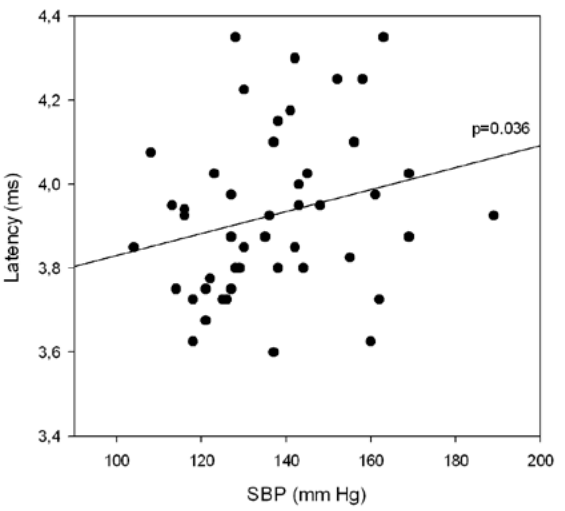

Figure 2. Linear correlation between systolic blood pressure and wave III latency (scatter plot and regression line)

≥25 kg/m^2 and <30 kg/m^2) and 14 were obese (BMI ≥30 kg/m^2). No significant differences in the ABR latencies between the three groups of patients were revealed (Table 2). Also no linear correlations between BMI and wave or interpeak latencies in ABR were noted.

Discussion

our study demonstrated that, apart from the known risk factors of hearing loss, several other mediators may influence the auditory organ function in diabetic patients.

The most of evidence indicate deleterious impact of poor metabolic control on auditory pathway function presented as ABR abnormalities.[16-21] However, in our study HbA_{1c} level was not associated with ABR disturbances.

The association between hyperlipidemia and ABR abnormalities has been evaluated in only two studies. Ben-David et al. revealed that hyperlipidemia (type non-specified) was associated with significantly longer all interpeak latencies in ABR.[22] In contrary, Bhattacharjee et al. did not find any significant differences in ABR audiometry between patients with cholesterol level above vs. below or equal to 200 mg/dl (5.2 mmol/L).[23] Unexpectedly, in our study total cholesterol level above median was associated with shorter interpeak I-III latency, while no relationship between

ABR latencies and LDL-cholesterol concentration was revealed. HDL-cholesterol level appeared to influence the ABR results and patients with lower HDL-cholesterol concentration had a significantly delayed wave V and interpeak I-V latencies. Also triglycerides level was associated with abnormal ABR results. Patients with higher triglycerides values had significantly delayed wave I and wave V latencies, and linear correlation between triglycerides concentration and wave I and wave III latencies was revealed. Because such relationship has not been analyzed previously, it requires further larger studies to be confirmed or excluded. However, some data regarding peripheral or autonomic nerves function support our findings. Triglycerides level above 300 mg/dl (3.39 mmol/L) affected conduction parameters in peripheral nerves.[24] Elevated triglycerides were also associated with progression of peripheral neuropathy in diabetes.[25] In type 1 diabetic patients triglycerides concentration exceeding 0.94 mmol/L (83.2 mg/dl) were related to higher prevalence of cardiac autonomic neuropathy (CAN) compared to the referent group with triglycerides level lower or equal to 0.71 mmol/L (62.8 mg/dl).[26] In this study HDL-cholesterol concentration was inversely associated with CAN prevalence, while total and LDL-cholesterol did not affect the risk of CAN. In the study by Voulgari et al., patients with both type 1 and type 2 diabetes and CAN appeared to have higher triglycerides, total and LDL-cholesterol and also lower HDL-cholesterol level compared to patients without CAN.[27] Thus, such an effect may be also seen in the cranial nerves, and this, at least in part, explains the altered function of a retrocochlear part of the auditory pathway revealed in our study.

Only few studies analyzed the relationship between hypertension and ABR abnormalities. In the first study in the field Tandon et al. revealed relationship between severity of hypertension and prolongation of wave I, II and V, as well as interpeak III-V latencies in subjects with grade III hypertension.[28] Also Goyal et al. observed relationship between severity of hypertension and ABR abnormalities (delayed latencies of wave I, V and interpeak III-V).[29] Similar results were obtained by Khullar et al. In this study delayed latencies of wave I, II and interpeak III-V were observed.[30] Bhattacharjee et al. demonstrated significantly prolonged wave I, II and V, and interpeak III-V latencies in patients with elevated both SBP and DBP. Among patients with both hypertension and hyperlipidemia almost all latencies were affected.[23]

In our study hypertension appeared to affect wave I and wave III latencies in ABR (wave II was not analyzed). Also linear correlation between both SBP and DBP level and wave III latency was revealed. Potential mechanisms of these findings remain unclear. In the mentioned earlier study by Voulgari et al. hypertension and SBP (together with other modifiable risk factors) appeared to be associated with the risk of cardiac autonomic neuropathy in both type 1 and type 2 diabetes.[27]

In two large population-based studies, and in one original study higher BMI appeared to correlate with a hearing impairment.[10,11,31] To date, the impact of BMI on ABR has not been studied yet. In our study we did not find significant differences in ABR results between patients with normal weight, overweight, and obese. Also no linear correlation between BMI and ABR latencies was noted.

The most important limitation of our study, frequently seen also in a vast majority of other original studies, is relatively small group of analyzed patients. Thus, random effect of our findings cannot be excluded. Also some trends observed in our study appeared to be insignificant, likely due to small study group. On the other hand, the strength of our study is a wide range of analyzed variables, which allowed us to find some relationships between these variables and auditory pathway function.

Relationship between blood lipids, blood pressure and ABR disturbances revealed in our and also in other studies, together with association of poor metabolic control with ABR abnormalities found by other researchers, can be, at least in part, explained by the fact, that both hyperglycemia, dyslipidemia and hypertension have a deleterious effect on the structure and function of both the macro- as well as the microvasculature. This may lead to accelerated atherosclerosis of arteries supplying auditory organ, and to development of microangiopathy of the cochlea and acoustic nerve nutritive vessels.[32-34] Moreover, hyperglycemia directly impairs function of a nervous tissue. Also elevated triglycerides and low HDL-cholesterol level seem to play an important role in the metabolism of nervous tissue. As a result an altered acoustic nerve function and delayed acoustic stimulus conduction through peripheral part of the auditory pathway may develop.

It is worth to note that both our study, as well as other original studies were conducted in a relatively small groups of patients. Moreover, in different studies frequently different methodology has been used. This can explain discrepancies in the obtained results, and it is obvious that further observations, involving a larger groups of patients and control subjects are required to confirm the existence of a relationship between these modifiable variables and hearing organ function in diabetic patients.

If these findings are confirmed, a vast area of possible interventions for the preservation of the auditory function in diabetic population will open. In the Fremantle Diabetes Study treatment with fibrates was associated with a lower prevalence of peripheral neuropathy

in type 2 diabetic subjects. Longitudinal observation showed also a lower neuropathy incidence among patients using statins and fibrates.[35] Thus, various hypolipemic and anti-hypertensive drugs, may be potentially useful in prevention of hearing deterioration in diabetes. However, this requires prospective, interventional studies to determine the value of such a treatment methods.

Disclosure

The authors declare no conflict of interest on the area covered by this paper.

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ORIGINAL PAPER

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Real world data supporting identification of the pharmacist's role in obesity and overweight treatment in Poland – a preliminary report

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ABSTRACT

Introduction. Obesity is a significant health and economic problem, both for the patient and the health care system. An essential element in the prevention and treatment of each disease is the engagement of all groups of healthcare professionals. In our study, we performed an analysis of the real world data, obtained from a survey of the medical and socioeconomic problems associated with overweight and obesity. We aimed to identify the pharmacist's role in the management of overweight and obese patients, including their individualized education in an outpatient setting.

Material and methods. The study material consisted of responses obtained from a specially designed questionnaire. Our findings indicate that the study patients had easy access to a pharmacist's professional knowledge, relevant to comprehensive treatment of obesity. In addition, our data indicates a lack of patient knowledge of a healthy lifestyle and an inability to implement such knowledge in practice.

Results. The community pharmacist should actively provide support to patients with obesity (including the primary obesity and those who want to lose excessive body mass for health-related and also for aesthetic reasons) and the management of their weight. The results of our study should be considered as an introduction to further research to facilitate the understanding of problems and expectations of patients and to prepare pharmacists to perform pharmaceutical care (PC) in this regard.

Conclusion. One of the potential options to protect society against the obesity epidemic is an education about the risks inherent to obesity and promotion of a healthy lifestyle.

Keywords. overweight, obesity, pharmaceutical care, treatment, real world data

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Introduction

The role of the pharmacist in supporting patients is increasing, especially concerning diseases related to lifestyle and those affecting a significant part of the society, e.g. related to diabetes or obesity, the last being in the focus of real world data collected in Poland.

Obesity is one of the major health problems societies are facing nowadays. According to the World Health Organization (WHO), overweight and obesity are defined as abnormal or excessive fat accumulation that may impair health.[1] Since 1985, obesity is considered to be a chronic disease.[2] To determine the degree of obesity and overweight, most commonly Body Mass Index (BMI) has been used.[3] For adults, the WHO defines a person with a BMI equal to or more than 25 is overweight and a person with a BMI 30 or more is obese[4]. At present, in addition to the calculation of BMI, the waist circumference (WC) measurement is important for prediction of diseases which are commonly related to overweight and obesity. Based on waist circumference and hip circumference measurements, the waist-hip ratio (WHR) is calculated. The value of WHR above 0.88 in women and above 1.1 in men is defined as abdominal or central obesity.[5,6]

Obesity is a systemic disease that affects people of all ages.[7, 8]. A typical feature is excessive fat tissue accumulation, due to an increased number and size of adipocytes.[9] Nowadays, obesity is not only a single disease, but also a significant social problem, with which medicine is not able to cope. It affects more and more people and sometimes is called the epidemic of the 21st century.

Obesity appears mostly as a concomitant disease accompanying multiple diseases, e.g. central nervous system diseases, metabolic diseases, and chromosomal defects. Obesity can also be a side effect of certain drugs. Obesity created in this way is called secondary obesity.[10]

Obesity leads to serious negative consequences, both medical and social. The first to be mentioned is the type II diabetes mellitus (T2DM) that approximately 80% of obese patients suffer from.[11] The problem of obesity and overweight is increasingly affecting children.[7] The second major complications are cardiovascular disorders (CVD) which are a consequence of atherosclerosis. Other medical conditions that cause obesity include changes in joints, fractures, or dislocations.[12] Other disorders in the organism are related to skin: fungal infections, eczema, sores, stretch marks, and furunculosis. Long-term obesity leads to disorders of the liver, cirrhosis and steatosis.[11] From the reproductive system, we observe abnormalities occurring during the menstrual cycle, anovulatory cycles, decreased libido, and reduced fertility.[7] It should also be mentioned that obesity can lead to sleep apnea syndrome and asthma.[11] Consequently, obesity carries serious health consequences and even leads to a shorter lifetime expectancy.[12]

According to the results of IASO/IOTF (International Association for the Study of Obesity/International Obesity Task Force) from 2010, it is estimated that about 1 billion adults have an overweight (BMI 25-29.9 kg/m^2) and another 475 million are obese.[13] The results of epidemiological studies conducted in 2003-2007, on the prevalence of obesity and overweight in among Polish adults (above 20 years) suggest that 28.4% of women and 40.3% of men suffer from being overweight and 23.8% of women and 20.8% men were obese.[14]

Different research has been performed in relation to obesity. A study by Kwagyan et al. demonstrated a high incidence of obesity and related cardiovascular (CV) events. They emphasized the need to focus on reducing obesity in a population at high risk. Associated with obesity, the incidence of hypertension, dyslipidemia and diabetes was 57%, 27% and 24%, respectively. The predicted 10-year risk of developing coronary heart disease (CHD) ranged from 4% to 17% for women and 6% to 29% for men. After six months of lifestyle changes, many of the risk factors improved, and the risk of CHD was reduced from 6% to 4% in women and from 16% to 13% in men.[15] However, no research was found in relation to the pharmacist's role in supporting obese patient treatment.

There is a need for evaluations of interventions to manage obesity and overweight in the pharmacist's community. Research in this area is warranted and trials should include the assessment of age, sex and socioeconomic status and contextual factors.[16]

Objective

Our research aimed to determine the role of the pharmacist in the prevention of obesity, as well as in pharmaceutical care delivered for patients with obesity or who are overweight.

On the basis of obtained real world data in order to fulfill the study objective, our project describes epidemiological characteristics of respondents with obesity, as well as those with normal body weight.

Materials and methods

We used a specially constructed questionnaire for this study. It contained 43 closed questions and 7 questions half-opened, divided into sections addressing lifestyle, including dietary habits and physical activity. We also collected data about chronic diseases, nutritional therapy, and on the participant's opinions about being assisted by a pharmacist during treatment. The questionnaire contained information about the respondent, including their data on weight, height, and the ability to calculate BMI.

The study was approved by the Ethics Committee of the Medical University of Lublin.

The survey was dedicated to the adult population of Polish people who believed that they are overweight or obese. Before conducting the study, the readability and understanding of the questionnaire was assessed and validated in a group of 10 patients. The study lasted from February 2012 to May 2012. The study was conducted using an online questionnaire. The survey was secured against being filled several times by the same person. A total of 177 completed questionnaires were collected. Information about the survey was placed on social networks.

The data obtained were analyzed using the computer software MS Excel 2007. The results were analyzed in aggregated form as descriptive statistics, showing the distribution of the quantity and a percentage of answers in each category.

Results and analysis

The study involved 177 people, including 114 women and 63 men. Analysis of the age structure of respondents revealed that the most numerous group was represented by people younger than 25 years. Demographic characteristics of the participants are presented in Table 1.

Only 22 people (12.4%) indicated physical work, including 5 women that indicated two types of work. Among the women who filled out the survey, the observed body weight was 38 kg as a minimum and 124 kg as the maximum and their height ranged from 142 to 179 cm. Body weight of men was in the range of 63 to 140 kg and the height from 168 to 192 cm. Among the respondents, 19 men (30.2%) and 37 women (32.5%) were not able to calculate their BMI. It is worth noting that only overweight and obese patients had a problem with the correct calculation of BMI, in total it was 31.6% of respondents.

The majority of respondents (72.3%) usually consumed 3-4 meals per day, 21.5% of people consumed 5 meals and only a few individuals among respondents declared consumption of 1-2 meals (5% of respondents) or more than 5 meals per day (1.6% of respondents). 36% of women drawn attention to a number of calories in the food. 40 women (35.1%) and more than half of men (52.4%) did not pay attention to a number of calories in the meals. Following the recommendations of nutritionists, an adult should consume 5 small meals, taking into account their caloric content and to avoid frying meals. The vast majority of people filling out the questionnaire (78.5% of respondents) declared that they do not apply to these rules. However, 49.1% of respondents (87 persons) believe that they are eating healthy. While an equally large group of respondents indicated that they are eating poorly, 67 persons (37.9%) and 23 persons (13%) were not able to determine their eating habits.

Self-assessment of physical fitness of respondents is quite high and both women and men chose the answer as good or rather good, which represents 142 persons (80.1%) of all responses. The most common sport among the respondents was riding a bike. That answer was provided by 61 respondents (34.5%), i.e. 40 (36.8%) women and 9 (30.2%) men), while in second place, swimming and fitness were mentioned by 45 persons (25.4%) and 42 persons (23.7%) respectively. Among men, the most popular sport is strength training (21 persons, 33.3%). Other sports activities not listed in the questionnaire were declared by 17 (14.9%) of women and 18 (28.6%) men. Respondents mentioned karate, water and winter skiing, hunting, rock climbing and

Table 1. Patient demographic characteristics

		Women (N=114)	Men (N=63)	Total (N=177)
		n (%)	n (%)	n (%)
Age group	<25 years	75 (65.8)	35 (55.5)	110 (62.1)
	26-45 years	21 (18.4)	24 (38.1)	45 (25.4)
	46-60 years	17 (14.9)	3 (4.7)	20 (11.3)
	> 60 years	1 (0.8)	1 (1.6)	2 (1.1)
Type of work	physical	16 (14.0)	6 (9.5)	22 (12.4)
	intellectual	103 (90.3)	57 (90.5)	160 (90.4)
BMI	<18.5	9 (7.9)	0 (0)	9 (5.1)
	18.5-24.99	82 (71.9)	37 (58.7)	119 (67.2)
	25.00-29.99	15 (13.2)	17 (27.0)	32 (18.1)
	>30.00	8 (7.0)	9 (14.3)	17 (9.6)
	mean	22.67	25.24	23.69
	median	21.70	24.19	22.86
	Min	15.43	20.34	15.43
	Max	40.48	39.44	40.48
	SD	4.15	4.13	4.39

Table 2. Respondents knowledge regarding the consequences of obesity

	Women		Men		Total	
	(N=114) n (%)	mean BMI (SD)	(N=63) n (%)	mean BMI (SD)	(N=177) n (%)	mean BMI (SD)
Yes	86 (75.4)	21.74 (3.67)	53 (84.1)	25.46 (4.38)	139 (78.5)	23.16 (4.34)
No	9 (7.9)	25.83 (2.83)	6 (9.5)	26.12 (4.12)	15 (8.5)	25.95 (3.27)
I don't know	4 (3.5)	27.09 (2.92)	1 (1.6)	24.22 (3.67)	5 (2.8)	26.52 (2.84)
I'm not interested	15 (13.2)	24.92 (5.30)	3 (4.8)	26.12 (3.90)	18 (10.2)	25.12 (5.01)

rope parks, table tennis, tennis, squash and team games e.g. football, volleyball, basketball and paintball.

Among the respondents, very few people perform sports activities every day. It was declared by less than 14 (8%) of all respondents. 34 (53.5%) of men and 53 (46.1%) of women reported physical activity 3 times a week, indicating the activity time of 30-60 minutes among women and more than 60 minutes among men. More than 19 (11%) of respondents do not undertake any exercise.

When asked about changes in their lives influenced by physical activity, they mentioned frequently improvement in their mood (41–36.4% of women and 24 –38% men), an increase of energy to work or to study (30–26.3% women and 15–23.9% of men) and improvement of their physical appearance (28–24.6% women and 17–26.8% men).

The cause of low physical activity is the lack of free time in the case of 66 (37.3%) of all respondents, lack of willingness (23–20.3% women and 13–20.2% men), lack of financial resources (19–16.9% women) and an excess of duties (16–14.3% of women and 7–1.5% men).

Another objective of the study was to test the knowledge of the respondents regarding the consequences of obesity. The results are shown in Table 2.

Most of the respondents (139, 78.5% people) claim to know the consequences of obesity. It can be noted that among the respondents, 53 (84.1%) men and 86 (75.4%) women are aware of the consequences of obesity. It is interesting also the statement by 15 (13.2%) of women and 3 (4.8%) of men that the consequences of obesity are not in the scope of their interest. However, it should be noted that this response was provided in the vast majority by persons with a BMI above 25.

An important aspect of the study was to determine the health status of the respondents and the impact of obesity on that state. Obesity does not interfere with daily life in case of 54 people (30.5%), while 48 (27.1%) respondents are aware of the risks associated with this disease. In the case of 3 (2.6%) women and 4 (6.3%) men, obesity contributed to the development of diseases such as diabetes, arthritis, hypertension, elevated cholesterol and triglycerides plasma levels and cholelithiasis. One person pointed out two diseases - diabetes and osteoarthritis. From chronic diseases, 21 (11.9%) suffer out of 177 respondents. Diseases mentioned by the respondents were: hormonal disorders (7 people, 4.0% of the studied population), circulatory disorders (5 people, 2.8% of the studied population), diabetes mellitus (3 people, 1.7% of the studied population), respiratory diseases (2 people, 1.1% of the studied population), arthritis and chronic allergy (2 people respectively, 1.1% of the studied population and glaucoma (1 person, 0.6% of the studied population).

Among the respondents, 24 (21.1%) women and 14 (22.2%) men answered that they are slimming contin-

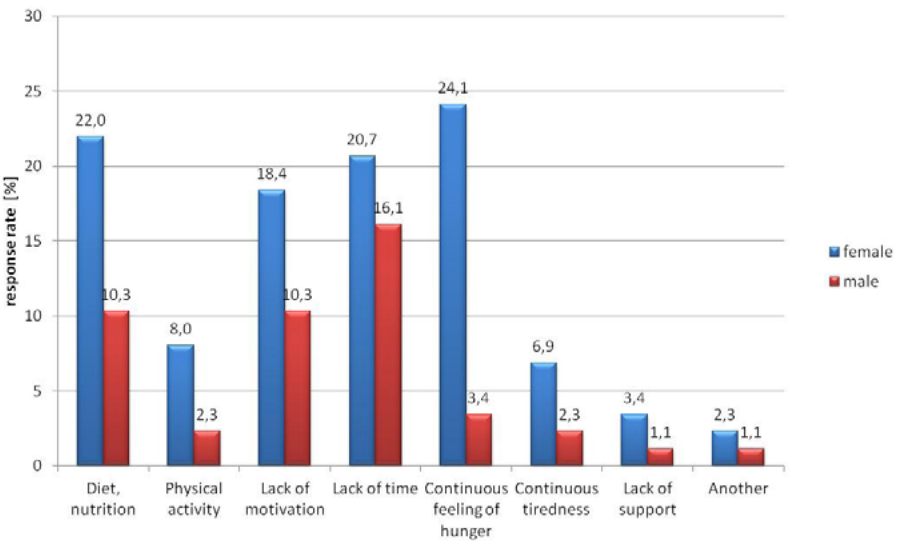

Figure 1. Most difficult situations during weight loss

Table 3. Effectiveness of treatment and occurrence of adverse events assessed by respondents using drugs and dietary supplement weight loss

		Female	Male	Total
		n (%)	n (%)	n (%)
Effectiveness of treatment with drugs and dietary supplements	Effective	7 (14.3)	5 (41.7)	12 (19.7)
	Not effective	13 (26.5)	4 (33.3)	17 (27.9)
	Difficult to say	29 (59.2)	3 (25.0)	32 (53.5)
Adverse events	Yes	8 (16.3)	2 (15.4)	10 (16.1)
	No	33 (67.3)	8 (61.5)	41 (66.1)
	I don't know	8 (16.3)	3 (23.1)	11 (17.7)

uously. The answer that sometimes was chosen only by 44 (38.6%) women and 13 (20.6%) men. Among those group, they were asked what are the most difficult situations and the biggest problems during the weight loss process. Figure 1 shows the results.

Respondents were asked whether they use dietary supplements or drugs for weight loss. 119 (67.2%) responded that they do not, while 44 (24.8%) of people answered that they use supplements or drugs and 19 (10.7%) only occasionally. Among the used products the most frequently mentioned (by 100 respondents, 56.5%) were plant preparations. Three patients indicated sibutramine, as a product they used. That is a very worrying information since sibutramine was withdrawn from trading on the Polish pharmaceutical market in 2010.

Analysis of the answers has shown that 78 (43.9%) of persons treated with drugs or food supplements use them irregularly, only when necessary and 12 (7%) are using them for longer than six months.

Respondents also determined the effectiveness of treatment and occurrence of adverse events. The results are summarized in Table 3.

The effectiveness of medications or dietary supplements used by 95 respondents in order to lose weight was assessed rather negatively as 53.5% replied difficult to say and (49) 27.9% as ineffective. This is essential information for the pharmacist as an advisor in the self-treatment process. 117 respondents in the vast majority (66.1%) stated that there were no side effects observed by them when they were using drugs and dietary supplements. Particular attention must be paid to those who responded affirmatively to this question since it is important their response after the diagnosis of the adverse event (10 people - 5.6%).

Those who responded do not know (11 persons - 6.2%) require a detailed education on the occurrence of adverse drug reactions. Regarding this, necessary information should be given by a pharmacist during the dispensing of medicines and diet supplements. The collected data should be an indication for the pharmacists that patients must be informed about the possibility of the occurrence and character adverse events during any pharmaceutical advice-giving situation, especially in the process of self-medication.

Seeing the need to involve the pharmacist into the process of pharmacotherapy of patients with obesity and overweight the respondents were asked whether they expect such assistance from pharmacists. The results are shown in Figure 2.

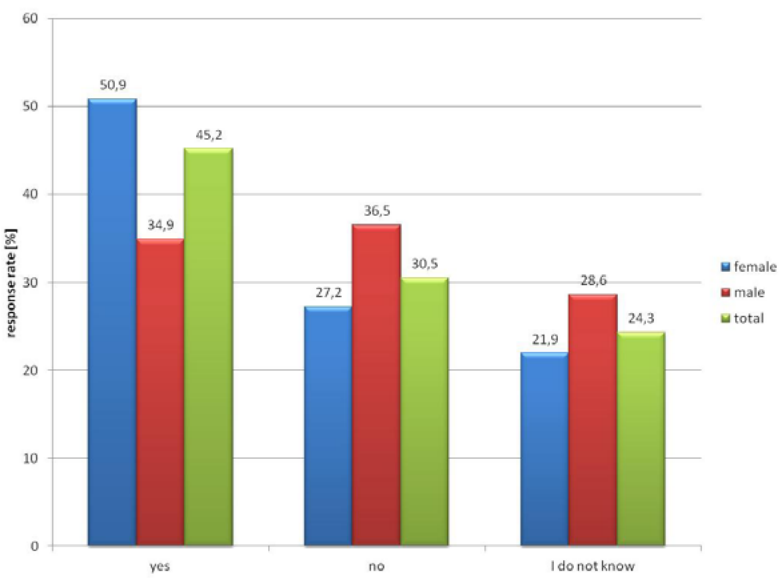

Figure 2. Respondent opinions regarding availability of Pharmaceutical Care (PC) services aimed at weight loss

More than 80 (45%) of respondents see the possibility and the need to be assisted by a pharmacist in their fight against obesity. Among the study group, 54 (30.5%) of respondents do not want to use the knowledge and experience of the pharmacists. However, among the selected answers in the questionnaires, a significant percentage of the patients do not know how to evaluate the possibility of using pharmacist support.

104 respondents (58.8%) believe that pharmaceutical care delivered by pharmacists would help them in the management of overweight and obesity. Unfortunately, 51 (28.8%) of respondents believe the contrary, while 22 (12.4%) did not know anything about the service of pharmaceutical care. Taking advantage of the easy access offered by pharmacies to the possibility of using the services of a pharmacist, an important issue for pharmacists is to show the advantages, opportunities and benefits of implemented pharmaceutical care, particularly to those who do not know anything about the pharmaceutical care or are against it.

Discussion

Numerous studies have indicated the impact of obesity on patient health as well as the presence of concomitant diseases. Among data available in the literature, a similar relationship to our findings was described by A. Abramczyk. The authors emphasized that among patients with diabetes, normal body weight was declared only by 12.8% of patients.[17] Other patients were overweight or obese.[17] Within the responses on the self-assessment of their health and knowledge about the impact of obesity on their health, every third person could see the risks associated with this disease. Obesity in the case of 7 (4%) respondents contributed to the development of diseases such as diabetes, arthritis, hypertension, gallbladder stones and abnormal diagnostic tests in particular, elevated cholesterol and triglycerides. Due to the number of analyzed persons, this analysis cannot confirm the epidemiological data about diabetes in the obese population. Chronic diseases indicated by 21 of the respondents (11.9%) certainly require the use of medicinal products and compliance with dietary recommendations. In this regard it should be noted a possible solution that has been discussed for years concerning the ability to use the knowledge and skills of pharmacists in ensuring safe pharmacotherapy. One of the proposed activities of pharmacists is the implementation of medical use review (MUR) in the area of drugs used in chronic diseases. These actions undertaken by pharmacists in other countries produce tangible therapeutic effects and improve the quality of life of patients. The task for the pharmacist in the process of delivering the drug or diet supplement used for weight loss is to provide the patient with detailed information about the duration of treatment.

Undoubtedly, the causes of overweight and obesity should be sought in the cultural conditions and habits. Assessing the lifestyles of Polish people based on a survey, we can conclude that it deviates from the desired standards such as planning five balanced meals and physical activity for at least 30 minutes per day seven days a week. In the study group, most patients consumed up to four meals a day and had a good self-esteem in their physical fitness. These results confirm the need to implement healthy eating habits, physical activity from an early age. Wojtyla-Bucior et al., when analyzing the situation of Polish children and adolescents, found that the dietary habits of these groups are unsatisfactory. [18] They consume an insufficient amount of fruits, vegetables and fishes and a lot of snacks, meals and sweet beverages. Knowledge, beliefs, skills and attitudes towards healthy diets and lifestyles acquired during puberty determine lifestyle in adulthood. S. H. Babey et al. indicated positive patterns of social and cultural activities and the support of schools as protective social factors that promote health and well-being of young people. The positive action in the area of health of children and adolescents should include the elimination of the junk food from school shops. These actions are the result of recent changes to the law on food safety and nutrition.[19] Promoting a healthy lifestyle among the population should also be a priority task for the pharmacists. Every third person interviewed confirmed the need to include pharmacists in solving the problems of overweight and obesity. The motivation for a healthy lifestyle, education in the area of calculating calories content of meals or selection of supplementation supporting proper nutrition are just some of the tasks that permanently should be part of the daily life of pharmacists. The consequences of receiving inadequate nutrition are especially severe in the period of growth and development and at old age. A characteristic feature of these periods is the lack of an energy balance. The process of aging is associated with a reduction in body weight associated with a reduction in organ weight, skeletal muscles and bones. According to some researchers, the optimal BMI for persons over 65 years of age should be in the range of 24 to 29 kg/m^2. However due to the necessity to verify the latest data on BMI it is still considered to be optimal for this age group a BMI between 18 to 24.9kg/m^2.[20-22]

Dietz et al. believe that the treatment of obesity needs changes including clinical management and improving the training of health care workers with the skills necessary for the treatment of patients with obesity. The authors pay particular attention to behavioral skills and ability to work in a team of specialists which include the most elementary skills such as reasonable conversations with patients about their weight and the ability to assess their readiness for change. Therefore, authors propose to redefine the professional competen-

cies of the specialists in health care.[23] The need for these changes is confirmed by the fact that in our survey conducted, every eighth respondent was able to determine their expectations for pharmacists.

On the question concerning the application of medicines and diet supplements for weight loss, 100 respondents most often (56.5%) mentioned plant preparations For weight-reduction drugs, three respondents mentioned sibutramine. This response causes concern since sibutramine was withdrawn from the market in the European Union in 2010. Respondents may be indicating this product due to its use in the past. However, the option of purchase via the Internet cannot be excluded. Also, in this situation, the pharmacist can educate the patient indicating the risks associated with the use of products purchased outside the regular circulation of questionable quality and threatening health or the patient's life. This way of distribution is often related to falsified products. It is evident that also these issues that should be explained to the patient by a professional pharmacy team. Another issue in choosing dietary supplements for the treatment of overweight or obesity is the need to correct the information obtained from unreliable advertisements. Advice provided by a pharmacist in the course of issuing to the patient medication or diet supplement used for weight loss should also contain information about the time of the treatment duration.[24]

The majority of respondents (104 - 58.8%) believe that pharmaceutical care would help in recovery from the consequences of overweight and obesity. As M. Panas and J. Brandys note, the problem of obesity is a medical problem and obesity prevention and treatment is a process that requires constant motivation of the patient.[25]

To our knowledge, the present study is one of the very few studies that explore the importance of the role of pharmaceutical services in a daily management of obese patients.

Taking into account the results and expectations of patients, it seems that the community pharmacy, due to easy access to the use of services of a pharmacist, should serve as the primary connection between the patient and all healthcare professions involved in the treatment of overweight and obesity.

Brown et al. conducted a systematic study review of community pharmacy intervention for Public Health. Five studies evaluated the effectiveness of community pharmacy-based weight-loss interventions and did not demonstrate significant differences in weight between groups. However, the majority of these studies were comparing a pharmacy-based intervention with another active intervention either within the pharmacy or in another setting. Five studies evaluated the effectiveness of community pharmacy-based weight-loss interventions that did not demonstrate significant differences in weight between analyzed groups.[16]

In one study participants had significant weight loss compared with the control group after 1 year. Two weight-loss trials reported for cost-effectiveness. The pharmacy-based trial was not cost-effective when compared to the commercial programs. Another study reported costs for two primary care-based weight-loss services (GP and pharmacy) and the costs were broadly similar to that of the pharmacy-based.[16] The overall lack of information in this area supports the need for more research regarding the attitudes of pharmacy staff towards members of the public who are overweight and obese. This work must build and be extended beyond descriptive statistical representations of this phenomenon by including information on the behaviours of pharmacists and other pharmacy staff members and the impact on outcomes for the public.[26]

Conclusion

The community pharmacist should play an active role in facilitating weight loss and maintenance among patients with overweight and obesity (including primarily those, who want to lose the excessive body mass for health-related reasons and also for aesthetic reasons). Potential options to protect society from the obesity epidemic are education about the cardio-metabolic risks (which are inherent to obesity) and promotion of a healthy lifestyle. Regarding this, the pharmacist's expertise, aimed at prevention of potential problems, related to the medications (e.g.: adverse effects, interactions with food, or drug-drug interactions) used for multiple comorbidities of obesity (e.g., CVD), combined with ongoing patient support and improving their quality of life should be utilized by healthcare teams, including collaborating physicians and nurses in the community.

However, further research, focused on a deeper understanding of the psychosomatic problems and expectations of patients with obesity, as well as on designing novel methods to prepare pharmacists to perform pharmaceutical care (PC) in this high-risk patient population is merited.

Study limitations

In the present study, we reported that the conducted research was addressed especially to people who are overweight and obese. However, a significant number of individuals who responded to the questionnaire did not report a BMI over 25. Perhaps this is because the respondents were people under 25 years of age. Respondents with overweight and obesity accounted for a quarter of the studied group. The decision to analyze all questionnaires was taken on the basis that people who filled the questionnaires perceived themselves as obese or overweight. The analysis of the results confirmed that in this group are included respondents who reported chronic diseases such as diabetes or hypertension inseparably associated with overweight and obesity.

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Association between body mass and physical activity with quality of life in patients with rheumatoid arthritis

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ABSTRACT

Introduction. Rheumatoid arthritis (RA) is a progressive joint condition that leads to joints destruction and complications in the internal organs and significantly affects the a patient's functional, physical, psychological and social condition. Over the last few years, research into the quality of life (QoL) in people with chronic disease has been conducted to assess the results of treatment.

Aim. The aim of the study was to assess QoL in various areas of life in regards to physical and mental functioning, social relations, and environmental influences in people with RA.

Material and methods. The study group (subjects with RA) and the control group (subjects without RA) consisted of 48 people each. Subject age ranged from 19 to 68. In order to assess QoL, the WHOQOL-BREF questionnaire was used, while socio-demographic data were assessed with a questionnaire developed by the authors.

Results. QoL in people with RA was lower than that of healthy individuals. The worst QoL was observed in the physical domain. No statistically significant association was found between BMI and QoL. It was found, however, that subjects with RA and a higher level of physical activity had a better QoL than those with a lower level of physical activity.

Conclusion. There was no association between the body mass of RA patients and QoL assessment. However, an association was found between the level of physical activity in people with RA and QoL in the physical and environmental domain.

Keywords. body mass index, quality of life, physical activity, rheumatoid arthritis

Introduction

Rheumatologic diseases include over 300 distinct disease entities. A significant number of patients have a chronic inflammatory process spreading in the connective tissue which is triggered by autoimmune reactions.[1] One of the most common and aggressive connective tissue diseases resulting in deterioration of health and quality of life (QoL) is rheumatoid arthritis (RA). Progressive inflammation of the synovial membrane causes damage to articular and periarticular tissues.[2]

Rheumatoid arthritis is a chronic inflammatory polyarthritis affecting 1% of the general population. In Poland,

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about 400,000 people suffer from RA. Every year between 8,000 and 16,000 new cases are diagnosed. The disease occurs 3-4 times more often in women than men. The peak incidence of this disease is in the fourth and fifth decade of life, although younger and younger people are suffering from this condition. RA is a disease that shortens life of an average of 3 years for women and 7 for men.[3]

Despite the progressive character, the course of RA can be varied. In 70% of people with RA there are periods of relative remission and exacerbation. However, in 15% of patients, the disease-related process has mild activity with the destruction of a few joints. Only 10% of patients suffer long-term remissions, that may take even several years. RA develops rapidly - within a few weeks, and in 15% of patients even within a few days. This condition can lead to significant damage to the joints and, consequently, to disability within 2 years from its onset.[4] It is estimated that every fourth person with RA requires surgical treatment due to the destruction of i.e. a large joint, e.g. a hip or knee joint. Half of the patients become unable to work after five years of illness, and within 10 years this number increases to 100%.[5]

RA has a significant impact on human life. Patients are often dissatisfied with their health and assess their functioning as worsening. The disease is largely associated with suffering due to limitations in performing

Table 1. General characteristics of the studied groups

Variable			*Group*		*p*
			Study	*Control*	
Education	Primary	n	2	0	0.36
		%	4.2	0.0	
	Professional	n	6	8	
		%	12.5	16.7	
	Secondary	n	15	11	
		%	31.3	22.9	
	Higher	n	25	29	
		%	52.1	60.4	
Marital status	Unmarried	n	12	14	0.76
		%	25.0	29.2	
	Married	n	31	30	
		%	64.6	62.5	
	Divorced	n	4	4	
		%	8.3	8.3	
	Widower	n	1	0	
		%	2.1	0.0	
Financial situation	Very good	n	1	14	p<0.001. V Kramera=0.50. Chi-kwadrat=24.28 (df=3)
		%	2.1	29.2	
	Good	n	25	30	
		%	52.1	62.5	
	Sufficient	n	21	4	
		%	43.8	8.3	
	Poor	n	1	0	
		%	2.1	0.0	
Body mass index	Underweight	n	4	2	0.47
		%	8.3	4.2	
	Healthy	n	25	28	
		%	52.1	58.3	
	Overweight	n	11	14	
		%	22.9	29.2	
	Obesity	n	8	4	
		%	16.7	8.3	
Level of physical activity	High	n	5	15	p=0.005. V Kramera=0.33. Chi-kwadrat=10.65 (df=2)
		%	10.4	31.3	
	Moderate	n	21	24	
		%	43.8	50.0	
	Low	n	22	9	
		%	45.8	18.8	

social roles and pain. As a consequence, it leads to a decrease in social and occupational activity, deterioration of the economic situation, thus lowering QoL.[6] Therefore, the study of QoL in people with RA is an important indicator of the effectiveness of treatment and rehabilitation.[7,8]

The aim of the study was to assess the association between body mass, the level of physical activity and QoL in different life domains in people with RA.

Material and methods

Participants

The study group consisted of adults diagnosed with RA whereas the control group were healthy participants. Written consent for participation was obtained from participants prior to the study. All subjects were informed about the possibility of leaving the study at any stage.

Inclusion criteria were as follows: age over 18, diagnosis of rheumatoid arthritis, and the patient's consent

Table 2. Assessment of quality of life in the studied groups

Group	Variable	Domains of quality of life (WHOQOL-BREF)			
		Physical	Psychological	Social relationships	Environment
Study	Mean	42.3	58.0	66.1	57.6
	Median	44.0	56.0	69.0	59.5
	n	48	48	48	48
	SD	13.1	12.7	17.1	13.3
	Minimum	13.0	19.0	19.0	19.0
	Maximum	69.0	81.0	100.0	88.0
Control	Mean	85.5	79.9	82.2	82.2
	Median	88.0	81.0	81.0	81.0
	n	48	48	48	48
	SD	10.0	13.9	12.6	8.2
	Minimum	63.0	44.0	56.0	69.0
	Maximum	100.0	100.0	100.0	100.0
	Maximum	100.0	100.0	100.0	100.0
U Manna-Whitneya		8.500	302.500	528.500	100.000
p		**.000**	**.000**	**.000**	**.000**

Table 3. The association between BMI classification and quality of life

Body mass index	Variable	Study group				Control group			
		Domains of quality of life (WHOQOL-BREF)							
		Physical	Psychological	Social relationships	Environment	Physical	Psychological	Social relationships	Environment
Underweight	Mean	52.0	56.5	68.8	62.5	84.5	72.0	81.5	91.0
	Median	53.5	59.5	72.0	59.5	84.5	72.0	81.5	91.0
	n	4	4	4	4	2	2	2	2
	SD	12.9	13.4	9.0	9.0	4.9	12.7	17.7	4.2
Healthy	Mean	41.4	61.6	67.3	56.4	88.6	86.1	86.2	81.3
	Median	38.0	63.0	69.0	63.0	88.0	88.0	94.0	81.0
	n	25	25	25	25	28	28	28	28
	SD	14.5	13.3	19.9	14.6	8.9	10.4	11.9	7.3
Overweight	Mean	39.9	54.5	61.4	57.0	82.9	74.6	77.2	84.6
	Median	38.0	56.0	56.0	56.0	88.0	81.0	75.0	88.0
	n	11	11	11	11	14	14	14	14
	SD	10.5	6.3	14.1	8.7	10.5	14.2	12.7	10.1
Obesity	Mean	43.8	52.4	67.9	59.6	73.5	59.5	72.0	76.5
	Median	47.0	56.0	65.5	59.5	75.0	59.5	72.0	75.0
	n	8	8	8	8	4	4	4	4
	SD	11.5	16.0	15.6	17.4	7.5	8.3	3.5	3.0
***p* Kruskal Wallis test**		.440	.230	.776	.827	**.018**	**.000**	**.049**	.126

Table 4. The impact of physical activity assessment on quality of life

		Study group				Control group			
		Domains of quality of life (WHOQOL-BREF)							
Level of physical activity	Variable	Physical	Psychological	Social relationships	Environment	Physical	Psychological	Social relationships	Environment
High	Mean	45.0	57.6	66.2	71.6	89.8	87.2	86.3	85.1
	Median	50.0	56.0	56.0	69.0	88.0	88.0	94.0	88.0
	n	5	5	5	5	15	15	15	15
	SD	10.2	9.3	20.6	10.4	8.4	10.2	11.6	5.4
Moderate	Mean	47.8	61.0	63.7	57.9	85.7	81.1	83.4	83.0
	Median	44.0	56.0	69.0	56.0	88.0	81.0	81.0	81.0
	n	21	21	21	21	24	24	24	24
	SD	12.2	12.3	17.3	11.6	9.9	11.1	12.0	9.7
Low	Mean	36.5	55.2	68.5	54.2	77.9	64.7	72.2	75.7
	Median	38.0	56.0	72.0	56.0	75.0	63.0	75.0	75.0
	n	22	22	22	22	9	9	9	9
	SD	12.5	13.7	16.6	13.8	9.4	15.7	11.8	3.6
***p* Kruskal Wallis test**		**.013**	.329	.666	**.027**	**.015**	**.000**	**.021**	**.017**

to participate in the study. Exclusion criteria were following: significant random events within 2 months before examination (such as the death of a family member, divorce etc.), diagnosis of other diseases.

In total, the surveyed population amounted to 96 people. The study group was comprised of 48 people. A control group was also selected in order to maintain the same age and sex structure in relation to the study group (age and sex-adjustment). Most of the respondents (85.4%) lived in the city.

Outcome measurements

We used the WHOQOL-BREF questionnaire (Polish version) to evaluate QoL in our study subjects. The questionnaire allowed us to assess QoL in four domains: physical health, psychological well-being, social relationships, and environmental. The questionnaire consists of 26 questions about the functioning of a person during the last 2 weeks before the test. Questions are scored on a scale from 1 to 5 (1- not satisfied at all; 2 - somewhat satisfied; 3 - moderately satisfied; 4 - very satisfied; 5 - extremely satisfied). Answer scores are calculated according to the WHOQOL-BREF algorithm in the range of 0-100 points. Higher score corresponds to higher QoL.[9]

Anthropometric measures

For each participant, height and weight were measured. The height was measured to the nearest 0.1 cm. Body height was measured in standard conditions, with subjects assuming upright and straight body posture and wearing no shoes.

The body mass was determined to the nearest 0.1 kg with the subject dressed in underwear and without shoes. Body mass index (BMI) was calculated by dividing the average body mass (kg) of each individual by his or her average squared height (m^2).

The socio-demographic data and the level of physical activity were obtained using the author's questionnaire.

Data analysis

Data were analysed with IBM SPSS STATISTICS 20, a data analysis program. Descriptive statistics was used in the analysis: mean, median, standard deviation (SD), minimum, maximum. V Kramera, Chi-kwadrat test, Mann-Whitney*U* test (for binary variables) and Kruskal-Wallis test (for variables above two categories) were used to examine differences between independent quantitative variables.

Results

Table 1 presents the general characteristics of the groups. Statistically significant differences in the material situation and the level of physical activity was found between the subjects from the study and control groups. People from the study group more often showed a lower physical activity level than those in the control group.

The subjects were classified in terms of Body Mass Index (BMI). There was no statistically significant difference in the BMI classification between the subjects from both groups.

Table 2 presents the results of QoL assessment in the studied groups. The subjects from the study group were characterized by a lower QoL level in every analyzed domain (physical, psychological, social relations and environment).

Table 3 presents the association between the BMI classification and QoL level in the analyzed groups. We

found that the subjects from the control group with obesity assessed their QoL worse in every of four analyzed domains. No association between body mass and QoL was observed in RA patients.

Table 4 presents the association between the level of physical activity and QoL. We observed that the people with RA characterized by a high level of physical activity had better QoL in the physical and environmental domain, compared to the people with low levels of physical activity. In the case of healthy people with a high level of physical activity, QoL was significantly better in every of four analyzed domains.

Discussion

Rheumatoid arthritis is a common chronic autoimmune disorder characterized by inflammation and damage of the articular cartilage, joints and tendons. The progressive nature of RA results in deformity of the small joints of the hands and feet, the joints of wrists and shoulders. RA cause debilitating pain, swelling and stiffness of the affected joints, also can cause extra-articular manifestations (such as anemia, interstitial inflammation of the lungs and glands, and nodules in the lungs, skin and eyes) that reduce survival.[10] Thus, it is important to assess QoL of RA patient in clinical practice. The World Health Organization Quality of Life brief form (WHOQOL-BREF) is one of the best-known instruments developed for cross cultural comparisons of QOL, and it is available in more than 40 languages. It is a shortened version of the WHOQOL-100 that looks at four QoL domains, using all available data from the field trial version of the WHOQOL- 100.[11]

RA is associated with significant morbidity and functional impairment. The results of recent studies have shown that people with RA are dissatisfied with their QoL. The assessment of QoL in people with RA is influenced by both clinical factors (duration of the disease, the number of joints affected), as well as socio-demographic factors, such as gender, age, place of residence and social support. Study results have shown that patients experience a substantial burden on physical functioning and emotional well-being.[12] In addition, RA results in an economic burden to patients, their families, the healthcare system and society at large. It has been reported that the costs associated with rheumatic diseases were even greater than those for either cancer or cardiovascular disease.[13]

In this study, we demonstrated that (1) physical activity level of RA patients as significantly lower than that of the general population, (2) QoL for subjects with RA is significantly worse in every domain than in the general population, (3) there is a significant association between the physical activity level and QoL in physical and environmental domain, (4) there is no association between the BMI and QoL in RA patients. The general analysis of individual domains of QoL showed that social domain was rated the best, and the worst was the physical domain. Similar results obtained Sierakowska et.al[14] and Moćko and Zurzycka.[2]

In this study, there were no statistically significant relationships between BMI and QoL in the physical, social, psychological or environmental aspect. However, Jankowska et al. demonstrated that people with obesity had a worse QoL.[15] The authors showed a significant relationship between BMI and QoL. The above results may indicate that obesity in people with RA affects the level of self-esteem and significantly impacts satisfaction that they feel. In obese people, an increased level of stress, lowered mood and depression are often noticeable, which in turn lead to social isolation and deterioration of QoL in the emotional and social sphere. Similarly, the results of the García-Poma et al. indicated that obese patients had lower QoL in three areas (social, psychological and environmental) than overweight patients and patients with normal weight. The association between obesity and impaired QoL was confirmed with a linear regression model and remained significant after adjustment for age, sex, disease activity, extra-articular disease, comorbidities, X-ray erosions, presence of rheumatoid factor, depression, education, and disease duration.[16] On the other hand, Fukuda et al. showed that the QoL of subjects RA was significantly lower in the low BMI group than that in the moderate BMI group, which exhibited the highest score among the three groups. This means that malnutrition is associated with the deterioration of QoL in RA patients.[17]

Research has shown that people who have RA do not usually participate in enough physical activity to obtain the benefits of optimal physical activity levels.[18] Most RA patients suffer from muscle loss which contributes to decreased physical function and QoL. The results of our research also indicate a lower level of physical activity in RA patients than in people from the general population. In addition, we have demonstrated that patients with a higher level of physical activity have a better QoL in two domains (physical and environmental). The results of other authors are similar.[19-21] Lower level of physical activity was found to be associated with progressive motor problems, which in turn leads to a worse QoL assessment. Similar results obtained also Bączyk, who found that a worse QoL results from the limited opportunities to perform basic life activities that was associated with joint pain, limitations in joint mobility.[22] Promoting physical activity behavior in the RA population is important, particularly in relation to QoL, mortality and function.[18] The monitoring of physical activity in RA patients might facilitate a more objective evaluation of variations in disease activity, helping physicians to make general and therapeutic recommendations that will improve both the health status and the joint functionality of these patients.

Limitation

This study is not without limitations. The assessment of the level of physical activity using the self-assessment method can be considered as a study limitation. Moreover, our findings are only representative of a specific group of patients and may vary in other geographic areas with different cultures. There may have been selection bias because patients were selected from one health care institution.

Conclusion

There was no association between the body mass of RA patients and QoL assessment. However, association was found between the level of physical activity in people with RA and QoL in the physical and environmental domain.

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ORIGINAL PAPER

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The influence of oxalate decarboxylase on the urinary oxalate excretion in swine model of nephrocalcinosis induced by hydroxyproline

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ABSTRACT

Introduction. Kidney stone formation may be a result of increased urinary oxalate supersaturation.

Material and Methods. Eighteen pigs were randomly divided into: Control group, where standard cereal-based feed was supplemented with 4% HP only, Prevention group, where treatment with OxDc slurry started at the end of the adaptation period when pigs were switched to 4% HP diet, Reduction group, where the treatment with OxDc lyo powder started after pigs were already on a 4% HP diet for 6 days.

Results. OxDc slurry prevented oxalate excretion in urine. The reduction effect of OxDc lyo feed addition was generally visible during the first two days of the therapy ($p<0.05$). Both dietary intake of 4% HP and OxDc preparations did not influence weight gain, water or feed intake, urine excretion and creatinine clearance.

Conclusions. The capacity of OxDc in preventing induced hyperoxaluria was moderate. Most probably, this is due to the incoherent response of animals to the HP enriched diet dependent on their gut pH, since optimum pH for OxDc is around 5-6. A higher pH essentially reduces the activity of OxDc. The capacity of OxDc in reversing the hyperoxaluria induced by a HP enriched diet was significant during the first 2 days after introducing OxDc to the diet.

Keywords. Nephrocalcinosis, Oxalate decarboxylase, Hydroxyproline, Pig model

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Introduction

Kidney stone formation as a result of the accumulation of calcium salts in renal tissue is believed to be an effect of increased urinary supersaturation, mostly of calcium oxalate (CaOx) and calcium phosphate (CaP).[1] Therefore, lowering the concentration of oxalate and/or calcium in urine is an important part of medical treatment that could prevent the formation of calcium oxalate crystals and consequent crystaluria.

In healthy humans, urinary oxalate is derived from dietary (~40%) and endogenous pools (~60%). However, pathways leading to an endogenous synthesis of oxalate have not been fully elucidated. From studies in patients with type 1 and 2 of primary hyperoxaluria, high levels of oxalate are known to result from deficiencies in the glycolate metabolizing enzymes, alanine-glyoxylate aminotransferase and glycolate reductase.[2] Thus, glycolate is implicated as a precursor to endogenous oxalate. The endogenous precursors of glyoxylate and glycolate are not known to date, but hydroxyproline (HP) has been implicated as part of the pathway.[3]

The pig model of hyperoxaluria and calcium oxalate stone disease after feeding with hydroxyproline (HP) was described before by others.[4,5] HP, a component amino acid of collagen, is metabolized to pyruvate and glycolate, an oxalate precursor, in both hepatic mitochondria and renal proximal tubular cells.[3] It is important to address that at the functional level, humans and pigs/sows share many similarities with regard to the genitourinary structures. In addition to being multipyramidal structures (unlike rats), humans and swine have comparable maximal urinary concentration, glomerular filtration rate, and total renal blood flow characteristics.[4] Mandel NS et al. and Kaplon DM et al. [4,5] demonstrated that young growing pigs and sows fed HP became hyperoxaluric which provokes calcium oxalate plaque formation on renal papillae and stones known as crystalluria. Knight J et al. fed gelatin, a food ingredient that contains HP, to healthy human subjects, and created elevated levels of urinary oxalate and glycolate.[3] The Western-type diet, which has an abundance of animal protein, has been implicated as an increased risk factor for the formation of kidney stones in humans.[5] Consumption of the Western-type diet results in endogenous oxidation of excess cationic and sulfur-containing amino acids which impose a chronic metabolic acidosis that leads to bone demineralization and hypercalciuria that together with hyperoxaluria present a huge risk for stones and kidney failure.[5]

Oxalate decarboxylase (OxDc) is an enzyme that can be used for treatment of hyperoxaluria. OxDc has high specificity to degrade oxalate into the more soluble products carbon dioxide (CO_2) and formic acid (HCOOH). The rationale for the oral therapy with OxDc is that it is capable of breaking down oxalate found in the orally administered feed starting from the stomach and duodenum and thereby decreasing the oxalate available for absorption into systemic circulation. On the other hand, the decreased concentration of oxalate in the lower gut lumen will create a concentration gradient, causing the movement of oxalate back to the gut lumen from the blood, and enhancement of enteric excretion or intestinal elimination.[6] In the animal models, enteric excretion of oxalate is up regulated when the kidney function is compromised.[7]

The primary objective of this study was to find out if oral administration of OxDc will reduce urinary oxalate excretion and, by this means, will also prevent nephrocalcinosis and calcium oxalate crystal formation in kidneys of HP challenged pigs. The secondary objective was further development and testing of the swine model of dietary induced hyperoxaluria.

Materials and methods

All experimental procedures were approved by the Malmö/Lund Ethic Review Committee on Animal Experiments, Lunds city court (Malmö/Lunds djurförsöksetiska nämnd, Lunds tingsrätt), Lund, Sweden. During the study, the care and use of animals was conducted in accordance with the principles outlined in the current Guide to the Care and Use of Experimental Animals.

Animals and housing

The experiment was carried out on the Odarslövs research farm of Swedish Agriculture University and the Department of Biology of Lund University, Sweden.

Eighteen male pig (Swedish Landrace, Yorkshire, and Hampshire), 6 weeks of age and a weight of 6.5 ± 0.8 kg at the beginning of experiment, were used in the study. Animals were randomly selected from 7 litters from the University herd at Odarslöv, Swedish Agricultural University. The pigs had been weaned at four weeks of age and then housed in individual pens (1.0 × 1.5 m) with perforated plastic flooring, wood chips and bedding. All pens were equipped with a dry feeding trough, a drinking nipple and a constant heating lamp (150 W). During the experimental period, pigs were individually housed in "home-design" metabolic cages. Each metabolic cage was also equipped with a drinking nipple and red heating lamp (150 W). All pigs were acclimated and trained to the metabolic cage before the start of the experiment.

Study design

The eighteen pigs were randomly divided into three groups (n=6): 1) Control group, where feed was supplemented with 4% HP only, 2) Prevention group, where the treatment with OxDc slurry (3.5 mL, 15,750 u/meal) started at the end of the adaptation period when pigs were switched to 4% HP diet and 3) Reduction group,

where the treatment with OxDc lyo powder (500 mg, 11,500 u/meal) started after pigs were already for 6 days on a 4% HP diet. OxDc in form of slurry was given at the beginning of the meal with syringe to mouth to all pigs in the Prevention group, while OxDc lyo powder was mixed with the feed and was given with the first small portion of the meal to all pigs in the Reduction group. (Figure 1)

Monitoring and Assessments. Body weights were obtained before, during and at the end of experiments. Animals were also assessed for signs of poor health and other conditions that might interfere with results.

Feeding and water administration

Pigs were fed with cereal-based feed for young growing pigs (53908 VÄXTILL 320 P BK, Lantmannen, Sweden) twice daily (2% body mass per meal) at 8-9 am and 5-6 pm. This amount is comparable to the amount of consumed food when given *ad libitum* in similar conditions. During the pre-treatment period, feed was enriched gradually with HP (from 1% to 4%) and after a week of adaption all pigs were switched to a 4% HP diet until the end of the experiment. Drinking water was provided *ad libitum* when pigs stayed in pens, but during the study while pigs were in metabolic cages, water was provided 4 times per day, again *ad libitum*, for accurate measurement of water intake.

Inducing the hyperoxaluria. To achieve the hyperoxaluria, pigs were challenged with trans-4-hydroxy-L-proline (HP) obtained from TIANJIN WRI BR SHE YI SHU GOAN, BAN SHI CHU, 309 999 TIANJIN, China.

Oxalate decarboxylase

Oxalate decarboxylase used in the experiment was formulated as a slurry or lyophylisate (lyo) formulations. Lyo OxDc CLEC Lot #768-9 and slury OxDc Lot #768-9 (Altus Pharmaceuticals, Cambridge, MA, USA). Specific activity, of the both formulations were tested (Alnara Pharamceuticals, Cambridge, MA, USA) and the values were ~45 U/mg and ~23 U/mg for the OxDc slurry and lyo, respectively. Estimated activity of OxDc slurry might have been higher than indicated, due to improper dry weight measurement or increased solubility due to possible leaching of glutaraldehyde during storage. Both enzyme formulations were stored in tightly sealed containers at 2–8 °C.

Blood, urine and feces sampling

Blood and urine samples were taken at the following time points: basal (during adaptation time), last day on 2% HP and last day on 3% HP, before randomization, every second day during treatment period and on the last day of the study when pigs were sacrificed.

Blood. 5 mL blood samples were collected on the respective days before feeding from the jugular vein via direct venipuncture. Collected blood samples were placed in Vacutainer heparin tubes. After collection, tubes were centrifuged for 15 min at 3000 rpm and blood plasma was separated to new tubes. Samples were store at -20 °C for further analysis.

Urine. 24h urine samples were collected into container with 2 ml of 6 N HCL. After measurement of total volume of urine, 3 mL sample was transferred to the plastic tube and stored for further analysis.

Feces. Small fraction of fresh samples of the feces were collected in the morning from the pigs for oxalate estimation. Each sample was weighed, put in the plastic bag and stored at -20 °C for future analysis.

Analysis of oxalate concentration

Oxalate concentration in blood and urine was measured by sensitive spectrophotometric method with the use of Trinity Biotech Oxalate reagents (Kit #.591 D Trinity Biotech, Ireland). The severity of hyperoxaluria for the young growing pigs (5-12 weeks of age and 5-20 kg of body weight) was graded as shown in Table 1.

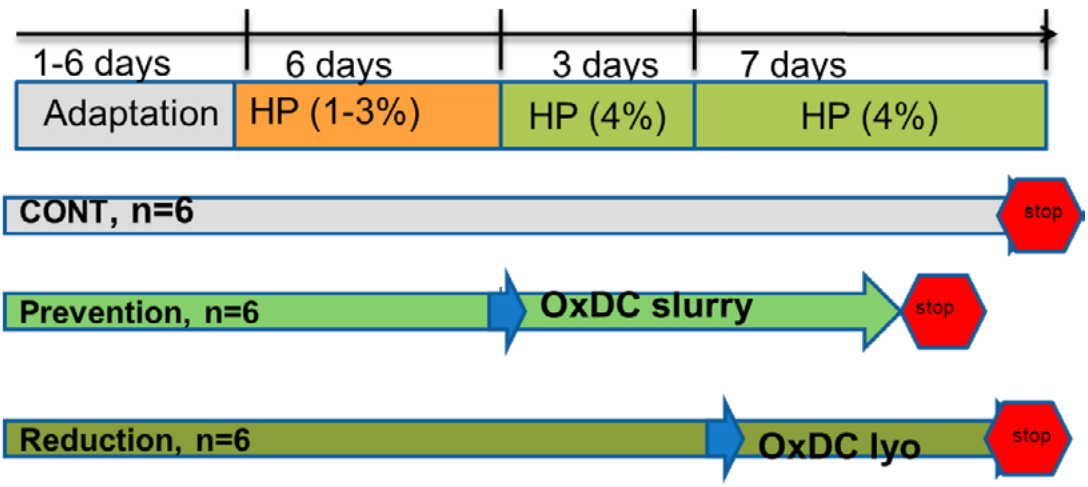


Figure 1. Study design

Table 1. Grading of the hyperoxaluria for the young growing pigs (5–12 weeks of age and 5–20 kg of body weight)

Hyperoxaluria	Urinary oxalate mg/24h
Normal	2–10
Minimal	10–15
Mild	15–40
Severe	>40

Analysis of creatinine concentration ant the creatinine clearence

Creatinine concentration. Creatinine in blood and urine was measured using a colorimetric method (QuantiChrom™ Creatinine Assay Kit, DICT-500, BioAssay Systems, USA). Urine samples that were used for analysis were acidified and charcoal extracted that might have resulted in lower read outs.

Creatinine clearance. Creatinine clearance is expressed as excretion rate ($U_{cr} \times V$), where U_{cr} presents concentration of creatinine (mg/dL) and V (Urine Volume) is the 24h urine sample (mL/24h), divided by plasma creatinine (Pcr in mg/dL), BW is body weight of pigs. The formula used was as follows:

$$C_{cr} = \frac{(U_{cr} \times \ Urine\ Vol\ xBW)}{P_{cr} \ \times 24 * 60} = mL/min$$

Collection of organs for histo-pathological analysis and gross examination

Gross analysis. At the end of the experiment, pigs were euthanized with sodium pentobarbiturate (20mg/kg). Selected organs: kidney, liver and small and large intestine were gross examined, kidneys and liver weight were recorded. Both right and left kidney were divided transversely longitudinally, exposing the corticomedullary surface and papillary tips. Gross appearance of the kidneys was recorded and digital images were obtained. After the gross examination, specimens of the kidneys, fixed in 10% formalin were taken for future histopathology analysis and Yasue specific staining.

Histopathology. Each kidney was cut in 12 serial sections at 4 μm per kidney and stained with hematoxylin and eosin for routine histological examination, or by specific Yasue metal substitution histochemical method to detect the presence of calcium oxalate crystals in the renal tissue.

Statistical analysis

Statistical analysis was performed on the data generated from this study using the unpaired two-tailed Student's t-test. Differences were considered significant if $p \leq 0.05$, all data are expressed as a mean ± standard deviation (±SD). The statistical software used was SAS *v* 9.2, 2008.

Results

Influence on the excretion of oxalate in urine

Total levels of oxalate in urine during pre-treatment and treatment period in both control and active groups were generally low and did not differ significantly ($p>0.05$). There was no effect of 4% HP administration on oxalate excretion in urine in both the Control and Prevention groups ($p>0.05$). Following, there was also no effect of oral administration of OxDc slurry visible in Prevention group ($p>0.05$). However, in the Reduction group, 4% HP induced severe hyperoxaluria (~5 fold elevation from normal levels) ($p<0.05$). The effect of OxDc lyo oral administration on oxalate excretion was visible from early stage of the therapy- as early as day 1 (6^{th} day from the beginning of study) ($p<0.05$). (Figure 2)

Influence on the renal function and urine excretion

Creatinine clearance. No differences in the creatinine clearance was noted between groups at baseline ($p>0.05$). Similarly, there was no difference recorded between the Control and the Prevention groups during the whole study period ($p>0.05$), which suggests also that there was also no differences in the GFR (*glomerular filtration rate*). However, creatinine clearance values were lowest, but not significant ($p>0.05$), in the Reduction group (which was in parallel with the highest values of oxalate excretion). Significant difference between the Control and the Reduction group (55.44 ± 31.38 mL/min *vs* 27.18 ± 19.93 mL/min, $p<0.05$) was recorded on day 22 (last day of the treatment). (Figure 3)

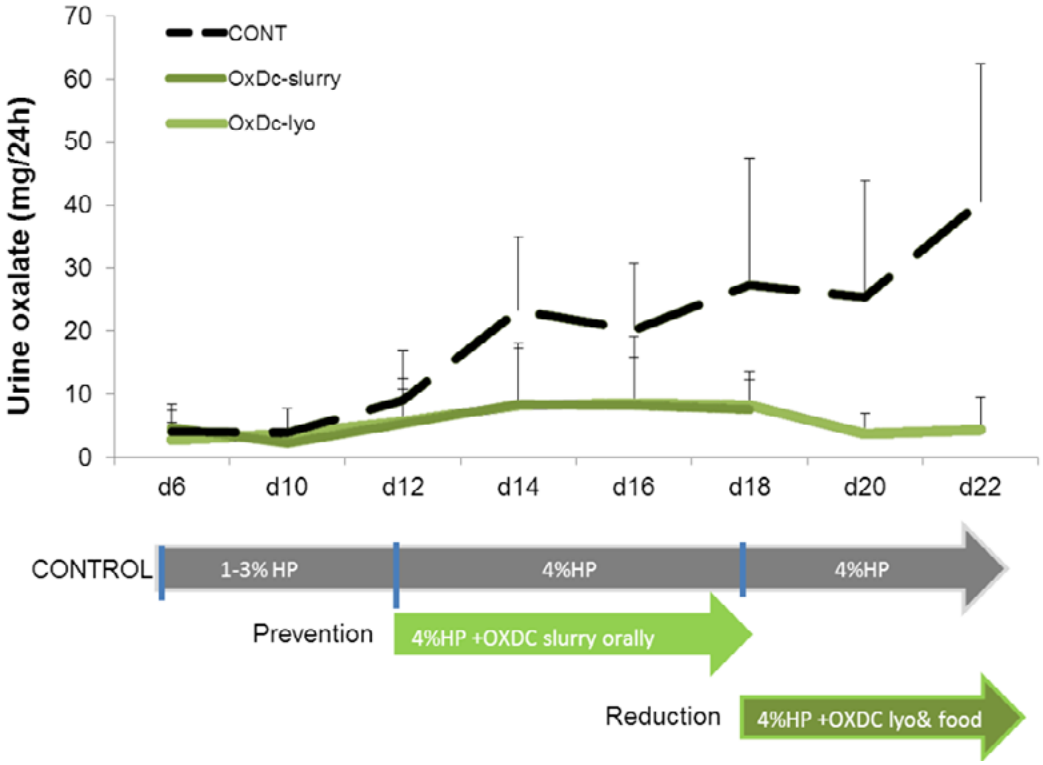
Urine excretion. There were distinct individual variations in both water intake and urine excretion within groups (data not shown). However, both water intake and urine excretion were higher in the treatment groups when compared to placebo, but the statistical significance was found only with regard to the Reduction group ($p<0.05$) (Table 2).

Table 2. Mean variations in feed intake (kg ± SD), water intake (kg ± SD) and the urine excretion (kg ± SD) during the whole study period. In all statistical analysis P<0.05 was taken as the level of significance

Groups	Food (g)	Water (mL)	Diuresis (mL)
CONT	276 ± 76.6	740 ± 229	278 ± 123
OxDc slurry	294 ± 64.39	903 ± 553	396 ± 327
OxDc lyo	336 ± 49.1	1150 ± 549	596 ± 463

Student's t-test: P<0.05

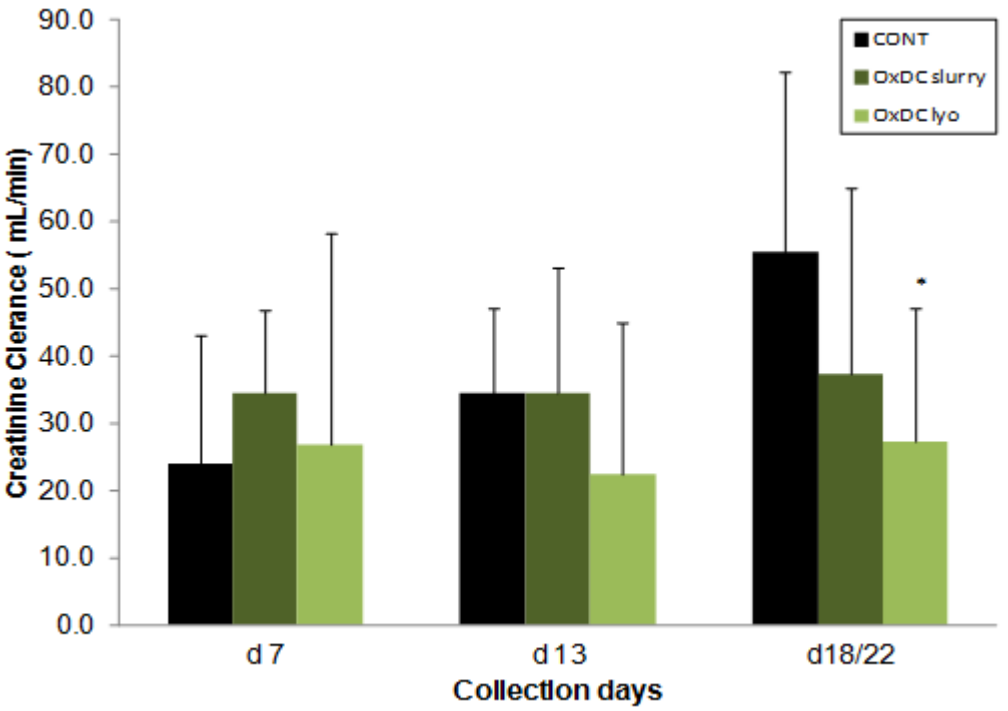
No statistical significance was found between study groups



Student's t-test: P<0.05

* Reduction vs Control group *P* < 0.05

Figure 2. Oxalate levels in 24h urine samples in pigs (mg/24h ± SD). In all statistical analysis, P<0.05 was taken as the level of significance



Student's t-test: P<0.05

* Reduction *vs* Control group *P* < 0.05

Figure 3. Creatinine clearance in pigs (mL/min ± SD). In all statistical analysis, P<0.05 was taken as the level of significance

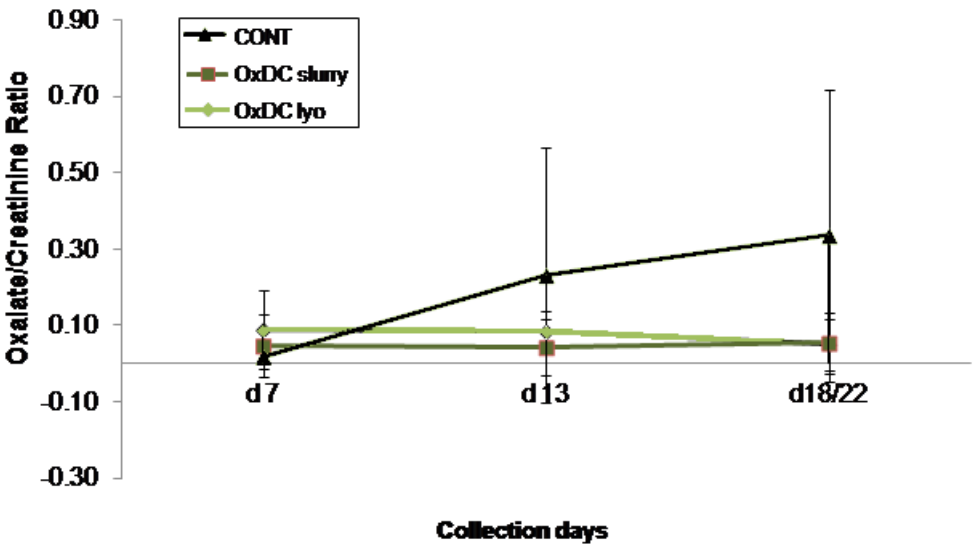
Influence on urinary oxalate levels normalized for daily creatinine excretion

Oxalate/Creatinine ratio. No differences in the oxalate levels normalized for daily creatinine excretion (oxalate/creatinine ratio) was noted within groups at baseline (p>0.05). Similarly, there was no difference recorded between the Control and the Prevention group during the whole study period (p>0.05). In the Reduction group, in which oxalate levels were increased, oxalate /creatinine ratio was also high and statistically significant when compared with Control group (p<0.05). (Figure 4)

Influence on body weight and feed consumption

Feed consumption. Daily feed consumption is presented in Figure 5. In general, differences in the daily feed consumption were observed in the selected time points within groups as well as between both treatment and control groups during the whole study period (p>0.05). (Figure 5, Table 2)

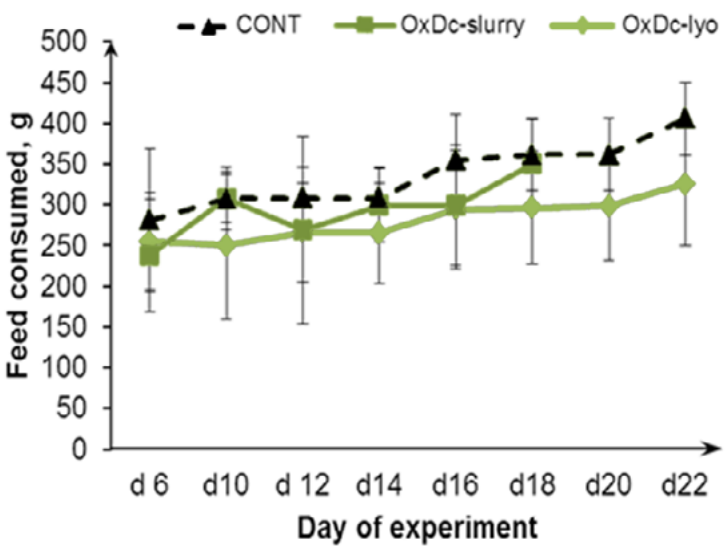
Body weight gain. There were no differences in body weight gain within groups as well as between experimental groups, however, the mean body weight in the Control group was insignificantly lower (~ 1 kg) when



Student's t-test: P<0.05

* Reduction vs Control group *P* < 0.05

Figure 4. Oxalate levels normalized for daily creatinine excretion in pigs (oxalate/creatinine ratio; L/min ± SD). In all statistical analysis P<0.05 was taken as the level of significance



Student's t-test: P<0.05

No statistical significance was found between study groups

Figure 5. Mean daily feed intake variation is study groups (g ± SD/24h). In all statistical analysis, P<0.05 was taken as the level of significance

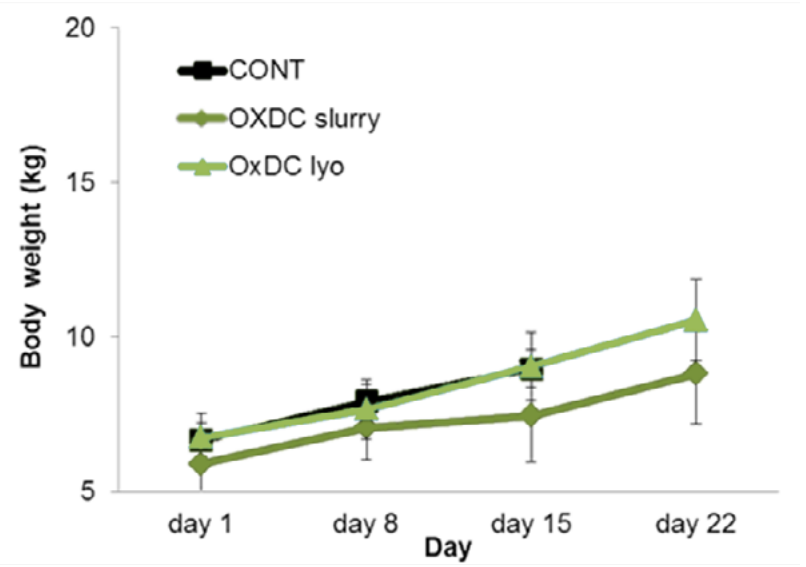
compared to both Prevention and Reduction groups at the end of the study (p>0.05). (Figure 6)

Macroscopic evaluation of the kidneys

The results of visual evaluation of the left and right kidney are given below.

Control group. In the control group. All six animals had fibrotic kidneys with the small spots of hemorrhages visible in both left and right kidney. Moreover in four of six animals in both sectioned kidneys small stones or/and crystals were visible.

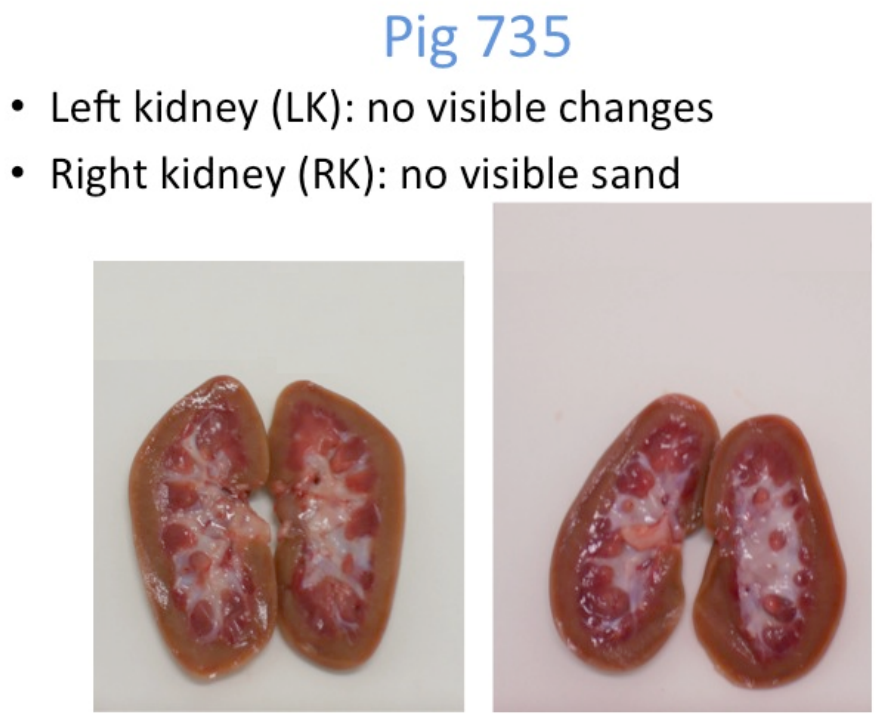
Prevention group. Two of six animals had normal kidneys, three had a small amount of crystals visible only in one kidney (left or right). One had small stones and crystals visible in both kidneys. (Figures 7a, 7b and 7c)



Student's t-test: P < 0.05

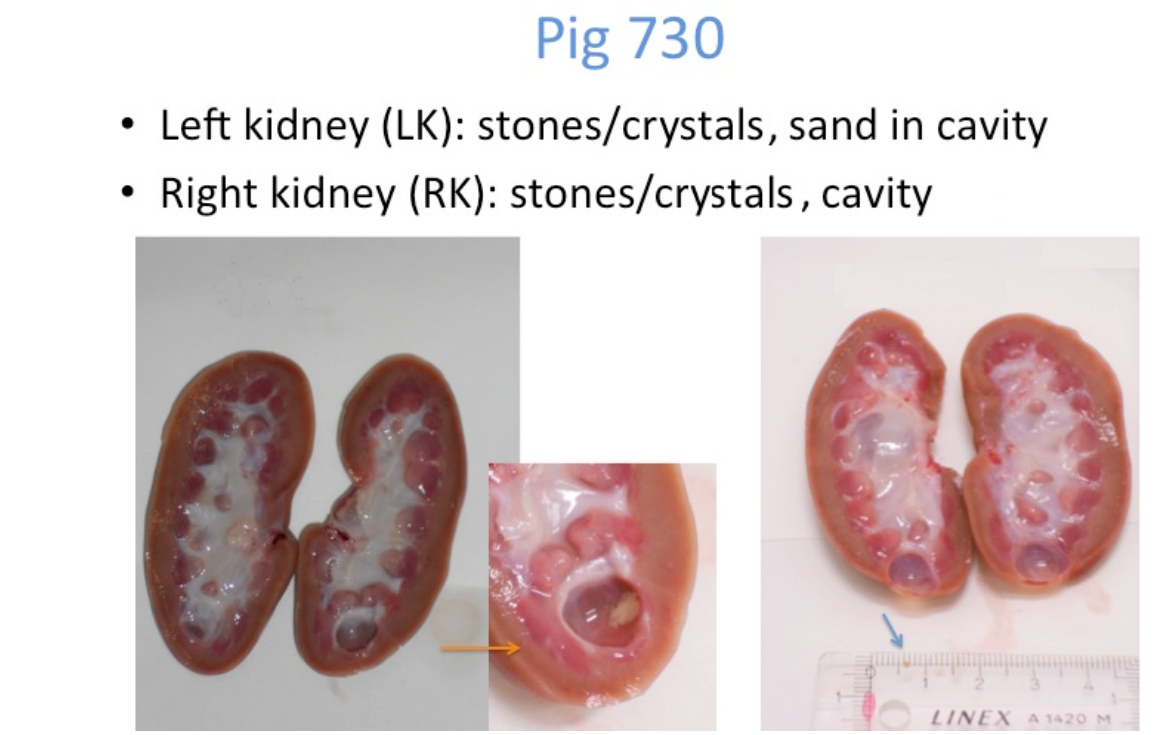
No statistical significance was found between study groups

Figure 6. Body weight during the pre-treatment and treatment phases (kg ± SD). In all statistical analysis P < 0.05 was taken as the level of significance

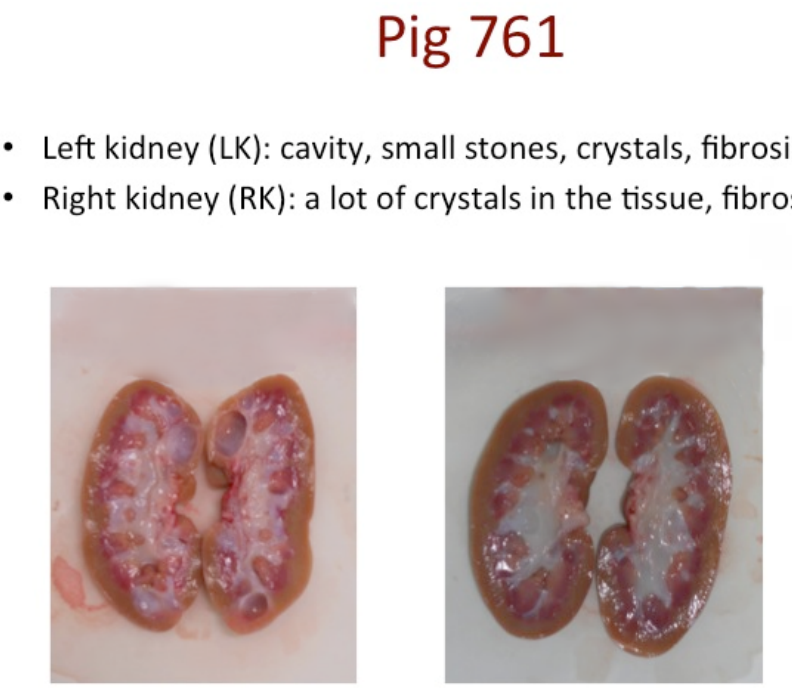


No macroscopic changes visible.

Figure 7a. An example of cross-sectioned normal kidneys (Prevention group)



Left and right kidneys: stones/crystals and abnormal cavities in medulla visible.
Figure 7b. An example of cross-sectioned kidneys with pathological changes (Prevention group)



Left and right kidneys: stones/crystals and fibrotic changes visible.
Figure 7c. An example of cross-sectioned kidneys with pathological changes (Prevention group)

Reduction group. Two of six animals had normal kidneys. Four animals had fibrotic kidneys with small cavities and small stones or/and crystals in visible in both left and right kidneys.

Histological evaluation of the kidneys

Thickness of the kidney cortex. No differences in the kidney cortex thickness was visible within groups (p>0.05). Similarly, there was no difference measured between the Control, Prevention and Reduction groups (p>0.05). (Table 3)

Table 3. Mean thickness of the kidney cortex (μm ± SD). In all statistical analysis P<0.05 was taken as the level of significance

Cortex thickness	Average
Control	4.68 ± 0.64
OxDc-slurry	4.75 ± 0.83
OxDc-lyo	4.86 ± 0.71

Student's t-test: P<0.05

No statistical significance was found between study groups

Histology examination using Yasue specific CaOx staining. CaOx stones were found mostly in the medulla of the kidney, suggesting that CaOx deposits are the result of oxalate precipitation during filtration through proximal and distal tubules. All animals in control group developed CaOx visible crystals in kidneys. Interestingly, in the group that was treated with OxDc-lyo (Reduction group) two out of six animals had normal kidneys without visible stones or crystals, while in the group treated with OxDc-slurry (Prevention) only one out of six pigs had normal (healthy) kidneys. (Table 4)

Discussion

based on the obtained results we believe that we have archived to develop a swine model of dietary induced primary hyperoxaluria. Most of the available data on kidney stone models concern rodents or piglets.[8,9] Although, our study is not the first presenting swine model of hyperoxaluria and stone formation, the novelty in the study was that we have archived the goal by administering to the pigs relatively low concentrations of HP in diet, when compared to other experiments.[1,4,5] This can be of great importance when taking under consideration the overall condition of animals. Modification of the diet by high dosing of HP or ethylene glycol may lead to appetite loss, lowering or gaining weight and may interfere the water intake and urine excretion.[10,11] Moreover, some data suggests that it may also cause metabolic acidosis and may lead to renal dysfunction.[10] All of the above mentioned dis-

Table 4. CaOx depositions in cortex (C), intermedulla (C-M) and medulla (M) of kidneys after staining with Yasue's metal substitution method that specifically detects calcium oxalate depositions*

Group	Pig #	Left kidney			Right kidney		
		C	C-M	M	C	C-M	M
CONT	727	none	none	minimal	none	none	minimal
	747	none	none	minimal	none	none	minimal
	757	none	none	none	none	none	minimal
	760	none	none	minimal	none	none	minimal
	765	minimal	minimal	minimal	none	minimal	moderate
	777	minimal	minimal	moderate	none	minimal	moderate
OxDc-slurry	724	none	none	minimal	none	none	minimal
	730	none	minimal	minimal	none	none	minimal
	735	none	minimal	minimal	none	minimal	minimal
	751	none	none	none	none	none	none
	759	none	none	minimal	none	none	minimal
	775	minimal	minimal	moderate	minimal	minimal	moderate
OxDc-lyo	731	minimal	minimal	moderate	minimal	minimal	moderate
	749	none	none	none	none	none	none
	754	none	none	none	none	none	none
	761	none	minimal	minimal	none	minimal	moderate
	763	minimal	minimal	minimal	minimal	minimal	moderate
	783	none	none	minimal	none	none	minimal

* For grading the severity of nephrocalcinosis , the scoring was done under a four category scale. The scoring was the following: none, no oxalate crystals in any field; minimal, 1-5 crystals in any field; moderate 6-10 crystals in any field; severe- all fields with multiple depositions of crystals.

crepancies may have an impact on the results of the studies with enzymes, drugs, etc., for which, in fact, animal kidney stone models are designed for, and, which is obviously of great importance for final outcome of studies. Of course, our newly developed model is not ideal, all pigs in control group and majority of animals in Reduction group had kidneys with clearly visible fibrotic changes, which raises the question about reliability and/or reversibility of this model. Further studies are needed to elucidate, at least in part, to what extend such way induced fibrotic changes may influence renal function.

In the presented study, supplementation of a typical diet with 4% HP did not influence weight gain, water or feed intake or urine excretion, creatinine clearance, and last but not least, the overall condition of the animals. However, we have surprisingly observed significantly lower oxalate excretion in the Control group when compared to the Reduction group both before and after the addiction the OxDc lyo to the diet. This is at least in part similar to the observations made by Kaplon et al., who observed, after a short peak in the first day of the oral 10% HP administration, a subsequent decline in urine oxalate levels despite continued feeding.[5] This is contrary to the results obtained by others as well as to our own results from previous experiments in which urine oxalate levels have significantly raised during the first few days and did not decline immediately after the HP enriched diet was ceased.[5,10] The explanation for this could be the individual differences in metabolic capacity and/or the influence of other, until now, unknown factors. But, we can be almost sure that the decline in oxalate urine levels observed in the Control group was not a result of the diet administration, because, as mentioned above, there were no differences in feed intake both within and between study groups. On the other hand, HP absorption in the gut and/or its subsequent metabolism to oxalate may have a rate limiting step, which was clearly shown by Bushinsy et al., who concluded that oxalate levels may not be strictly dose-related to HP in the diet.[11] Anyway, above described discrepancies raise also one more, very important issue regarding the action and effectiveness of OxDc, which in fact, was also the aim of the study.

Although the difference between the Control and Reduction group after 2 days of treatment (20th day of experiment) was found, it should not be attributed to increasing the oxaluria by 4% HP diet in Control animals, but rather to the decreasing oxaluria by the administration of OxDc lyo in the Reduction group. Moreover, the same issue does not allow us to conclude that the low oxaluria in the OxDc slurry receiving animals was really the result of enzyme action in the animal gut. However, we do not exclude such a possibility since macroscopic changes seen during the gross examination of the kidneys were much less advanced in animals receiving 4% HP enriched diet together with OxDc slury than in those receiving 4% HP enriched diet alone.

Both OxDc slurry and OxDc lyo were well tolerated and did influence water or feed intake as well as urine excretion and creatinine clearance. In the OxDc lyo receiving animals, we have observed a trend toward decreasing oxaluria during the first days of therapy (from the 18th until the 20th day of experiment), however, starting from day 21, urinary oxalate again increased reaching almost 40 mg/24h at the end of the study.

Another interesting observation from the presented study is that CaOx crystal/stone formation doesn't always correlate with the level of hyperoxaluria. Only the minimal urine oxalate excretion was recorded in the Control and Prevention group and yet, the majority of the animals had crystals or/and stones. On the other hand, in the Reduction group, where hyperoxaluria was relatively high, both gross and histopathological analysis did not show more pathology than we seen in other study groups.

Conclusions

In the presented experiment, we have created a model of hyperoxaluria in young pigs by increasing the amount of HP in the diet up to 4%. Histological and gross evaluation of the kidneys allows us to conclude that it is also a model for pig nephocalcinosis, due to clearly visible calcium oxalate crystals and small stones in renal tissue. The capacity of OxDc enzyme in preventing hyperoxaluria induced by HP enriched diet was moderate. This was most probably due to the incoherent response of study animals to the HP enriched diet dependent on their gut pH. It is well known that optimum pH for oxalate decarboxylase is around 5-6. Any higher pH essentially reduces the activity of oxalate decarboxylase. Anyway, the capacity of OxDc enzyme in reversing the hyperoxaluria induced by a HP enriched diet was significant during the first 2 days after introducing OxDc to the diet.

The model presented can be extrapolated to humans for future research. The rationale is that we nearly imitated the mechanisms which are, at least in part, responsible for the kidney stone formation in humans as in e.g. diet overloaded in animal protein and/or a highly acidifying diet. Moreover, pigs are believed to be the best model humans, due to very similar renal physiology and anatomical structure.

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ORIGINAL PAPER

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Changeableness of selected characteristics of the head in the Rzeszów children and adolescents aged 4 to 18 in during a 35-year period

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ABSTRACT

Introduction. Over the past decades, anthropometric studies have focused more on secular changes in body height and weight, and less on changes in head features. Meanwhile, changing socio-economic conditions, especially the nutritional status of the human population, support the need to document some of the metric head features in children and adolescents.

Aim. The aim of this study was to determine whether there has been changes over time in the morphological development of the head with respect to socio-economic conditions at the turn of the last century on sample population of children and adolescents from Rzeszów.

Material and methods. In the years 1978/79, 1993/94, 2003/04 and 2013/14, a total of 9041 Rzeszów children aged 4 to 18 were examined. Anthropometric measurements were based on a technique developed by Martin and Saller. The following features were taken into account: head length and width, morphological face height, maximum face width, nose height and width, and head circumference. The relevant head, face and nose indices were calculated from the measured data. New indices for head circumference have also been proposed.

Results. Such changes as head elongation, shortening of morphological face and nose height, and widening of the nose from hyperleptorrhinus to leptorrhinus were found in both sexes.

Conclusions. 1. During the past 35 years there have been noticeable changes in the morphological characteristics of the head, face and nose. 2. Further follow-up to the development of head features is recommended.

Keywords. time changes, children and adolescents, head indices, head circumference

Introduction

Over the past century anthropological research was characterized by the interest in the micro-evolutionary variability of the morphological construction of the skulls of the Central European population. Attention was drawn to the variability of selected features of the skull, especially from the Neolith to the early Middle Ages.[1,2] The perceived changes were associated with nat-

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ural selection and the migration of human groups. According to Piontek, the flow of genes, with regard to the characteristics of migrants, was secondary in microevolutional variability because the level of natural selection limited the amount of genetic information reproduced in the individual generations. [3] In the Polish lands, based on skeletal materials, the process of brachycephalisation was observed in the feudal period.[4] Czekanowski describing the process of doligocephalization and brachycephalisation, was the first to draw attention to the temporal variability of some craniometric features.[5] Based on statistical analysis of craniometric parameters and their temporal variability, it has also been found that over the last 700-800 years the process of facial regression has been taking place.[6] In the anthropometric features of the head, clear signs of accelerated development appear in its circumference. There is the view that temporal changes in some metric features of the head show dependence on changing socio-economic conditions, and especially on the nutritional status of the population.[7] Very well documented were secular changes in body height and weight and, to a lesser extent, head morphology, therefore, the study of the variability of head features occurring in the present is justified.

Aim of the study

The primary aim of the research on physical development of children and adolescents aged 4-18 years from Rzeszów was to determine, on a sample of the regional population, whether there are time changes in the morphological structure of the head with respect to socio-economic and cultural conditions at the turn of the 20th and 21st centuries.

Material and methods

Evaluations of changes occurring in physical development of children and adolescents from Rzeszów were carried out successively in 1978/79, 1993/94, 2003/04 and 2013/14. Over the years, the research methodology was based on the same principles.[8,9] Anthropometric research in 1978/79 covered 2332 subjects (1176 boys and 1056 girls), 1993/94 - 2586 (1300 boys and 1286 girls), while in 2003/04 2560 people (1280 boys and 1280 girls). A sample of children and adolescents was selected randomly in all three series, so as to be representative. In the years 1978/79-2003/04, on average 80 boys and 80 girls were examined in every age group.[10] Samples were randomized without repetition. Written consent for the study was obtained from the Education Board, the President of the City of Rzeszów, the directors of individual schools and parents, and oral consent was expressed individually by every child before the measurements. In the years 2013/14, the respondents were selected in the same way as in the previous series, with attempts to maintain a similar number of boys and girls in different age groups, but difficulties were encountered in this regard. They concerned the consent of the parents and the subjects themselves to carry out measurements which, is obviously not invasive and, therefore, do not pose any health or life threat. Finally, more than 5% of the population of Rzeszów children and adolescents aged 4 to 18 in every age group were tested. Data on live births of boys and girls born in the studied age groups were obtained from the Central Statistical Office in Rzeszow. A total of 1563 people were examined, including 779 boys and 784 girls. It was observed that the primary group, both boys and girls, was not less than 50 persons in each age group [8]. The children studied were healthy and did not have a disability certificate. We failed to collect a suitably large group of 3-year old boys and girls due to the lack of parental consent. The study of 3-year-olds was also disproportionately extended over time.[11,12]

For all the aforementioned series, anthropometric measurements were based on the technique proposed by Martin and Saller.[9] Anthropometric studies took into account the following features: head length (g-op) and head width (eu-eu), morphological face height (n-gn) and maximal face width (ny), and nose height (n-sn) and nose width (al-al). In the 2013/2014 series, the head circumference was also measured. The collected data were compiled statistically and graphically. The selected numerical characteristics of the tested parameters were designated: arithmetic mean (x) - in all discussed series, median (Me), standard deviation (s) in all discussed series, 25th and 75th centile (C25, C75). The following indicators were also calculated: head width-length index (main), total morphological face index and nose index. Indices of proportions differentiation - head size in relation to body size were taken into consideration.[13] Previously published data: body height and BMI were used for the calculation of the indices.[12] Formulas of indices are presented in Tables 15-16. For statistical calculations, ANOVA technique was used.[10-12] In order to answer the question whether the population of children and adolescents from Rzeszów continues to show the phenomenon of secular trend, the comparative analysis of statistical characteristics of selected anthropometric features and proportional coefficients was performed in the series 1978/79, 1993/94, 2003/04 and 2013/14.[10]

Results

In the analysis of the data of head features during 35-year period 1978/79-2013/14, it can be observed whether the phenomenon of time changeableness has still been present and what is its nature. Tables 1-12 show the arithmetic mean and standard deviations in such features as head length and width, facial height, facial height, nose width and height in 1978/79, 1993/94, 2003/04 with statistical characteristics of parameters discussed for the subjects in 2013/14 series. The changes

Table 1. Comparison of mean values of head length (g-op) in the Rzeszow boys [mm]

Age	Head length (g-op) [mm]										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	*Me*	s	c_{25}	C_{75}
4	167,4	5,1	171,4	6,2	175,4	7,6	163,9	161,0	6,3	160,0	170,0
5	170,2	4,8	173,5	6,5	176,7	8,1	168,3	169,0	4,7	164,0	172,0
6	171,4	4,8	175,2	6,3	177,9	7,2	171,7	171,0	5,2	167,0	178,0
7	172,3	5,2	176,1	6,2	178,5	8,4	173,3	174,0	6,4	169,0	179,0
8	174,6	5,7	177,1	6,0	179,4	6,9	175,4	176,0	8,5	173,0	180,0
9	176,4	6,0	177,5	5,8	181,4	7,9	176,2	176,0	5,2	173,0	179,5
10	177,0	6,5	177,6	6,2	182,9	7,7	176,8	177,0	7,7	173,0	180,0
11	177,8	6,6	178,7	6,5	183,3	8,0	178,3	178,0	9,0	173,5	182,5
12	178,6	6,2	180,4	5,3	184,4	7,9	180,3	180,0	9,4	177,0	185,0
13	179,1	6,0	181,7	7,1	185,1	7,6	180,7	182,0	4,3	180,0	183,0
14	180,0	6,0	183,3	6,4	185,3	8,1	183,9	184,0	3,4	181,0	188,0
15	182,3	6,8	185,3	6,8	186,3	8,9	185,6	185,0	5,9	183,0	190,0
16	184,5	5,6	188,0	5,7	186,9	9,3	188,0	190,0	6,6	182,5	192,0
17	186,1	5,5	188,4	6,9	187,9	7,4	188,5	190,0	7,5	185,5	193,0
18	187,3	6,3	188,6	5,4	189,3	5,1	188,6	190,0	5,3	185,0	192,0

Table 2. Comparison of mean values of head length (g-op) in the Rzeszow girls [mm]

Age	Head length(g-op) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	*Me*	s	c_{25}	C_{75}
4	164.3	4,7	168,9	5,8	169,8	7,7	165,1	165,0	6,1	160,0	170,0
5	165,0	4,8	169,9	5,9	172,5	8,4	165,2	165,0	5,5	160,5	169,5
6	166,9	5,4	170,5	6,9	173,7	7,0	165,5	164,5	5,7	160,0	172,0
7	168,4	5,7	171,4	5,0	174,3	8,2	168,2	168,0	11,1	162,5	175,0
8	169,4	5,9	171,6	5,4	176,2	6,5	169,6	171,5	7,2	168,0	174,0
9	170,9	6,2	172,7	5,9	176,5	9,0	170,9	170,0	6,7	165,0	174,5
10	172,9	6,2	174,0	5,6	177,9	7,9	172,0	169,0	5,7	168,0	172,0
11	174,0	6,4	174,8	5,0	179,9	7,1	172,6	174,0	3,1	170,0	176,0
12	174,5	5,8	176,7	4,9	181,1	6,3	172,9	175,0	5,2	170,0	175,0
13	176,3	5,2	177,6	5,2	181,5	6,5	174,0	175,0	7,0	171,0	179,0
14	177,8	5,4	178,6	5,5	181,8	7,4	175,0	175,0	4,2	172,0	177,0
15	178.3	5,2	179,5	5,9	182,0	6,9	177,5	177,5	6,4	172,0	183,0
16	178,8	5,4	180,5	5,9	181,9	8,2	177,8	179,0	6,4	174,0	180,0
17	178,9	5,3	181,1	5,1	182,1	6,5	181,2	182,2	4,4	178,0	185,0
18	179,1	4,5	181,8	5,6	182,3	5,1	182,1	183,0	4,8	178,0	185,0

that took place during 25-year period 1978/79-2003/04 were published in 2008.[10]

During 10-year period 2003/04-2013/14 the average head length values in boys decreased from 4 to 15 years as well as at the age of 18, and the width - up to 16 years of age. With regard to face parameters, this phenomenon was observed for face height from 4 to 6 yrs., its width - up to 17 yrs. and for the features of the nose, such as height - throughout whole examined ontogenesis period and width 4-7 and 13-18 yrs. The dimensions of the face height increased from 8 to 18 yrs. within the range of 0.3 mm (8 years) to 3.7 mm (13 and 15 years) (Table 13). In girls in the period 2003/04-2013/14, lower mean values of the head features are predominant in the individual age groups. The head length and total face height in 18-year-olds have similar values, face width at the age of 9 and 12, and nose width, generally between 8 and 12 yrs (mean values in this period range from 0.3 to 0.4 mm) (Table 13).

Over the 35-year period (1978/79-2013/14), in boys increasing head lengths in 7- and 8-year-olds and 11 to 18-year-olds were observed. Head width, total

Table 3. Comparison of mean values of head width (eu-eu) in the Rzeszow boys [mm]

Age	Head width (eu-eu) [mm]										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	145,8	5,0	145,1	5,4	142,5	6,0	140,7	140,0	6,9	136,0	146,0
5	147,2	4,6	147,5	5,3	146,0	7,6	141,4	141,0	5,1	137,0	145,0
6	147,9	5,3	149,5	5,5	146,8	6,9	144,5	146,0	6,7	140,0	149,0
7	149,3	5,5	150,3	4,7	148,2	7,3	144,7	145,0	6,1	140,0	148,0
8	150,6	5,3	151,2	4,8	150,2	6,5	144,8	144,0	6,8	140,0	146,0
9	151,5	5,0	152,4	4,8	151,5	5,9	145,0	145,0	6,7	140,0	148,0
10	152,1	4,8	153,1	4,6	152,0	6,9	145,2	144,0	8,2	141,0	149,0
11	152,7	4,8	153,8	5,1	152,1	6,0	145,8	145,0	6,3	143,0	150,0
12	153,4	5,1	154,3	5,0	152,7	6,1	147,3	146,0	3,7	145,0	151,0
13	154,1	5,3	155,1	5,4	152,9	5,9	148,4	148,0	7,0	145,0	151,5
14	155,7	5,3	157,2	5,2	153,0	8,1	151,2	152,0	4,2	147,0	154,0
15	157,7	5,2	157,7	4,9	153,4	5,5	151,4	151,0	5,6	147,0	156,0
16	159,1	5,2	158,5	5,5	153,8	8,1	152,7	152,0	6,3	150,0	157,0
17	159,4	4,9	158,5	5,7	154,5	6,6	154,7	155,0	4,6	151,5	159,0
18	159,5	4,9	158,6	5,8	154,7	6,5	*155,0*	*155,5*	9,2	152,0	*160,0*

Table 4. Comparison of mean values of head width (eu-eu) in the Rzeszow girls [mm]

Age	Head width (eu-eu) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	141,2	4,9	140,0	4,0	141,4	6,7	135,6	134,0	6,8	131,0	140,0
5	142,9	4,5	142,2	4,9	142,6	6,1	135,7	135,0	5,8	131,0	140,0
6	144,4	4,5	145,4	7,0	144,6	5,7	136,9	136,0	2,7	135,0	139,0
7	145,3	4,6	146,2	6,2	145,7	6,5	137,7	137,5	4,3	134,0	140,0
8	146,0	4,7	147,0	4,8	146,8	5,9	139,9	139,0	4,5	136,0	143,0
9	146,6	4,5	147,9	5,1	148,0	5,9	140,8	141,0	5,2	138,0	144,0
10	147,0	4,5	148,2	4,3	148,6	5,5	141,4	140,0	5,6	138,5	145,0
11	148,9	5,3	148,6	5,4	149,0	7,0	141,7	140,0	3,9	139,0	145,0
12	150,5	5,1	149,3	5,1	149,2	6,9	142,4	142,0	4,2	138,0	145,0
13	150,9	4,8	150,1	5,4	149,6	6,5	144,3	142,0	8,0	138,5	145,0
14	151,3	4,9	150,9	4,8	149,9	6,1	144,6	145,0	4,5	141,0	147,0
15	152,0	4,5	151,8	4,5	150,0	6,4	146,3	145,0	5,8	141,0	150,0
16	152,9	4,7	152,3	4,8	150,5	5,5	147,1	147,0	6,5	141,5	151,0
17	153,3	4,9	152,4	4,6	151,0	6,9	147,1	149,0	4,4	143,0	150,0
18	153,9	5,1	152,4	4,7	151,4	4,4	147,2	149,0	4,4	143,0	150,0

face height and width and nose height - were reduced, while the width of the nose showed some fluctuations throughout the study period (Table 14). In girls in the same period, the increase in head length at 4, 17 and 18 years can be observed. Head width, total face height and width, and nose height in the age range of 4 to 18 yrs - decreased, while nose width from 8 to 18 years showed an upward tendency (Table 14).

Clear directional variability over time can be observed based on the data included in Tables 17-22, which show proportional indices that complement the information about head changes during 35-year period. These tables also include statistical characteristics of indices for the 2013/14 series. The comparison of 2013/14 series with earlier series showed reduction in the average head width and head length indices in both sexes. Boys from the 1978/79 sample aged from 4 to 17 were characterized by hyperbrachycephalus, which in the 2013/14 sample appeared only in 4-year-olds. The boys have brachycephalus in the whole age range in the 2003/04 series, while in the 2013/14 series - from 5 and 18 yrs. In all compared series, 18-year-old boys had brachycephalus. The average value

Table 5. Comparison of mean values of length of morphological face (n-gn) in the Rzeszow boys (mm)

Age	(n-gn)										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	91,4	5,0	94,8	4,6	92,6	5,3	90,2	91,2	2,9	88,1	92,1
5	94,1	4,6	97,5	6,2	94,2	4,9	92,4	91,5	4,9	88,5	96,5
6	96,6	4,4	99,8	4,5	96,0	4,5	95,3	95,7	4,6	92,7	100,7
7	99,8	4,3	100,4	5,3	97,4	5,9	97,3	96,5	4,4	94,5	100,5
8	102,7	4,2	101,6	4,2	99,9	5,9	100,2	101,4	4,7	96,4	103,4
9	104,5	4,1	102,7	4,4	100,4	6,9	103,4	103,4	3,7	99,4	104,6
10	106,4	4,4	103,4	4,5	103,0	6,9	104,7	103,4	5,4	99,7	105,3
11	107,7	4,8	107,5	5,2	104,5	5,3	106,1	103,4	7,8	99,4	108,4
12	109,4	5,0	108,5	5,2	105,1	6,0	108,3	110,3	7,8	101,7	112,3
13	112,3	5,8	110,2	5,0	106,0	5,9	109,7	111.4	5,8	102,4	113,4
14	115,1	6,3	113,5	6,2	108,1	5,8	111,5	112,1	7,6	106,1	118,0
15	118,4	5,9	116,8	6,6	111,9	5,9	115,6	116,3	7,9	109,8	122,8
16	121,7	6,1	117,7	5,8	115,7	6,1	118,0	119,0	6,4	114,5	123,0
17	122,9	6,2	118,4	6,6	117,2	5,7	120,0	119,0	8,9	115,0	123,0
18	123,1	5,9	118,5	5,3	119,2	5,7	120,7	119,5	6,2	115,5	123,0

Table 6. Comparison of mean values of length of morphological face (n-gn) in the Rzeszow girls (mm)

Age	(n-gn) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	88,9	4,5	90,1	3,9	91,7	4,7	88,2	86,5	2,7	86,1	90,1
5	91,6	4,2	93,6	4,3	93,3	5,6	90,6	90,3	4,4	87,3	92,8
6	94,8	4,2	95,9	3,5	94,5	5,0	92,5	93,6	4,6	88,6	95,6
7	97,5	4,4	97,3	4,9	97,1	4,4	95,0	94,7	5,4	92,7	96,7
8	100,1	4,1	98,7	4,1	98,8	5,4	97,1	96,3	4,2	94,3	101,0
9	101,9	4,2	101,4	4,7	99,5	5,9	97,8	97,8	5,7	94,3	101,8
10	103,7	5,0	102,1	5,0	99,9	5,1	98,5	97,7	6,1	93,7	103,7
11	105,9	5,1	104,2	4,5	101,1	5,6	99,7	97,3	8,0	96,3	105,0
12	107,8	4,8	106,7	5,0	102,1	5,8	101,5	100,0	7,2	99,1	106,0
13	109,3	5,2	108,5	6,0	104,2	6,9	104,6	104,0	3,3	102,0	106,0
14	111,3	5,6	110,3	5,7	106,4	5,6	105,0	105,0	4,4	102,0	107,0
15	113,4	5,7	111,1	6,0	106,5	6,6	105,5	104,0	6,3	100,5	110,0
16	114,3	5,3	111,6	5,0	107,7	7,1	106,1	104,4	6,3	100,9	110,3
17	114,5	5,1	111,7	5,8	108,0	4,8	106,8	104,1	4,3	103,0	110,4
18	114,6	4,6	111,9	4,9	108,3	4,4	108,1	108,0	2,7	106,0	110,4

of the index in question in the 35-year period was declining, although in the 2003/04 and 2013/14 series it could be considered to be approximate (Table 17). Girls of the 1978/79, 1993/94 and 2003/04 series in all age groups had brachycephalus, and the mean head width-to-length index was lower in subsequent trials. Exceptions were the subjects in 1978/79 at the age of 5 and 6, who had hyperbrachycephalus. Further decrease in the average values of the index in question in the 2013/14 series indicated a more advanced process of head elongation in 35-year period in girls. The subjects from the 2013/14 series at the age of 17 and 18 years, were characterized by mesocephalus. From 4 up to 16 years old the mean head width-to-length index in the girls was approaching the arbitrarily defined boundary between brachycephalus and mesocephalus (Table 18).

Varied changes were also present in the mean values of morphological face index in both sexes in the compared series. Euryprosopus was a hallmark of the boys from the 1978/79 series between the ages of 4 and 8; from 1993/94 - since 4 to 13 years old; 2003/04 - since 4 to 15 years, and 2013/14 - since 4 to 8 years (similar to

Table 7. Comparison of mean values of face width (zy-zy) in the Rzeszow boys (mm)

Age	(zy-zy) [mm]										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	*Me*	s	c_{25}	C_{75}
4	116,6	5,3	115,3	4,2	115,5	4,6	111,4	111,5	6,5	107,5	114,0
5	118,4	5,0	117,5	4,7	117,8	4,6	114,6	115,0	6,7	110,5	117,5
6	119,6	4,4	120,0	4,5	120,9	6,6	117,7	117,0	5,8	113,5	120,5
7	121,6	4,3	122,1	4,4	121,9	7,1	119,4	119,0	8,3	114,5	123,0
8	123,2	4,1	123,0	4,3	124,1	7,3	120,6	119,5	9,1	115,5	127,0
9	124,4	4,1	123,7	4,7	125,3	6,8	122,0	119,5	8,1	115,5	130,5
10	125,2	4,4	125,8	4,5	126,9	7,1	123,3	123,0	6,8	117,0	130,0
11	125,8	4,4	128,3	4,6	128,5	7,3	125,3	125,0	6,9	121,0	129,5
12	127,9	4,5	130,1	4,8	130,0	5,8	127,0	127,0	6,0	123,0	131,0
13	130,7	4,9	132,0	4,6	131,5	6,0	128,5	129,0	6,5	125,0	133,0
14	132,9	5,1	134,1	4,2	134,7	5,4	131,8	131,5	8,4	127,5	134,0
15	135,6	5,2	136,1	5,1	136,5	5,5	133,6	133,0	5,8	130,0	137,0
16	137,5	4,8	138,8	4,4	137,5	6,2	136,1	135,0	8,4	133,0	136,5
17	138,1	4,0	139,0	5,0	138,1	5,0	137,2	137,0	6,0	136,0	139,0
18	139,0	4,2	139,8	4,5	138,8	5,7	138,5	138,0	6,6	136,0	140,0

Table 8. Comparison of mean values of face width (zy-zy) in the Rzeszow girls (mm)

Age	(zy-zy) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	*Me*	s	c_{25}	C_{75}
4	113,2	4,1	112,4	4,3	112,9	5,6	110,8	109,0	5,7	108,0	114,5
5	115,3	4,6	115,0	3,9	114,8	6,4	113,1	112,0	6,4	110,0	120,0
6	117,5	4,9	117,0	4,1	116,8	5,2	114,7	114,0	7,5	110,5	119,0
7	118,9	4,0	119,6	4,8	117,3	5,3	116,7	116,0	8,2	112,0	120,0
8	119,7	4,2	121,4	4,0	118,3	5,6	117,7	117,0	9,4	114,0	121,5
9	121,1	4,0	123,3	4,4	118,8	6,3	118,7	118,5	3,8	115,5	122,0
10	122,3	3,9	123,8	3,4	119,4	7,2	120,2	120,0	8,7	117,0	123,0
11	124,0	4,2	125,5	5,5	122,1	6,1	121,7	121,5	3,7	119,0	124,5
12	126,5	4,6	128,4	3,9	122,9	6,0	123,0	122,0	8,4	119,0	130,0
13	128,8	4,6	129,3	4,2	125,4	6,1	125,9	126,0	6,8	120,5	131,0
14	130,1	4,4	131,0	4,5	129,9	6,3	128,2	127,5	8,7	121,5	133,0
15	130,7	4,0	131,4	4,0	132,6	5,1	129,5	129,0	4,7	123,0	135,0
16	131,8	3,9	133,3	4,8	133,7	5,3	131,0	131,0	4,0	124,0	137,0
17	132,5	4,4	133,6	4,1	133,9	4,2	132,1	132,0	3,5	125,0	139,0
18	132,7	4,7	134,1	4,6	134,5	4,2	132,4	133,0	7,9	125,0	139,0

the 1978/79 series). The subjects from the 1978/79 series were mesoprosopus since 9 to 15 years old, and since 16 to 18 they were leptoprosopus. In the subsequent series, the latter feature no longer appeared while mesoprosopus was present in the 1993/94 series since 14 to 18 years old, 2003/04 - since 16 to 18 years and the longest in the 2013/14 series since 9 to 18 years (Table 19). The observed phenomenon resulted from the simultaneous reduction and narrowing of morphological face in boys in 35-year period. It was difficult to determine the tendency of changes in morphological face construction in girls in 35-year period due to fluctuations in subsequent series. The average values of this indicator after 35 years decreased. In the 2013/14 series they approximated the limits between the class of euryprosopus and mesoprosopus according to Saller classification. Girls at the age of 18 in the 1978/79 series were leptoprosopus, 1993/94 - mesoprosopus, 2003/04 - euryprosopus and 2013/14 - mesoprosopus as were their peers in the 1993/94 series (Table 20). However, it can be generally stated that after 35 years there was a tendency to face shortening and narrowing (Table 14).

Table 9. Comparison of mean values of nose height (n-sn) in the Rzeszów boys (mm)

Wiek Age	(n-sn) [mm]										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	40,7	3,1	40,3	3,8	40,0	3,2	37,0	37,0	2,5	35,0	39,0
5	42,1	2,9	43,1	3,7	40,9	2,4	39,0	38,5	2,0	37,0	40,0
6	43,7	2,8	44,9	3,1	41,6	2,2	38,1	38,0	3,7	34,0	42,0
7	45,5	3,0	45,4	3,8	41,6	3,3	39,4	39,0	3,7	37,0	42,0
8	47,5	2,8	45,9	2,8	41,7	3,2	40,2	40,0	4,0	37,0	44,0
9	49,7	2,9	46,4	2,9	43,3	3,8	41,2	40,5	3,4	39,0	44,0
10	51,2	3,3	46,6	2,8	43,7	3,3	42,1	42,0	2,5	40,5	43,5
11	52,1	3,5	48,4	3,0	44,8	3,2	43,8	43,5	3,0	42,5	44,0
12	53,4	3,7	48,8	3,3	46,9	3,7	45,8	46,0	3,8	43,0	48,0
13	54,8	3,7	51,2	3,3	47,5	3,9	46,7	46,0	2,8	44,0	48,0
14	56,1	3,9	52,5	3,4	48,0	4,0	47,0	48,0	2,7	45,0	48,0
15	58,5	3,8	53,3	4,1	49,3	3,5	48,2	48,0	3,7	46,0	50,0
16	60,4	3,5	53,8	3,5	51,0	4,2	49,9	50,0	3,9	47,0	53,0
17	60,6	3,8	54,3	3,8	53,0	3,6	51,8	52,0	2,7	49,5	54,0
18	60,9	3,9	54,8	4,1	53,9	3,0	52,2	52,0	2,8	50,0	54,0

Table 10. Comparison of mean values of nose height (n-sn) in the Rzeszów girls (mm)

Age	(n-sn) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	39,7	3,1	39,3	3,2	39,7	2,4	35,2	35,5	1,9	34,0	36,0
5	41,0	2,9	42,2	3,5	40,0	2,4	36,1	36,0	2,8	34,0	38,0
6	42,7	3,0	44,0	3,1	41,4	2,5	37,4	38,0	2,3	36,0	39,0
7	44,8	3,2	44,8	4,1	43,1	4,5	40,0	39,0	3,1	37,0	42,0
8	46,8	2,9	45,7	2,9	43,9	3,3	41,1	40,0	4,6	38,0	44,0
9	49,3	2,9	46,6	2,8	45,4	3,3	42,0	42,0	4,0	39,0	45,0
10	50,9	3,1	47,3	2,7	46,0	3,5	42,6	42,0	3,7	39,5	44,5
11	51,7	3,0	48,8	3,4	47,5	3,1	44,0	43,5	1,8	43,0	45,5
12	53,1	3,1	49,8	3,2	47,9	3,7	45,3	45,5	1,8	43,5	46,5
13	53,8	3,2	51,1	3,2	47,9	3,5	45,6	45,0	3,0	43,5	46,0
14	54,5	3,3	51,1	3,9	48,9	3,6	46,3	45,5	4,2	43,0	47,0
15	55,7	3,9	51,1	3,4	49,2	3,6	46,9	47,0	2,1	45,0	48,0
16	56,6	3,8	51,2	3,8	49,3	2,9	47,1	47,0	2,0	46,0	48,0
17	56,7	3,1	51,3	3,2	49,5	3,6	48,7	49,0	2,9	47,0	50,0
18	56,6	2,9	51,4	3,3	49,6	3,8	49,0	49,0	1,6	47,0	51,0

The differences between the average values of the nose index of the analyzed boys and girls indicated shortening of the nose, and in girls - also its widening. In the 1978/79 series, in boys aged 4 to 9 years, and in girls aged 4 to 8 years, leptorrhinus was present, and in the later age groups up to 18 years only hyperleptorrhinus. The subjects from the 1993/94, 2003/04, and 2013/14 series in all age groups were characterized by leptorrhinus. In both sexes after the 35 year period, widening of the nose from hyperleptorrhinus to leptorrhinus was observed. As a result of the changes in boys from the 2013/14 series at the age of 18 were characterized by brachycephalus, mesoprosopus, and leptorrhinus, and girls from the same sample were characterized by mesocephalus, mesoprosopus and, like their male peers, leptorrhinus (Tables 17-22).

The 2013/2014 series was enriched with new parameters that will also be evaluated in successive time

Table 11. Comparison of mean values of nose width (al-al) in the Rzeszów boys (mm)

Wiek Age	(al-al) [mm]										
	Chłopcy (Boys)										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	25,6	1,6	25,8	1,9	27,2	2,1	25,4	25,0	2,5	23,0	28,0
5	25,9	1,6	27,1	1,7	27,5	2,5	25,7	26,0	2,5	23,0	28,0
6	26,5	1,7	27,2	1,9	27,8	2,2	26,1	26,0	3,7	22,0	29,0
7	27,1	1,7	27,4	1,4	28,1	2,5	26,6	26,0	2,5	25,0	28,0
8	27,3	1,6	28,2	2,2	28,5	2,9	28,1	28,0	2,2	26,0	30,0
9	27,3	1,6	28,7	1,8	28,9	2,8	28,7	30,0	2,3	27,0	31,0
10	27,3	1,7	28,7	1,8	29,1	2,9	28,7	29,0	1,4	28,0	30,0
11	27,6	1,8	29,0	1,8	29,5	2,8	30,0	30,0	3,2	27,0	31,0
12	28,5	2,0	29,7	2,3	29,9	2,9	30,1	30,0	3,2	28,0	33,0
13	29,7	2,3	30,4	2,8	31,5	3,0	30,1	31,0	3,0	28,0	33,0
14	30,7	2,4	31,7	2,6	32,2	2,9	30,3	30,0	3,2	29,0	33,0
15	31,5	2,3	32,6	2,6	33,2	2,8	30,3	30,0	2,7	28,0	32,0
16	31,9	2,3	32,8	2,1	33,6	3,1	31,8	32,0	2,3	31,0	34,0
17	32,2	2,3	33,1	2,2	34,2	3,0	32,3	32,0	1,3	31,0	33,0
18	32,6	2,4	33,1	2,0	34,3	3,0	32,7	32,0	3,0	32,0	35,0

Table 12. Comparison of mean values of nose width (al-al) in the Rzeszów girls (mm)

Age	(al-al) [mm]										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	24,8	1,6	25,5	1,3	26,4	2,4	24,6	24,5	2,5	23,0	26,0
5	25,4	2,0	25,9	1,5	26,6	1,9	25,2	25,0	1,9	23,5	26,5
6	26,0	1,9	26,2	1,6	27,4	2,1	25,9	26,0	2,9	24,0	27,0
7	26,2	1,4	27,0	2,5	27,9	3,0	26,2	26,0	2,7	24,0	28,0
8	26,3	1,5	27,2	1,9	27,8	2,2	28,1	26,5	3,8	25,0	30,0
9	26,5	1,6	27,7	1,9	28,1	2,9	28,3	28,0	2,0	27,0	30,0
10	26,8	1,5	28,5	2,0	28,8	2,4	28,4	29,0	3,6	26,0	30,0
11	27,0	1,8	28,6	1,9	28,9	2,8	28,8	29,0	1,8	27,0	30,0
12	27,7	2,0	29,3	1,9	29,9	2,9	29,5	30,0	2,5	28,0	31,0
13	28,7	1,9	29,6	2,3	30,1	3,0	29,6	30,0	1,9	28,0	31,0
14	29,4	1,9	29,8	2,3	30,7	2,7	29,8	31,0	2,5	28,0	32,0
15	29,7	2,1	29,9	2,1	31,0	2,9	30,2	30,0	1,6	29,0	32,0
16	29,7	2,1	30,2	2,0	31,2	2,5	30,4	31,0	2,7	28,0	33,0
17	29,7	2,1	30,4	2,0	31,5	3,0	30,8	30,0	2,7	29,0	34,0
18	29,8	2,1	30,4	2,0	31,6	2,9	31,0	31,0	3,0	29,0	32,5

periods. The head circumference in examined children was compared to biological reference system centile charts developed by Palczewska and Niedźwiecka which were published in health books until 2015 and were considered to have normative values for the Polish population.[14,15] The mean head circumference values of the boys surveyed were generally between the 25 and 50 centile, except for 13 and 18-year-olds, where

Table 13. Absolute differences between mean values of head length and width, face height and width, and nose length and width in the Rzeszow boys and girls from the 2003/04 and 2013/14 series (mm)

Boys						Wiek	Girls					
g-op	eu-eu	n-gn	zy-zy	n-sn	al-al		g-op	eu-eu	n-gn	zy-zy	n-sn	al-al
-11,5	-1,8	-2,4	-4,1	-3,0	-1,8	4	-4,7	-5,8	-3,5	-2,1	-4,5	-1,8
-8,4	-4,6	-1,8	-3,2	-1,9	-1,8	5	-7,3	-6,9	-2,7	-1,7	-3,9	-1,4
-6,2	-2,3	-0,7	-3,2	-3,5	-1,7	6	-8,2	-7,7	-2,0	-2,1	-4,0	-1,5
-5,2	-3,5	-0,1	-2,5	-2,2	-1,5	7	-6,1	-8,0	-2,1	-0,6	-3,1	-1,7
-4,0	-5,4	0,3	-3,5	-1,5	-0,4	8	-6,6	-6,9	-1,7	-0,6	-2,8	0,3
-5,2	-6,5	3,0	-3,3	-2,1	-0,2	9	-5,6	-7,2	-1,7	-0,1	-3,4	0,2
-6,1	-6,8	1,7	-3,6	-1,6	-0,4	10	-5,9	-7,2	-1,4	0,8	-3,4	-0,4
-5,0	-6,3	1,6	-3,2	-1,0	0,5	11	-7,3	-7,3	-1,4	-0,4	-3,5	-0,1
-4,1	-5,4	3,2	-3,0	-1,1	0,2	12	-8,2	-6,8	-0,6	0,1	-2,6	-0,4
-4,4	-4,5	3,7	-3,0	-0,8	-1,4	13	-7,5	-5,3	0,4	0,5	-2,3	-0,5
-1,4	-1,8	3,4	-2,9	-1,0	-1,9	14	-6,8	-5,3	-1,4	-1,7	-2,6	-0,9
-0,7	-2,0	3,7	-2,9	-1,1	-2,9	15	-4,5	-3,7	-1,0	-3,1	-2,3	-0,8
1,1	-1,1	2,3	-1,4	-1,1	-1,8	16	-4,1	-3,4	-1,6	-2,7	-2,2	-0,8
0,6	0,2	2,8	-0,9	-1,2	-1,9	17	-0,9	-3,9	-1,2	-1,8	-0,8	-0,7
-0,7	*0,3*	1,5	-0,3	-1,7	-1,6	18	-0,2	-4,2	-0,2	-2,1	-0,6	-0,6

Table 14. Absolute differences between mean values of head length and width, face height and width, and nose length and width in the Rzeszow boys and girls from the 1978/79 and 2013/14 series (mm)

Boys						Age	Girls					
g-op	eu-eu	n-gn	zy-zy	n-sn	al-al		g-op	eu-eu	n-gn	zy-zy	n-sn	al-al
-3,5	-5,1	-1,2	-5,2	-3,7	-0,2	4	0,8	-5,6	-0,7	-2,4	-4,5	-0,2
-1,9	-5,8	-1,7	-3,8	-3,1	-0,2	5	0,2	-7,2	-1,0	-2,2	-4,9	-0,2
0,3	-3,4	-1,3	-1,9	-5,6	-0,4	6	-1,4	-7,5	-2,3	-2,8	-5,3	-0,1
1,0	-4,6	-2,5	-2,2	-6,1	-0,5	7	-0,2	-7,6	-2,5	-2,2	-4,8	0,0
0,8	-5,8	-2,5	-2,6	-7,3	0,8	8	0,2	-6,1	-3,0	-2,0	-5,7	1,8
-0,2	-6,5	-1,1	-2,4	-8,5	1,4	9	0,0	-5,8	-4,1	-2,4	-7,3	1,8
-0,2	-6,9	-1,7	-1,9	-9,1	1,4	10	-0,9	-5,6	-5,2	-2,1	-8,3	2,2
0,5	-6,9	-1,6	-0,5	-8,3	2,4	11	-1,4	-7,2	-6,2	-2,3	-7,7	1,8
1,7	-6,1	-1,1	-0,9	-7,6	1,6	12	-1,6	-8,1	-6,3	-3,5	-7,8	1,8
1,6	-5,7	-2,6	-2,2	-8,1	0,4	13	-2,3	-6,6	-4,7	-2,9	-8,2	0,9
3,9	-4,5	-3,6	-1,1	-9,1	-0,4	14	-2,8	-6,7	-6,3	-1,9	-8,2	0,4
3,3	-6,3	-2,8	-2,0	-10,3	-1,2	15	-0,8	-5,7	-7,9	-1,2	-8,8	0,5
3,5	-6,4	-3,7	-1,4	-10,5	-0,1	16	-1,0	-5,8	-8,2	-0,8	-9,5	0,7
2,4	-4,7	-2,9	-0,9	-8,8	0,1	17	2,3	-6,2	-7,7	-0,4	-8,0	1,1
1,3	*-4,5*	-2,4	-0,5	-8,7	0,1	18	3,0	-6,7	-6,5	-0,3	-7,6	1,2

they ranged between the 10 and 25 centile (Table 15). The mean head circumference values of girls surveyed were generally between the 50 to 75 centile, except for the 13-year-olds where they were between the 25 and 50 centile (Table 16). Taking into account the proportions between head circumference and body height and Michalski's classification[13] boys aged 4-11 years were characterized by a very large head, 12-13 years – a large head, 14 years – a medium head, 15-18 years – a small head (Table 15), while girls aged 4-11 years – a very large head, 12 years – a large head, 13-17 years – a medium head, 18 years – a small head (Table 16).

Table 15. Descriptive statistics related to head circumference and proposed proportion indices in boys from the 2013/14 series

Age	Boys														
	Head circumference [cm]					Head circumference [cm] / Body height [cm]					Head circumference [cm] x BMI [kg/m^2]				
	$\bar{x}$	Me	s	c_{25}	c_{75}	$\bar{x}$	Me	s	c_{25}	c_{75}	$\bar{x}$	Me	s	c_{25}	c_{75}
4	50,8	51,0	1,1	50,0	51,6	0,495	0,497	0,026	0,475	0,519	8,05	8,06	0,67	7,64	8,45
5	51,2	51,0	1,8	50,2	52,3	0,475	0,473	0,023	0,461	0,486	8,18	8,07	0,80	7,65	8,68
6	52,0	52,0	1,4	51,0	53,7	0,440	0,442	0,019	0,420	0,453	8,86	8,75	1,36	7,79	9,52
7	52,1	52,0	1,5	51,0	53,2	0,413	0,411	0,018	0,401	0,425	8,84	8,79	1,03	8,01	9,74
8	52,6	52,6	1,3	52,0	53,5	0,405	0,407	0,017	0,394	0,417	8,76	8,18	1,42	7,88	9,83
9	52,7	53,0	1,3	52,0	53,7	0,385	0,380	0,012	0,377	0,389	10,39	9,71	2,28	8,87	12,10
10	52,6	53,0	1,4	51,6	53,5	0,371	0,372	0,017	0,358	0,381	9,76	9,44	1,69	8,38	10,77
11	52,6	52,4	1,6	51,8	53,5	0,361	0,359	0,014	0,354	0,368	9,69	8,65	2,08	8,17	11,42
12	54,0	54,0	1,4	53,4	54,5	0,354	0,353	0,013	0,342	0,360	10,58	10,49	1,73	9,26	11,81
13	53,3	52,6	1,6	52,3	54,7	0,346	0,347	0,011	0,340	0,357	10,18	10,09	1,66	8,81	10,72
14	55,3	55,2	1,4	54,4	56,3	0,329	0,329	0,015	0,320	0,337	11,61	11,36	1,56	10,37	12,92
15	55,7	55,7	1,1	55,0	56,0	0,310	0,310	0,013	0,301	0,319	10,75	11,04	1,08	10,16	11,52
16	56,4	56,5	1,4	55,2	57,4	0,319	0,322	0,009	0,314	0,326	11,29	11,35	1,07	10,38	11,94
17	55,9	56,5	1,5	54,3	57,0	0,311	0,313	0,012	0,301	0,321	12,26	11,80	1,46	11,06	13,86
18	55,2	55,0	1,1	54,5	55,5	0,307	0,302	0,011	0,298	0,315	11,72	12,14	1,60	10,33	12,80

Table 16. Descriptive statistics related to head circumference and proposed proportion indices in girls from the 2013/14 series

Wiek [lata]	Girls														
	Head circumference [cm]					Head circumference [cm] / Body height [cm]					Head circumference [m] x BMI [kg/m^2]				
	$\bar{x}$	Me	s	c_{25}	c_{75}	$\bar{x}$	Me	s	c_{25}	c_{75}	$\bar{x}$	Me	s	c_{25}	c_{75}
4	50,1	50,8	1,6	48,7	51,5	0,495	0,499	0,016	0,487	0,506	8,36	8,18	0,63	8,05	8,75
5	50,4	50,5	1,4	49,6	51,0	0,465	0,465	0,018	0,452	0,481	7,79	7,74	0,79	7,39	8,30
6	51,1	51,1	1,8	50,0	52,2	0,451	0,453	0,015	0,439	0,457	8,23	8,16	0,86	7,46	8,96
7	51,7	51,1	1,3	50,8	52,7	0,417	0,410	0,026	0,398	0,432	8,77	8,58	1,76	7,60	9,72
8	52,2	51,6	1,1	51,3	53,0	0,404	0,402	0,018	0,396	0,412	10,00	9,87	1,84	8,46	11,07
9	52,5	52,0	2,0	51,0	53,0	0,389	0,388	0,023	0,373	0,394	9,02	8,80	1,30	8,25	10,38
10	52,4	52,5	1,3	51,2	53,6	0,373	0,370	0,019	0,363	0,386	9,14	8,79	1,68	8,11	10,12
11	51,7	51,7	1,2	51,2	52,1	0,362	0,363	0,014	0,352	0,372	9,97	9,94	1,10	9,03	10,76
12	53,9	53,9	1,9	52,3	54,2	0,350	0,356	0,020	0,335	0,364	10,82	10,52	1,78	9,59	12,08
13	53,4	54,0	1,3	51,6	54,6	0,323	0,325	0,011	0,316	0,329	9,60	9,68	0,96	8,69	10,11
14	54,3	54,0	1,5	53,0	55,0	0,331	0,328	0,015	0,325	0,337	10,92	10,39	1,55	9,94	11,45
15	55,0	55,4	0,9	54,5	56,0	0,335	0,333	0,018	0,324	0,346	10,44	10,30	1,08	9,59	11,10
16	54,4	54,5	1,6	52,4	56,0	0,339	0,340	0,018	0,321	0,353	11,50	11,53	1,30	10,24	12,85
17	52,6	52,2	1,2	51,6	53,7	0,313	0,311	0,015	0,306	0,323	11,05	11,01	0,58	10,73	11,09
18	53,6	53,4	1,5	52,5	55,0	0,320	0,321	0,012	0,313	0,329	11,11	11,12	0,95	10,45	11,68

Discussion

With age, body dimensions increase and its proportions differentiate.[16] Various anthropometric parameters are used to describe the growth process, and the body proportion indices are used for typological characteristics. Various examples of proportion parameters and indices used in classical anthropometric studies can be found in the literature. An acknowledged anthropometric feature used to evaluate a head size is the maximum occipitofrontal head circumference.[17,18] Therefore, this parameter was added in the 2013/14 series. The cephalometric parameters and proportional indices presented by other authors are the same as in this study[19] or differ, taking into account: the length of the body of the mandible (gn-go).[20] In some cases, osteometric parameters were used for life testing, for example the head length was assumed to be the chord of the head (g-i)[21,26] or the height of the nose (n-ns)[22] and the head width[21] or head, nose indices[22] were

Table 17. Comparison of mean values of head width-length index in the Rzeszów boys

Age	eu – eu / g – op										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	87,2	3,6	84,5	4,8	81,5	5,3	85,5	84,8	4,8	82,6	88,3
5	86,5	3,6	84,9	4,3	82,3	5,5	83,9	84,1	4,9	82,0	86,6
6	86,3	3,9	85,0	4,8	82,7	5,0	84,0	83,3	4,5	80,0	88,6
7	86,7	4,2	85,4	4,3	83,0	5,7	83,4	83,8	4,9	81,1	85,8
8	86,3	4,2	85,1	3,5	83,4	4,7	82,3	81,9	7,2	79,6	85,5
9	85,9	3,9	85,7	4,0	83,3	4,5	82,1	81,1	6,0	79,6	84,0
10	85,9	3,7	85,7	3,6	83,3	4,9	81,9	81,4	6,0	78,9	83,5
11	85,9	3,8	85,9	4,0	83,0	4,9	81,5	81,4	6,1	78,7	83,9
12	85,9	3,6	85,3	3,6	82,9	4,0	81,5	81,5	7,5	80,1	83,0
13	85,9	3,4	85,2	3,9	82,8	8,4	82,0	81,3	3,4	79,9	84,5
14	86,4	3,4	85,5	3,9	82,5	5,2	82,1	81,1	4,5	80,1	84,0
15	86,6	3,4	85,1	3,3	82,3	4,8	81,7	81,4	4,7	78,9	84,0
16	86,4	3,2	84,1	3,9	82,3	4,5	81,6	81,6	4,7	80,1	83,0
17	85,5	3,2	83,8	3,6	82,1	4,8	81,9	80,9	4,5	79,5	83,5
18	85,1	3,2	84,4	3,4	81,9	4,5	82,7	82,5	3,6	80,0	84,5

Table 18. Comparison of mean values of head width-length index in the Rzeszów girls

Age	eu – eu / g – op										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	86,0	3,9	82,8	3,7	83,2	4,5	82,0	81,1	4,6	78,8	86,5
5	86,7	3,7	83,5	4,9	82,6	4,5	82,5	81,4	5,0	79,6	86,5
6	86,7	4,0	84,9	4,7	83,2	6,0	82,3	82,1	4,6	79,1	85,8
7	86,4	4,2	85,1	4,8	83,5	4,3	82,5	82,0	2,9	80,2	85,9
8	86,1	4,0	85,2	3,9	83,5	5,3	82,9	81,7	4,8	78,8	84,7
9	85,9	4,0	85,4	4,3	83,8	4,1	82,7	81,0	5,1	78,9	85,7
10	85,1	4,0	84,8	3,6	83,6	4,5	82,5	82,7	3,0	79,7	85,7
11	85,4	3,9	84,9	3,8	82,8	4,5	82,2	82,4	4,6	79,1	85,9
12	85,9	3,2	84,1	3,7	82,5	4,5	82,1	81,4	5,0	78,5	86,0
13	85,5	2,9	84,2	3,5	82,4	5,0	82,4	81,5	2,3	79,5	85,5
14	85,1	3,1	84,6	3,4	82,4	4,7	82,5	82,0	3,4	79,5	85,0
15	85,2	3,2	84,5	3,7	82,5	4,8	82,3	82,2	3,7	79,1	85,5
16	85,6	3,2	84,2	3,3	82,8	4,4	82,5	82,2	3,0	70,4	85,9
17	85,8	3,0	84,0	3,1	82,9	4,0	81,6	81,1	3,1	78,8	85,0
18	86,0	2,9	83,7	3,0	82,9	3,9	81,1	80,0	3,0	78,5	84,9

calculated based on parameters from two groups: cephalometric and osteometric. Different typological classifications were also observed based on the width-length index: according to Saller[19] and Franz Boas.[23] Posthumous examinations of skulls were based on traditional osteometry. Skull chords and arches were evaluated.[24] In addition to the traditional anthropometric method assessing face morphology, also photogrammetric method was used including: morphological upper face height (n-sto), morphological face height / length (n-gn), lower face height (sto-gn), nose height (n-sn), upper lip height (sn-sto), lower lip height (sto-sm), height of vermilion border of the upper lip (ls-sto), height of vermilion border of the lower lip (ls-sto), nose width (al- al), rima oris width (ch-ch), external interocular width (ex-ex) and internal interocular width (en-en) and proportional indi-

Table 19. Comparison of mean values of morphological face index in the Rzeszów boys

Age	n– gn / zy–zy										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	78,5	4,6	81,9	4,8	80,5	5,4	81,5	80,0	6,9	77,9	83,5
5	79,5	4,2	82,8	5,2	80,0	4,3	81,0	80,9	6,1	77,8	84,0
6	80,9	3,6	83,0	4,5	79,4	4,5	81,5	80,5	5,7	77,5	83,5
7	82,2	3,7	82,2	4,1	80,0	6,5	81,9	82,4	4,0	81,0	84,0
8	83,4	3,9	82,2	3,5	80,6	6,4	82,8	82,0	6,5	79,5	85,5
9	84,1	3,7	82,6	3,9	80,5	7,0	84,0	83,5	4,0	80,0	86,5
10	85,0	3,3	82,0	2,3	81,1	7,4	84,7	85,0	5,5	81,5	87,0
11	85,5	3,4	83,5	4,4	81,5	5,9	84,9	85,0	5,6	81,6	87,0
12	85,4	3,7	83,2	4,7	80,8	5,5	85,0	85,5	5,7	81,9	87,5
13	85,8	4,1	83,2	3,9	80,8	5,9	85,5	85,6	5,5	81,5	88,5
14	86,5	4,5	84,4	5,1	80,4	5,0	85,0	84,9	6,0	82,0	88,0
15	87,2	4,8	85,5	4,8	82,0	5,7	85,9	86,5	5,7	82,3	89,0
16	88,2	4,8	84,4	4,2	84,0	6,6	86,2	86,6	4,9	83,1	89,5
17	88,6	4,5	84,0	5,0	84,3	5,4	86,8	86,6	4,8	82,8	90,5
18	88,5	4,0	84,7	4,1	85,5	5,1	87,5	86,9	3,5	84,5	91,0

Table 20. Comparison of mean values of morphological face index in the Rzeszów girls

Age	n– gn / zy–zy										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	Me	s	c_{25}	C_{75}
4	78,2	4,7	80,0	3,9	81,0	5,0	79,5	78,7	4,5	74,9	80,5
5	79,5	4,4	81,2	4,1	81,3	7,1	79,9	80,2	5,0	77,6	84,0
6	80,7	3,8	81,4	4,0	81,0	5,5	80,4	82,4	5,5	77,4	84,5
7	82,1	4,0	81,6	4,7	82,9	5,9	81,7	80,0	6,5	77,5	84,0
8	83,7	4,1	81,6	4,2	83,3	6,0	82,1	82,5	5,9	78,0	85,0
9	84,2	4,0	82,1	4,1	83,8	6,6	82,6	83,0	5,0	77,9	86,0
10	84,8	4,2	82,6	3,8	83,6	7,5	82,2	83,1	6,5	78,9	86,5
11	85,4	4,1	83,3	4,4	82,9	5,8	82,4	81,5	6,0	79,0	87,0
12	85,3	4,1	83,0	3,7	83,0	7,0	82,5	83,1	5,6	79,0	87,0
13	84,8	3,9	84,3	4,1	83,1	7,1	83,5	83,3	4,0	80,0	86,9
14	85,6	4,0	84,4	4,3	82,0	5,5	82,3	82,0	4,7	78,6	86,0
15	86,7	4,1	84,4	5,1	80,3	5,5	81,9	82,1	6,0	78,2	86,0
16	86,7	4,0	83,3	4,9	80,6	7,0	81,9	80,7	4,0	79,0	86,4
17	86,4	4,0	83,1	4,6	80,7	4,9	81,5	82,7	3,9	80,0	86,7
18	86,2	3,9	83,0	4,0	80,5	4,4	81,9	82,3	3,7	78,9	86,0

ces were calculated.[25] The method of magnetic resonance imaging was also used. In the sagittal projection the measurements of the traditional cephalometric points: nasion (n), basion (ba), ophisthion (o), zygion (zy), and non-traditional: sella, menton, anterior and posterior nasal spine were plotted.[26] It was also necessary to describe the relationship between head and body size - hence the two proportional indices were calculated (Table 15-16). The head circumference was used in the studies in the 1960s and is currently underestimated.[13] In animals, there was a correlation between brain size and body size and was described by the encephalization index.[27] A study of 5079 Turkish children and adolescents aged 5 to 18 in 2010-2013 indicated significant positive correlation between

Table 21. Comparison of mean values of nose index in the Rzeszów boys

Age	al-al n–sn										
	Boys										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	*Me*	s	c_{25}	C_{75}
4	63,0	5,4	63,5	6,8	67,9	7,3	68,1	67,5	5,9	63,5	70,0
5	61,8	5,1	62,4	6,6	67,5	5,5	65,7	64,0	6,0	60,0	71,5
6	60,8	5,0	60,4	6,2	66,5	5,3	68,3	67,9	6,5	62,2	73,0
7	59,9	5,1	60,3	5,7	67,6	7,5	67,9	68,1	7,5	62,2	73,5
8	57,6	4,7	61,8	6,4	68,2	8,5	69.6	69,2	6,5	65,5	74,0
9	55,0	4,4	61,8	5,2	66,9	7,6	69,4	68,9	7,0	65,4	74,0
10	53,5	4,6	61,4	5,5	66,6	7,5	68,5	67,5	6,7	64,5	73,5
11	53,1	5,0	59,8	5,9	66,0	7,1	68,5	68,2	6,5	64,0	73,0
12	53,6	5,0	60,7	5,8	63,9	6,8	66,0	66,6	6,0	61,7	72,1
13	54,5	4,6	59,2	5,5	66,0	7,9	64,3	63,3	7,5	56,3	70,0
14	54,8	4,9	60,7	6,1	66,9	7,0	64,3	63,6	7,5	56,9	69,5
15	54,0	5,2	60,9	6,3	67,3	6,8	62,7	62,8	4,8	58,0	67,6
16	52,9	5,0	61,2	5,7	65,8	7,5	63,5	62,9	5,0	59,3	67,3
17	53,3	5,0	61,2	6,3	64,7	6,4	62,5	60,9	6,9	58,3	67,0
18	53,7	5,1	60,8	5,8	63,7	6,0	62,6	61,3	7,0	58,5	67,0

Table 22. Comparison of mean values of nose index in the Rzeszów girls

Age	al-al n–sn										
	Girls										
	1978/79		1993/94		2003/04		2013/14				
	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	s	$\bar{x}$	*Me*	s	c_{25}	C_{75}
4	62,9	4,7	64,8	5,8	66,5	6,0	69,5	68,2	6,4	65,1	74,5
5	62,1	4,4	61,4	6,5	66,4	5,8	69,3	69,9	6,0	65,5	75,0
6	60,9	3,8	59,6	5,9	66,0	6,5	68,9	68,6	7,4	63,2	74,0
7	58,4	4,0	60,0	7,2	64,5	7,9	65,5	65,7	5,8	60,0	71,9
8	56,1	4,1	60,1	4,9	63,2	4,8	68,1	67,8	7,9	62,2	73,5
9	54,2	4,0	59,3	4,9	62,0	4,5	67,2	67,4	6,1	63,6	71,0
10	53,0	4,2	60,1	5,1	62,5	4,4	66.4	66,6	6,9	63.6	69,6
11	52,3	4,1	58,4	5,0	61,0	5,0	65,1	64,0	7,9	56,9	70,0
12	52,3	4,1	59,1	5,1	62,3	5,5	65,0	67,1	7,8	58,0	70,2
13	53,5	3,9	58,1	5,4	62,9	5,9	64,9	63,6	8,0	56,6	70,1
14	54,2	4,0	58,2	6,4	62,8	6,1	64,5	63,6	7,6	56,6	70,0
15	53,4	4,1	58,3	5,1	63,1	5,7	64,2	63,7	7,5	56,4	70,3
16	52,3	4,0	59,1	6,5	63,3	4,9	64,4	63,8	7,5	56,6	70,0
17	52,3	4,0	59,1	6,3	63,5	7,1	63,2	62,8	4,9	59,3	67,4
18	52,6	3,9	59,2	6,1	63,6	5,0	63,1	62,5	5,0	59,4	67,5

head circumference and body height and head circumference and body weight.[28]

An important direction of anthropometric research is the establishment of development standards, and also the creation of a biological reference system. The mean values and standard deviations shown in the tables of 2013/2014 cephalometric parameters (Table 1-12, 15-16) can be used as a biological reference system. Since

2015, in Poland, the normative values of head circumference according to the WHO for children aged 0 to 3 years are presented in the Child Health Book.[29] The head circumference was monitored among 27,209 Colombian children and adolescents aged 0-20 years from families with good and average economic status. Measurements were made in 2009-2010 and were considered as normalized values, useful for assessing the development of children and adolescents from Colombia and other Latin American countries.[30] In Norway, between 2003 and 2006 similar studies were conducted among 8299 children and adolescents aged 0-19 years to develop reference values, including the head circumference for the Norwegian population.[31] Based on the photogrammetric assessment of the face of 514 Chinese subjects aged 12, developmental norms and characteristic types of faces for this age group have been established, normative values and gender differences. They were found useful in plastic surgery and orthodontics [25]. Detailed evaluation of anthropometric features and indices using basic research tools can be used to monitor patients treated for the premature fusion of the cranial sutures.[32]

Some developmental rules are also sought. Latvian studies have allowed to trace certain head development patterns in this population. The study covered 503 newborns born between 2004 and 2007. The head width-length index was similar for the newborns in both sexes, and in the first months of life it decreased, and in the following months it increased, it was generally higher in boys. The dolichocephalus type was more common between 1 and 3 months of life. The most common type in infant boys was brachycephalus, similarly in girls, except for 9-12 months of age - when mesocephalus dominated.[23] In 2005-2007 also in Latvia, 1359 boys aged 7-18 were examined. Increasing head dimensions occurred throughout all age categories and is the most intense between 14-15 years of age. On the basis of the value of the head width-length index in this age group in the boys were distinguished types from hyperbrachycephalus to brachycephalus, but the most typical type was mesocephalus, especially typical of the people of Northern Europe.[20] In our research in the 2013/2014 series, a change in the head circumference and body height in both sexes was observed: from a very large head at the age of 4 to a small head at the age of 18. The typological changes were different for both sexes over 11 years of age.

Some authors point out that the morphological development of the head differs from other parts of the body because it remains closely connected with the development of the brain.[20] However, no disturbances in head index differentiation were found based on the head width-length index in children with neurodysfunctions and abnormal brain structure. The study was conducted in 2012, the values of the index were compared in 112 children of both sexes aged 0-18 years with abnormal brain structure and 218 healthy individuals in the same age group.[33] As it is known, somatic development is determined by genetic factors, and is different in both sexes.[16] For example, between 1992 and 2006 the study on the development of Turkish children aged 0-19 was conducted. There were 2391 boys and 2102 girls aged 0-5 years, 1100 boys and 1020 girls aged 6-19. The results were compared with WHO, Belgian and Norwegian reference values. Turkish children and adolescents over 5 years of age have been found to have higher head circumference than those indicated by WHO and over 9 years of age than Belgian and Norwegian children and adolescents. This fact was related to genetic conditions.[17] Another study has shown that there is a difference in white and black skull construction. A total of thirty-two MRI examinations were performed in healthy, white and black children aged 4-8 years. There was a difference between white and black races, especially in face height determined as the distance between nasion and menton points.[26] Head length, width, and head width-length index of 700 children and adolescents aged 11-20 from the Nigerian Ogbia tribe have indicated that the dominant type of head width- length index is mesocephalus.[21]

Endogenous non-genetic maternal factors[34], exogenous environmental factors, including socioeconomic conditions[19,35] and chronic diseases[14,22,36] modify the course of somatic development. Pedersen et al. have shown that neurotoxic acrylamide, which is produced during heat treatment of carbohydrate-containing foods, penetrates the placenta and affects the reduction of intrauterine growth of the fetus and contributes significantly to the reduction of the head circumference at birth. 1101 pregnant women living in Denmark, England, Greece, Norway and Spain were included in the study in 2006-2010.[34] In the years 2004/2005, the study on the morphological development of the head was conducted among 3696 boys and girls aged 6-19 from rural areas of the Podkarpackie Province. The results of the study were compared to those presented in this paper (the series 2003/2004 and 6-19 age group was considered). It was found that children and adolescents from rural areas of Podkarpacie had lower head length than those from Rzeszów with more pronounced brachycephalus and leptorrhinus. Head length was considered the most ecosensitive parameter.[19] The relationship between head shape and certain chronic genetic diseases was also considered. There was no significant difference in the shape of the face between Nigerian children with sickle cell anemia and children in the control group. In addition to the abnormal genome, major factor in developmental disorders was primarily seen in recurrent ischemic episodes. The study was conducted in 2004-2007. A total of 600 children were studied, 100 of whom suffered from sickle cell anemia and the others were the

control. Parameters characterizing the structure of the nose were lower than in the control group, and it was elevated in case of philtrum height, platyrrhine type was dominating.[22].

Extremely interesting were studies on the changes in somatic development that take place between the generations or the secular trend. This phenomenon is considered to be non-evolutional, not related to the genome, which is adaptive, influenced by changes in the development of civilization.[24,37] It was found that during the period of significant epidemiological changes, manifested by the reduction of infant mortality and life expectancy increase, migration of people to cities, increase in access to medical care, there was a secular trend in the development of the skull. It was noted that during 150 years in the United States, the most significant changes were the increase in the size of the posterior cranial fossa, which develops most significantly in the fetus and in the first year of life, and in Portugal - the facial skeleton and the lateral cranial fossa, which develop the most intensively between 3 and 9 years of age. These differences were related to different patterns of mortality in the same period, in both populations. Portugal entered into the mentioned period of significant epidemiological changes later. The examined skulls came from people born between 1802 and 1975. A total of 1720 skulls were examined. There was a correlation between birth year and osteometric parameters.[24] Research on the secular trend was also carried out in the urbanized area of Sardinia, Italy. The largest head length and width and head width-length index were compared in children between 3 and 5 years of age between 1986 and 2001. The sample size was 262 and 414 children, respectively. There was an increase in head length and a decrease in head width-length index between 1986 and 2001.[37] Research conducted in the 35-year period 1978/79-2013/14 in the population of children and adolescents from Rzeszów showed some changes in the development of the head. The characteristic feature of this population during this period in both sexes is: head elongation, shortening of morphological height of face and nose and its broadening. The observed developmental changes are more pronounced in girls than in boys. Tracking developmental changes over time is important because it allows to update biological reference systems in the form of standards for evaluating the somatic development of children and adolescents in the traditional sense.

Conclusions

1. In the analyzed 35-year-period the phenomenon of head elongation is observed in boys, and to a greater extent in girls from Rzeszów.
2. At the same period, boys and girls experienced shortening of the height of the morphological face and nose. This process is more pronounced in girls.
3. In both sexes after 35 years the nose gets widened from hyperleptorrhinus to leptorrhinus.
4. Further studies on variation in morphology (shape) of the head are recommended due to the differences observed in the development of head features over the 35-year period.
5. There is a need to update biological references used to assess the physical development of children and adolescents.

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ORIGINAL PAPER

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Patient's satisfaction with anesthesia based on the polish version of the of Iowa Satisfaction with Anesthesia Scale. Satisfaction with anesthesia in patients with craniofacial trauma

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ABSTRACT

Purpose. The article presents an assessment concerning patient satisfaction with anesthesia as based on the Polish version of the Iowa Satisfaction with Anesthesia Scale.

Material and Methods. The study group consisted of 198 patients with maxillofacial injury admitted to the Clinical Ward of Maxillofacial Surgery. The quality of the anesthesiological care was evaluated with the Polish version of Iowa Satisfaction with Anesthesia Scale.

Results. It was stated that the level of satisfaction with the anesthesia in patients operated on due to maxillofacial injury used was average. According to the Polish version of the Iowa Satisfaction with Anesthesia Scale, the average score in the studied population was 0.8 on a scale from -3 to +3, SD 2.41. There were differences observed depending on patient age (18-30 years old ($p = 0.0001$)) and clinical condition.

Conclusion. The level of satisfaction with anesthesia in patients with craniofacial trauma is moderately positive, however, in patients with an injury of the upper face and in patients with ASA scale I and II, the same level of satisfaction is higher. Among the analyzed socio-demographical factors only the age determines the level of satisfaction with anesthesia. The level of satisfaction is higher in older patients.

Keywords. satisfaction with anesthesia, patient after maxillofacial trauma, Polish version of the Iowa Satisfaction with Anesthesia Scale

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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Introduction

According to Pascoe, patient 'satisfaction' is defined as their subjective reaction to the health care they receive at the time.[1] Each patient compares his or her health care experience with an expectation. The expectations can have various levels such as an ideal one, a minimal level of expectations, an average level, all deriving from recent experience. Only the patient can spot the differences between the expected health care standards and what he or she actually experienced. The transition in the level of satisfaction occurs when the difference between the actual and expected level of satisfaction is significant for the patient. Low level of satisfaction does not necessarily mean that the patient was not happy with the care received, because the patient may have very little expectations towards the health care. Patient's satisfaction is based on emotions, internal psychological features (for example a tendency to be grateful), a cultural approach towards health and health care as well as a combination of all of these elements.[2-5] Current research results emphasise the importance of assessing the level of patient 'satisfaction' with anesthesia making it one of the significant areas of quality management.[6-9] Dexter et al. claims that the anesthesiological team has to be able to measure patient satisfaction with anesthesia due to at least three reasons. First of all, the care quality ought to be evaluated from the patient's point of view, not only the anesthesiologist's. Secondly, the satisfaction assessed by means of a standardized scale may be used to measure preferences of various patient groups when types of anesthesia and anesthetics are concerned. Lastly, the results of such evaluation can indicate when and how to improve the care quality.[7-11] A patient's assessment and their satisfaction may mirror many aspects of care such as current patient needs, the patients participation in the decision making process, as well as the effects of efficacy of communicating with patients and giving them information, which are very difficult to evaluate in any other way.[5,12-15]

The main aim of this article was to assess the level of patient's satisfaction with anesthesia on the basis of the Polish version of the Iowa Satisfaction with Anesthesia Scale (ISAS) in patients operated on due to a maxillofacial injury.

Material and Methods

The study group consisted of patients operated on due to a maxillofacial injury from random accidents. Usually these apply to young people, aged between 20-44 years and the majority of them were male (70–80 %). The main causes of such injuries are road accidents, fights, sport injuries etc.[16] Fractures of the craniofacial skeleton happen by two main mechanisms, which may or may not occur together in one injury. The indirect mechanism is a result of crashing and the direct mechanism is a result of a straightening of the physiological curvatures of the skeleton.[17-18] There are many classifications of facial fractures. For the sake of the study, a three-level distinction has been applied. Types of injury were defined as type I injury - upper face fracture/ forehead sinus/the bridge of nose/ethmoid bone, type II injuries - mid face fracture including maxilla, the base of nose as well as malar bones and malar arches and type III lower face fracture, mandible.[17-18] The research was conducted from January to December 2009 in the group of 198 patients, who were admitted to the Clinical Ward of Maxillofacial Surgery with a Third reference level. It is the only ward of this type in the Subcarpathian region. Patients with a maxillofacial injury are transported there directly from the emergency room or from other hospitals. The choice of the study group was purposeful. The patients were successively included at the time of being admitted to the Clinical Ward for the Maxillofacial Surgery. They had to fulfill the following criteria: hospitalization due to maxillofacial injury, surgical procedure performed, no cognitive disorders, a conscious written consent for taking part in the research, and an age over 18. The exclusion criteria were a life threatening condition, postsurgical transfer of the patient in an induced coma to an ICU for further treatment, lack of written consent, age ≤18. Every patient was informed about the aim of the research as well as the time needed to complete the questionnaire. The study was conducted in line with the regulations by the Bioethical Committee at the Medical University in Poznan (No 1239, December 18th 2008).

To evaluate the satisfaction with anesthesia, we used a method of a diagnostic survey and a questionnaire technique. The Polish version of Iowa Satisfaction with Anesthesia was employed as a research tool. Iowa Satisfaction with Anesthesia Scale (ISAS) is a questionnaire measuring the level of patient's satisfaction with health care after anesthesia. It was invented by a team of scientists lead by Professor Dexter from the Department of Anesthesiology at the Iowa State University in 1997.[7] ISAS consists of 11 questions (5 negative and 6 positive ones). Three of them ask patients to assess the pain they experience, six concern every other sensation or ailment experienced by the patients during anesthesia. Two questions require patients to directly evaluate the anesthesia experience.[7-9,19] Every question includes a six-point answer form in the Stapel scale (strongly disagree, disagree, partially disagree, partially agree, agree, strongly agree) form -3 to +3. The values were properly reversed in the negative questions. The final result constitutes a mean of all of the 11 questions. We obtained the consent for cultural adaptation of the Iowa Satisfaction with Anesthesia Scale to Polish conditions.

Statistical Analysis

The analysis was performed using the statistical package STATISTICA 10, Polish version along with the SPSS program. The statistical analysis included basic measurement adjusted to the variables that is mean, standard deviation, minimal and maximal values. The variables were measured on a quotient scale- age was described using arithmetic mean and standard deviation (SD). The variables measured nominally were sex, education, source of income and were presented as numerical data as quantity (n) and percentage showing the share of a given variable in the study group. The variables measured ordinal scale, such as pain level, and were presented with descriptive statistics including median, minimal and maximal values. The following nonparametric tests were incorporated: Mann Whitney test, Spearman rank correlation coefficient, Kruskal-Wallis test, and the Fischer test (for small groups). The following rules were set: $p<0.5$ is a statistically significant dependency (marked by *); $p<0.01$ is a highly significant dependency (marked by **); $p<0.001$ is a dependency of extremely high significance (marked by ***). In the evaluation of psychometric equivalence criteria of the Polish version of Iowa Satisfaction with Anesthesia Scale with the original Iowa Satisfaction with Anesthesia Scale, the Alfa Cronbach coefficient was used, with values 0.6-1.0 accepted as values confirming the scale's validity. Theoretical correctness of the scale was investigated with the Spearman rank correlation coefficient. For both test elements and the general result values <0.4 were set as the threshold ones. The Polish version of ISAS complies with chosen psychometric equivalence criteria of the original scale. The Cronbach coefficient was 0.598. The values of Spearman's rank correlation coefficient were from 0.454 to 0.744.

Results

In the study 198 questionnaires were distributed, 100% was returned. Finally 195 of the total were qualified for further analysis. It constituted 98% of the patients qualified for the study at the time of admittance to the ward. The majority of the respondents were aged 21-30 (33.8%). The smallest subpopulation was the elderly, aged 81 or more (0.5%). The biggest group consisted of 96 patients (49.0%) who live in the countryside followed by 70 (36.0%) people living in a county town, and 29 patients (15.0%) lived in the region's capital.

When asked about the source of income the respondents listed: professional work- 85 patients (45.9%), pension/retirement- 12 people each (6.5%), no regular income- 16 people (16.2%), other sources- 24 people (24.9%). 10 patients did not answer the question. Among the 195 respondents, 77 people (39.5%) presented a secondary education, 50 (25.6%) vocational education, 49 (25.1%) primary and 19 people (9.7%) higher education (Table 1).

Table 1. Demographic characteristics of the patients

Variable	N
Age	**all: 195**
Min –Max	18–82
Mean ±SD	34.8(14.6)
Sex	**all: 195**
F	22 (11.3%)
M	173 (88.7%)
Place of residence	**all: 195**
Regional city	29 (15.0%)
County town	70 (36.0%)
Countryside	96 (49.0%)
Education	**all: 195**
Primary	49 (25.1%)
Vocational	50 (25.6%)
Secondary	77 (39.5%)
University	19 (9.7%)
Source of income	**all: 195**
Professional work	85 (45.9%)
Retirement	12 (6.5%)
Pension	12 (6.5%)
No fixed source of income	16 (8.6%)
Other	24 (13.0%)
	36 (19.5%)

Patient satisfaction with anesthesia on the basis of the Polish version of the ISAS

The results for question 1 which was 'I vomited or felt nauseous' are presented next. It was stated that 36.0% of the respondents did not experience vomiting or nausea in the early postoperative stage. A majority, 74.0%, conveyed vomiting or nausea (negative answers from -3 to -1 were elicited). An analysis of the second question 'I would like to have anesthesia again' makes it possible to notice that the most commonly chosen answer was positive (+3) - strongly agree for 70.2% of the respondents. In question 3 which was 'I felt itchy', the majority of the patients in the study answered 'strongly agree' and 'partially agree', which shows that pruritus may constitute a problem after the procedure. Less than half of the group (46.1%) said there were no problems with itchiness after anesthesia. Question 4 evaluated the level of relaxation in the direct postoperative stage. The majority of the respondents (81.1%) answered positively to this question (+3,+2,+1). Not many people (18.9%) responded negatively (-1 to -3). In the following questions of the Polish version of the ISAS, the patients were asked about the level of pain they experienced. Less than half of the respondents (49.7%) were in pain after the surgery (the answers ranged from -3 to -1). 50.3% did not experience any pain. The question 'I felt safe' was answered positively by 50.3% of the patients (answers +3 to +1) while 28.8% chose 'strongly disagree'. In the question concerning mood the patients assessed whether they felt

too cold or too hot. More than a half (55.5%) did not experience such sensations, whereas 45.5% confirmed the presence of such symptoms. The vast majority (85.9%) of the respondents gave positive answers (from +1 to +3) when asked about their satisfaction with anesthesiological care. Only 14.1% evaluated it negatively.

In the study group, 30.9% confirmed they experienced pain (+3 to +1). The majority (88.2%) felt good after the anesthesia. The rest of the patients (17.8%) felt uncomfortable.

When asked whether they felt sore, the majority admitted to feeling unwell (54.4%), 45.6% negated the statement. The general analysis showed that 64.2% of patients answered positively, choosing one of the options and the results are present as follows, +3(41.3%), +2 (11.7%), +1(11.2%). Negative answers were given by 35.8% of the patients, -3(18.2%), -2 (9.8%),-1(7.8%) (Table 2).

The average result of the assessment of the satisfaction with anesthesia in the population in this study was 0.77% (-3 to+3) M=2, SD=2.41. The lowest score was '0' which means a neutral attitude and was marked in 5 questions, which constitutes 45.5% of the total number of questions. A '1' was given to 4 questions (36.3%), '2' was given by 2 questions (18.2%), which indicates that the level of satisfaction in study was high (Table 3).

The results presented in Table 3 indicate a differentiation in the assessment concerning patient satisfaction with anesthesia. The average of the answer value (0.8) for 11 questions was positive. The respondents ranked 5 questions with '0', including the question, 'I vomited or felt nauseous'. In the light of the analysis of respondent answers there were no negative answers noted in the range between 'disagree' and 'strongly disagree'. The average of the answer score for ISAS was 0.8 SD=2.41.

Table 2. The results of assessing patient satisfaction for particular questions

Question No.	Type of answer												
	+3		+2		+1		-1		-2		-3		%
	N	%	N	%	N	%	N	%	N	%	N	%	
Question 1. I vomited or felt I was going to vomit	58	30.4	9	4.7	2	1.0	47	24.6	37	19.4	38	19.9	100
Question 2. I would like to have anesthesia again.	134	70.2	12	6.3	11	5.8	9	4.7	2	1.0	23	12.0	100
Question 3. I felt itchy.	72	37.7	12	6.3	4	2.1	27	14.1	15	7.9	61	39.1	100
Question 4. I felt relaxed.	70	36.6	42	22.0	43	22.5	3	1.6	8	4.2	25	13,1	100
Question 5. I was in pain.	62	32.5	8	4.2	26	13.6	19	9.9	21	11.0	55	28.8	100
Question 6. I felt safe.	80	41.9	36	18.8	23	12.0	5	2.6	20	10.5	27	14.1	100
Question 7. I was too cold or too hot.	51	26.7	23	12.0	32	16.8	14	7.3	23	12.0	48	25.1	100
Question 8. I was satisfied with the anesthesiological care.	82	42.9	45	23.6	37	19.4	2	1.0	2	1.0	23	12.0	100
Question 9. I was in pain during the procedure.	86	45.0	17	8.9	29	15.2	15	7.9	30	15.7	14	7.3	100
Question 10. I felt good.	105	55.0	31	16.2	21	11.0	9	4.7	17	8.9	8	4.2	100
Question 11. I was sore	68	35.6	11	5.8	8	4.2	13	6.8	31	16.2	60	31.4	100
All answers	868	41.3	243	11.7	236	11.2	163	7.8	206	9.8	382	18.2	

Table 3. The results for the average question values in ISAS

Question No.	Mean	SD
Question 1. I vomited or felt nauseous	0	2.39
Question 2. I would like to have anesthesia again.	2	2.09
Question 3. I felt itchy.	0	2.65
Question 4. I felt relaxed.	1	2.04
Question 5. I was in pain.	0	2.53
Question 6. I felt safe.	1	2.28
Question 7. I was too cold or too hot.	0	2.42
Question 8. I was satisfied with the anesthesiological care.	2	1.93
Question 9. I was in pain during the procedure.	1	2.19
Question 10. I felt good.	1	1.87
Question 11. I was sore	0	2.00
ISAS Result	0.8	2.41

The evaluation of dependencies between patient satisfaction with anesthesia and socio-demographic factors

This article analyses the satisfaction with anesthesia in relations to patient age, sex, education, place of residence, financial status and the type of injury on the ASA scale. The analysis indicates there is no connection between the patient's sex and satisfaction with anesthesia (p=0.89). The average value in the Polish version of ISAS for female patients was slightly higher (0.78) than for male patients (0.74). An analysis of the age impact on the level of satisfaction with anesthesia showed that the younger patients aged 18-30 ranked their satisfaction highest (p=0.0001). There was no relation found between patient education or place of residence and the level of satisfaction with anesthesia (p=0.3662 and p=0.089 respectively). There was no dependency found between the source of income and the general result of the Polish version of ISAS (p=0.2752). A significant difference was observed between patients suffering from injuries as classified into three types and the general result of the Polish version of ISAS. Higher levels of satisfaction with anesthesia was a characteristic of patients who had type I injuries which are upper face fractures (forehead sinus, the bridge of nose, ethmoid bone). Of the patients who were qualified for anesthesia with I and II in the ASA scale assessed their satisfaction level with the highest marks.

Discussion

The results show a moderately positive level of patient satisfaction with anesthesia, as based on the Polish version of ISAS. The average score for the entire scale was 0.77, M=2, SD=2.41 (scale range from -3 to +3). None of the 11 questions in the Polish version of ISAS obtained a negative result. However, a detailed analysis of particular answers presented the team with areas in the post anesthesia health care which got a majority of negative answers (from -3 to -1). It applied to problems such as: vomiting (Q.1)- 63.9% of negative answers, itchiness (Q.3)- 61.1%, felling sore (Q.11)- 54.4% of negative answers.

A very similar average general result was presented in a Spanish study incorporating the ISAS. The result was 0.80.[17-18] Higher scores were obtained in research conducted in Canada. The level of satisfaction with anesthesia amounted to 0.87. The Canadian study indicated as well that there is a statistically significant dependency between the level of study and variables such as the type of procedure, the anesthesiologist, the time of anesthesia, complications during the surgery, pain intensity, and any adverse events. It was not demonstrated, however, that there is any statistically significant connection between the general ISAS score and the type of sedatives used during the surgery.[8-9] Rodrigueset et al. presented following data: 82% of patients were very satisfied with the surgery, 12% - satisfied and only 6% of the patients expressed their dissatisfaction.[20] The study was based on the ISAS scale. Similar research was performed in Madrid in 2006 and in London in 2009.[21-23] Benatar-Haserfaty et al., assessed the level of satisfaction with anesthesia during a cataract surgery using the result of the study as a quality indicator for this type of surgery. The authors modified the point range of ISAS scale by introducing values from +1 to +6. There were 233 patients interviewed. The average result of the ISAS scale was 6.0 (inter quartile range 5.6-6.0). 10 patients (4.3%) evaluated their pain level at 3 or more on the VAS scale. The average time of the procedure was 9 minutes.[21-22] The results point at a very high level of satisfaction with anesthesia and good pain management. Further studies conducted by the same authors concerned assessing satisfaction with anesthesia in a group of 58 patients.[21-22] In that case, the level of the satisfaction was 4.85 SD=0.80. Boezaart et al. showed that the level of satisfaction with anesthesia was dependent on the length of a patient's stay at the hospital.[24] The lowest level of the satisfaction was expressed by patients in the in the '0^{th}' day where the score was 4.19 SD=1.10, 6 hours after the surgery 4.28 SD=1.01, two weeks after the surgery 4.69 SD=1.05. Sylvie Le May et al., demonstrated that there are 4 perisurgical factors influencing patients 'level of satisfaction with anesthesia: patient-anesthesiologist interaction, fear of anesthesia, prior anesthesia and pain treatment experience.[25] The global average satisfaction was 4.45 SD=0.64 (maximal score – 6.0). The main elements, which indicate high satisfaction level are: satisfaction with premedication, anesthesiological staff's empathy, pain management. On the other hand, the main factors influencing dissatisfaction are: lack of information about blood transfusion and plans for extubation. In the study discussed in this article it has been presented that the patient's evaluation according to the ASA scale has an impact on patients' satisfaction with anesthesia. This dependency has been identified as statistically significant. The sick from the first and second group on ASA scale ranked their satisfaction level definitely higher. According to many authors the peri-surgical condition assessed on ASA scale does not influence patient's satisfaction with anesthesia.[20-22,26] The analysis of the dependency between the source of income and the satisfaction with anesthesia proved that the abovementioned variable does not influence the satisfaction level in study. The patients who earned less were more satisfied with anesthesia.[8-9] The original study has indicated that the most common cause of hospitalisation were fractures of the mid and upper face. The type of injury had influence on the level of satisfaction only

in one group. The patients diagnosed with type I injury, the upper face fracture (forehead sinus/the bridge of nose/ethmoid bone,) assessed the service provided to them as high. 88.7% of them were men, with average age approximately 34.8. The instruments used in the investigation should be properly constructed and verified in order to meet the desired psychometric requirements, including patient's specificity. If improving patients' satisfaction with anesthesia should become a goal in the medical services the growing number of publications suggest that the anesthesiological staff has to consider patients' former experience with anesthesia, and their expectations and how it may influence the expectations associated with the future anesthesia. Therefore, a process of constant improvement is required in the medical field so as to keep the patients' satisfaction at the highest possible level.

Conclusions

The level of satisfaction with anesthesia in patients with craniofacial injury based on the Polish version of ISAS is moderately positive whereas in patients with upper face fractures and ASA I and II patients it is even higher.

Among the socio-demographic factors analysed only the age seems to make an impact on the level of satisfaction with anesthesia. The level of the satisfaction is higher in younger patients.

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ORIGINAL PAPER

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Sexual activity of Subcarpathia residents

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ABSTRACT

Introduction. Sexuality is an inseparable attribute of humans that makes it possible to take new challenges connected with it at every stage of life and to enjoy its new aspects as well as
to accept the resulting restrictions.

Aim. The objective of this study was to compare how sexual activity changes in different age groups. An important step in achieving the main objective was to determine the age of sexual initiation, the number of sexual partners and the most commonly used methods of preventing pregnancy.

Material and methods. The study was conducted between 2010 and 2013 among 924 persons. The respondents were the students of secondary schools, technical schools, post-secondary schools and the University of Rzeszów.

Results. Two-thirds of a group aged 16-18 did not start sexual relations. Only 2% of the respondents at the age groups of 16-18,19-23 and only 1% of the respondents at the age group of 24-48 began having sexual relations under the age of 15. 67% of adolescents from big cities began sexual relations. 33% of the secondary schools/technical schools respondents, 51% of the post-secondary schools respondents, 35% of a higher education institution respondents most commonly use condoms as a method of contraception.

Conclusions. The average age of sexual initiation is gradually decreasing in each age group. Most respondents declare having one sexual partner. The respondents from big cities more often begin sexual relations. Condoms are the most commonly used method of contraception among the respodents in all age groups.

Keywords. sexual initiation, condom, sexual relations

Introduction

Sexuality is an inseparable attribute of humans that makes it possible to take new challenges connected with it at every stage of life and to enjoy its new aspects as well as to accept the resulting restrictions.[1] Sexuality is felt and expressed in thoughts, fantasies, desires, beliefs, attitudes, values, behaviours, practices, roles and relationships.[2] Sexual development is divided into three stages: childhood, adolescence and adulthood.

Childhood is the period of biological silence that occurs after the period of gender differentiation in fetal life.

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In adolescence, the proportions of biological, social and psychological elements that shape sexuality change. Sexual behaviours of boys in adolescence can be described as immature, disordered and unrestrained. Erotic sensations are extremely intense. Moreover, the role of first experiences identified as sexual is of vital importance in shaping later sexual life as well as for creating satisfying and lasting relationships.[1,3,4] The period of adolescence is for girls a time of many changes conditioned by hormones. It is a time of shaping one's personality, gaining independence, engaging in new tasks and social roles and being particularly interested in one's own person as well as being interested in the sexual sphere.[4,5] Models of sexual behaviours are shaped by: gender identification patterns, worldview, religious and moral principles. Human sexuality is influenced by the problems of the epoch, culture and peers as well. The following forms of sexual activity may be observed among the adolescents: petting, masturbation, oral sex, anal sex, vaginal intercourse and other behaviours such as sexual relations through electronic media (e.g. „sex on the phone").[4] Many Polish surveys present data from which we learn that the age of first sexual contact is decreasing, mainly in the generation of middle schools students, upper-secondary schools students, higher education institutions students and working young people. The age of first sexual contact in the relevant age groups is as follows: age group of 18-25 - 17 years 4 months (2014 - 17 years 7 months; 2011 - 18 years 1 month), age group of 26-40 - 18 years 3 months, (2014 - 18 years 4 months, 2011 - 19 years 2 months), age group of 41-50 - 19 years 8 months (2014 - 19 years 7 months, 2011 - 19 years 10 months). Considering survey participants, 69% of upper-secondary schools students (2014 - 56%; 2011 - 58%) and 96% of a higher education institution students (2014 - 95%, 2011 - 92%) have sexual relations.

Interestingly enough, when it comes to a group of a higher education institution respondents and students of upper-secondary schools almost 19% of women (2014 - 14%) and 22% of men (2014 - 17%) have had more than 5 sexual partners.[6] Other authors' studies show that 57.3% of eighteen-year-olds who have had sexual initiation used methods of contraception during their sexual intercourse. Nearly three out of four respondents (72%) declare that during first sexual intercourse they used a condom. 23% of the respondents point to coitus interruptus and 10% of them point to contraceptive pills. More than half of the respondents (54.8%) agreed with the statement that „the peer pressure makes many teenagers start having sex".[2] According to the report „Poles' Sexuality 2017" [Seksualność Polaków 2017], 53% of the respondents in the age group of 18-29 are satisfied with their sexual life.[7] Adolescents separate clearly sexual activity from procreation and they relate marriage to child planning. Earlier biological maturity is not accompanied by the process of social, economic, and psychological maturation. In addition to medical problems (consequences of unsafe abortions, an increase in the mortality rate of young mothers, an increase in the number of people infected with venereal diseases), sex initiation too early involves many negative socioeconomic consequences such as: an increased risk of divorce, single motherhood, interrupted education, drug addiction, and cases of rape.[8]

Adulthood is the last stage in the sexual development cycle. It begins with the willingness to create a mature sexual relationship that fulfills also a procreative function and it ends with death.[3] According to the report „Poles' Sexuality 2017" [Seksualność Polaków 2017] 70% of Poles aged 30-49 are satisfied with their sexual life. Over the course of the past 20 years, in the age group of 18-48 the proportion of people who have sexual relations, i.e. those who have had at least one vaginal intercourse during the last 12 months, has decreased (from 86% in 1997 to 76% in 2017).[7]

Objective

The objective of this study was to compare how sexual activity changes in different age groups. An important step in achieving the main objective was to determine the age of sexual initiation, the number of sexual partners and the most commonly used methods of preventing pregnancy.

Material and methods

The study was conducted between 2010 and 2013 among 924 persons. The respondents were the students of secondary schools, technical schools, post-secondary schools from Rzeszów and its environs as well as the students of the University of Rzeszów.

794 (86%) women and 130 (14%) men aged 16-48 participated in the study and the average age of the respondents was 19. Participation in the study was voluntary and anonymous. The respondents agreed to participate in the project before commencing the study. An authorial questionnaire which consisted of two parts was used as a study tool. The first part included questions about: gender, age, place of residence, school profile. The second part included questions about the most commonly used methods of contraception, the age of sexual initiation, the number of sexual partners. The respondents were instructed how to fill in the prepared questionnaire. An approval No. 4/07/2010 was granted to conduct the study by the Bioethics Committee of the University of Rzeszów. People who did not consent to participate in the study or gave inconsistent data, e.g. they gave higher age of sexual initiation than their current age, were excluded from the study. The database was prepared with the use of Excel 2003 for Windows, while the statistical analysis was performed with the use

of IBM SPSS Statistics 20 computer software. The Fisher exact test for RxC was used to examine the correlation between the features. The materiality level $p < 0.05$ was assumed, indicating the existence of statistically significant differences or dependencies.

Conclusions

The group of respondents was diverse in terms of gender, school profile, age and place of residence. The respondents represented three age groups. The group aged 16-18 was represented by 398 persons (43%), the group aged 19-23 was represented by 450 persons (49%) and the group aged 24-48 was represented by 76 persons (8%).

The biggest group of respondents was represented by 640 (69%) students of secondary schools and technical schools. Other groups of respondents were: the group of post-secondary schools students – 107 respondents (12%) and the group of a higher education institution students – 177 respondents (19%). 189 respondents (20%) were the residents of the voivodeship city, 286 respondents (31%) were the residents of the cities or towns and nearly half of the respondents were from the villages - 449 (49%). 30% of the respondents declared having very good living conditions, 63% of the respondents declared having good living conditions and 7% of the respondents presented their situation as difficult.

Regarding the analysis of the results of our own study, it was found that there is a strong correlation between the beginning of having sexual relations and the school profile. 46% of secondary schools and technical schools respondents confirmed having sexual initiation. This proportion almost doubled among the post-secondary schools respondents and it was 74%, while in the group of a higher education institution students it was 75% (Table 1).

Current studies show that respondents from voivodeship cities more often begin having sexual relations. Comparing these results with the results concerning the towns and the villages, it proves that the results decrease by about 10% for relevant locations (Table 2).

The results of the study show that the age of the first sexual intercourse depends on the age of the respondents. 62% of the youngest respondents declare that they have not begun having sexual relations and only 2% of the respondents began having sexual relations under the age of 15. It is important to note that 26% and 32% of the respondents in the age group of 19-23 gave the age of 15-17 and the age of 18-21 as the age of their first sexual intercourse. 46% and 29% of the respondents in the age group of 24-48 began having sexual relations

Table 1. School profile and the beginning of having sexual relations

Have you ever had a sexual intercourse?	School profile					
	Secondary schools and technical schools N = 640		Post-secondary schools N = 107		Higher education institution N = 177	
	N	%	N	%	N	%
Yes	294	46	79	74	133	75
No	346	54	28	26	44	25

Table 2. Place of residence and the beginning of having sexual relations

Have you ever had a sexual intercourse?	Place of residence					
	Voivodeship city N = 189		Cities, towns N = 286		Villages N = 449	
	N	%	N	%	N	%
Yes	126	67	166	58	215	48
No	63	33	120	42	234	52

Table 3. The age of the respondents and the age of their first sexual intercourse

How old were you when you first had a sexual intercourse?	Age					
	16-18 N = 398		19-23 N = 450		24-48 N = 76	
	N	%	N	%	N	%
I have never had a sexual intercourse	247	62	176	39	9	12
Age under 15	8	2	9	2	1	1
Age of 15-17	113	28	119	26	9	12
Age of 18-21	30	8	143	32	35	46
22 or over the age of 22	-	-	3	1	22	29

at the age of 18-21 and 22 or over the age of 22 (Table 3). The analysis of the collected material shows that the respondents' average age of beginning having sexual relations in the age group of 16-18 was 16, in the age group of 19-23 it was less than 18 and in the oldest age group of 24-48 it was 20.

Taking into consideration the type of respondents' school as a factor that could influence the number of their sexual partners, the students of the following types of schools were considered: secondary schools/technical schools, post-secondary schools and one higher education institution. More than half of the secondary schools and technical schools respondents have no sexual partner. The results of the study show that approximately 39% of the post-secondary schools and a higher education institution respondents declare having only one sexual partner. Having four or more sexual partners is confirmed by a small group of respondents, including 7% of the secondary schools respondents, 11% of the post-secondary schools respondents and 15% of a higher education institution respondents (Table 4).

Taking into consideration age as a factor that may influence the decision to choose the method of contraception preventing unwanted pregnancies 29% of the youngest respondents, 40% of the respondents aged 19-23 and 39% of the respondents aged 24-48 prefer condoms and they used this method during their last intercourse (p = 0.00251) (Table 5). Contarceptive pills was the second most common method of contraception. Thus, 5% of the adolescents aged 16-18, 9% of the respondents aged 19-23 and 21% of the respondents aged 24-48 used this method during their last intercourse. On the other hand, the most rarely used method of preventing pregnancy was the method of chemical spermicides - 1% of the respondents aged 16-18, 19-23 and 24-48 declared to use this method. It is worrying that 2% of the adolescents aged 16-18, 6% of the persons aged 19-21 and 14% of the persons aged 24-48 have not used any method of preventing pregnancy during their last sexual intercourse.

33% of the secondary schools and technical schools respondents, 51% of the post-secondary schools respondents, 35% of a higher education institution respondents most often use condoms as a method of contraception (p = 0.00001) (Table 6). Also, an important issue to which attention should be paid was the correlation (p = 0.00286) concerning the fact that adolescents do not use any method of contraception during sexual intercourse.

Table 4. School profile and the number of sexual partners

How many sexual partners have you had so far?	School profile					
	Secondary schools and technical schools N = 640		Post-secondary schools N = 107		Higher education institution N = 177	
	N	%	N	%	N	%
0	354	55	28	26	47	27
1	146	23	37	35	70	39
2	64	10	14	13	20	11
3	35	5	16	15	14	8
4 or more	41	7	12	11	26	15

Table 5. The age of the respondents and the methods of preventing pregnancies

What method of preventing pregnacies did you use during your last sexual intercourse?	Age						Fisher's exact test for RxC
	16-18 lat N = 398		19-23 lat N = 450		24-48 lat N = 76		
	N	%*	N	%*	N	%*	
Contraceptive pills	20	5	41	9	16	21	p=0.00006
Condoms	115	29	180	40	30	39	p=0.00251
Chemical spermicides (globules, foams, creams, jellies)	3	1	3	1	1	1	p=0.70305
Coitus interruptus	19	5	41	9	10	13	p=0.01039
Natural methods of preventing pregnancies (the observation of body temperature, the observation of cervical mucus)	3	1	13	3	12	16	p=0.00000
I did not use any method of preventing pregnancy	8	2	28	6	11	14	p=0.00002
I do not remember	9	2	1	0.22	1	1	p=0.01713

* The figures cannot be added up to 100% because of the fact that each respondent could choose more than one answer

Other answers given by the respondents also deserve attention, for example, the figures concerning the use of chemical spermicides (globules, foams, creams, jellies), which present the lowest proportion of confidence among the group of the respondents.

Discussion

Many authors claim that the earlier age of sexual initiation may be associated with earlier maturity, which is indicated by the first menstrual period at the girls'earlier age.[9] The Polish author Tokarz et al. drew interesting conclusions. Namely, they showed that attending vocational schools, poor school performance, frequent contact with alcohol, visiting pornographic websites and reading pornographic magazines are the factors that are concurrent with increased risk of early initiation in Poland. Bad relationships with parents are more common among persons who have begun having sexual relations.[10,11,12] Physical and sexual violence may also have an impact on sexual behaviours of the adolescents. The increased risk of having sexual relations at a young age and involving in risky sexual behaviours is increasing among girls whose fathers do not participate in their upbringing.[13]

The media promote a vision of sex without love, they teach to experience pleasure and to put focus on experiencing orgasm and not to nurture closeness and intimacy. The press creates a canon of beauty, hence everything that is presented to adolescents has an influence on the way they begin to perceive themselves. Nowadays, youth magazines play a role of educators in sex sphere among young people. Bravo, Bravo Girl, Popcorn, Twist are examples of the press which contribute considerably to begin premature sexual contacts. In columns like „My first time" or „Psychological advices" one can find statements of 12-13 year-olds describing their experiences. Sexologists and pedagogues are critical when it comes to these types of magazines. Karasińska states that she is not „a supporter of youth magazines which subject areas revolves overly around erotic themes and shock their readers".[14] Religion also has an impact on the beginning of having sexual relations. The correlation between the lack of religion and earlier beginning of sexual initiation is also confirmed by Wróblewska's studies. Among young people who claim to be believers and regular church-goers only 19% have already had sexual initiation while among non-believers it was as many as 45%.[15,16,17]

Comparing the data in own study we observe that respondents from voivodeship cities show a higher proportion of early sexual initiation. CBOS' results from 2010 comply with this opinion. Young people living in the villages and those from less wealthy families have more restrictive attitude towards sex matters. The lower level of education of parents, especially of mothers, has an impact on decreasing the number of sexual intercourses.[18] On the basis of their own study, Zielińska and Filipp et al. stated that people living in the cities do not wait to marry to begin sex life - 51% of the respondents give such information. Only 38% of the respondents believe that their first sexual contact should be after getting married. Almost two thirds (63%) of the respondents also agree that it is normal for a couple in love to have sexual contacts with each other and they believe that getting married is not necessary to have sexual contact. The opposite opinion is presented by one in four respondents (26%). One in three persons (33%) is convinced that sex does not require either love or marriage and that even a short-lived relationship can provide pleasant, beautiful experiences while more than one in two persons (54%) does not agree with this opinion.[19]

Table 6. School profile and the methods of preventing pregnancies

What method of preventing pregnacies did you use during your last sexual intercourse?	School profile						Fisher's exact test for RxC
	Secondary schools and technical schools N = 639		Post-secondary schools N = 105		Higher education institution N = 176		
	N	%*	N	%*	N	%*	
Contraceptive pills	40	6	11	10	26	15	p=0.05343
Condoms	209	33	54	51	61	35	p=0.00001
Chemical spermicides (globules, foams, creams, jellies)	3	0	4	2	2	1	p=0.60588
Coitus interruptus	44	7	7	7	18	10	p=0.35614
Natural methods of preventing pregnancies (the observation of body temperature , the observation of cervical mucus)	10	2	3	3	15	9	p=0.00515
I did not use any method of preventing pregnancy	20	3	8	8	19	11	p=0.00286
I do not remember	9	1	0	0	2	1	p=0.75455

*The figures cannot be added up to 100% because of the fact that each respondent could choose more than one answer

The type of school also has an impact on early beginning of sexual relations. Bień's studies have shown a significant connection between the type of school and having experienced sexual initiation. In her study more than half (52.9%) of the students of technical schools and 35.3% students of middle schools have already had their first sexual intercourse, however, 70.1% of the students who still have not experienced sexual initiation were secondary schools students.[16] Tokarz also emphasizes the fact that the adolescents who are on a higher level of education more rarely begin their sexual initiation. In all countries, persons who continue learning at higher education institutions later engage in sexual relationships than those who have only completed lower-level education.[10] Own studies show a slightly different correlation where we note that as age increases, the number of sexual initiations increases. 46% of the students of secondary schools and technical schools have confirmed sexual initiation. In post-secondary schools, this proportion has doubled and reached 79% of persons who have started their sexual relations and in the group of a higher education institution students it was 75%.

Sexual initiation is a kind of rite of passage during which a young person passes from adolescent group to adult group.[8] Nowadays, there is a constant tendency towards decreasing the average age of sexual initiation. According to Filipp et al, the average age of the first sexual intercourse among women and men is the age of 17-18 in western and central Europe and the age of about 20 in the eastern Europe. [9] Similar results were obtained by Bień where the average age in which young respondents started sexual relations was the age of 17.05.[16] In Poland, until the 1980s, the changing attitudes and behaviours of adolescents in the field of sexual life were evolutionary and followed relatively slowly. In the generation of present 40-50 year-olds most people began their sexual relations at the age of at least 20 (the median is 20.5-21) and experiencing sexual initiation among adolescents, especially women, was generally related to marriage or plans concerning marriage. In Poland, fast changes in the code of sexual sphere of children and adolescents could have been observed in the late 1980s and early 1990s. Studies conducted in 1977/1978 revealed further decreasing of the age of sexual initiation; that is the age of 18.9 for women and the age of 18.1 for men. Similar results were obtained from CBOS studies which were conducted in 1994, 1996 and 1998 for the oldest students of secondary schools. Recent studies conducted in 2005 among 16-18 year-olds show that among boys one in three 16 year-olds and one in two 18 year-olds declared sexual initiation experience. Among girls, respectively, one in five in the age group of 16 year-olds and nearly half of 18 year-old girls declared such an experience.[15, 20, 21, 22, 23,24]

Health Behavior in School-aged Children Study which involved 35 countries show that Poland is in the group of countries with the lowest proportion of adolescents declaring sexual initiation at the age up to 15. The highest proportions of sexually active adolescents at the age of 15 exceed 40% and have been observed among girls living in England and Wales as well as Sweden and Germany and among boys in Ukraine, Russia, Belgium, England, Scotland and Macedonia. High proportions of beginning early sexual initiation are also reported among adolescents in the United States.[15,25,26]

Our own studies show that 2% of the youngest respondents aged 16-18 declare having begun sexual relations under the age of 15 and the same situation may be observed in the age group of 19-23. Comparing the results of the study, we observe that only 1% of the oldest respondents in the age group of 24-48 declare having first intercourse under the age of 15. It is important to mention the fact that in the group of respondents aged 19-23 and 24-48 the age of 18-21 is mentioned most often as the age of beginning of having sexual relations. 26% and 32% of the respondents aged 19-23 declared the age of 15-17 and 18-21 as the age of having first sexual intercourse. 46% and 29% of the respondents aged 24-48 began their sexual relations at the age of 18-21 and 22 or over. In the studies of Łepecka-Klusek et al. more than half of 39 respondents (53.4%) began having sexual relatons at the age of 15-16. Moreover, 27 people (37.0%) declare the age of 17-18 (37.0%) as the age of beginning having sexual relations and the remaining 7 respondents (9.6%) declare the age of 13-14.[25] Early sexual initiation may have a negative impact on later sexual life. Negative first sexual experiences can damage the self-image and well-being of a growing girl.[13] The early age of sexual initiation is also associated with a higher risk of depressive symptoms occurrence.[27] In fact, postponing the beginning of sexual activity is considered as a factor of protection of psychological health among adolescents.[28]

Adolescents enter the world of physical love, without knowing much about their own physiology and contraception. Therefore, almost all respondents mention condoms (83.8%) as a method of preventing pregnancy. Contraceptive pills are taken by 24.2% of the respondents and 15.2% of the respondents mention coitus interruptus as a method of preventing pregnancy.[9,17,29,30,31,32,33,34]. Own studies also confirm this opinion. Thus, 29% of the youngest respondents aged 16-18, 40% of the adolescents aged 19-23 and 39% of the respondents aged 24-48 prefer condoms and they used this method during their last intercourse. It is worrying that 2% of adolescents aged 16-18, 6% of persons aged 19-21 and 14% of persons aged 24-48 did not use any method of preventing pregnancy during their last sexual intercourse. Lucia et al. also observes that more than one third of all adolescent girls do not use any contraceptives during their first sexual intercourses.[13]Adolescents do not use methods of contraception because of fear,

lack of knowledge, misinformation and myths. Many workers of health service discourage adolescents from using services because of lack of confidentiality, judgement of attitudes, disrespect or lack of respect for the needs of their patients.[27] There is a growing problem of nonuse of contraception among adolescents from families with lower socioeconomic status. Perhaps it is related to the lack of funds for contraceptives or with low levels of sexual education. [9] The use of contraceptives depends on social factors (place of residence - village / city), religion, effectiveness, reversibility, safety, acceptance and other benefits of different methods which are not connected with contraception.[17]

It is surprising why natural methods of preventing pregnancy are chosen so rarely. Data analysis in this study shows that only 1% of adolescents aged 16-18 use natural methods of family planning. In the other age groups the results were as follows: 3% of the respondents aged 19-23 and 16% of the respondents aged 24-48 used natural methods of family planning during their last intercourse. The study conducted by Filipp et al. confirms the results obtained by the author where natural methods of family planning were used by 1% of adolescents aged 15-19. The use of natural methods requires more effort, patience, time and these are not the strengths of the young people. Maybe that is why they are not popular among adolescents and adults.

The World Durex 2003 and 2004 report presents that 71% of Poles use condoms and 19.8% of the respondents in the age group of 16-20 have not used any contraceptive method. [9,34] According to the Durex study, the condoms were still the most popular contraceptives in 2012. This method is used by as many as 49% of the respondents. [31]

In accordance with own study, the second most commonly used method was the method of contraceptive pills where 5% of the adolescents aged 16-18, 9% of the persons aged 19-23 and 21% of the the persons aged 24-48 used it during their last sexual intercourse. Literature provides us with the information that the proportion of failures in using oral contraceptives among adolescents and young women is higher in comparison to the older age group. It is mainly due to the fact that the procedure of using the given contraceptives is not properly followed by younger group. It is mainly about such mistakes as: omitting the doses or time shifts in taking the pharmaceutical drug.[35]

The results of the study show that approximately 39% of the post-secondary schools and a higher education institution respondents declare having one sexual partner. A small group of the respondents admits having up to four or more sexual partners, including 7% of the secondary schools and technical schools respondents, 11% of the post-secondary schools respondents and 15% of a higher education institution respondents. Bień et al. found silmilar observations concerning the fact that more than half of the respondents (55.5%) declare that they have had sexual relations with one partner so far. One fifth of the respondents (20.2%) declare having two sexual partners so far and every tenth of the respondents (10.1%) declare having three sexual partners so far.[16] When sexual initiation is at the age of 13 or 14 the average number of sexual partners is thirteen. For women whose initiation was at the age of 19-20 the average number of partners was 4.5 and for women whose initiation was at the age of 23-25 the average number of partners was 2.7.[15]

Early sexual initiation contributes to the occurrence of frequent pregnancies among adolescents. Young mothers who give birth to children outside marriage considerably outnumber in the cities when comparing the situation to this of the villages.[36] According to the data of Central Statistical Office, in 2012 there were 15 704 live births among girls at the age of up to 19 of which 3756 of births were given by the girls under 17.[16] Among other social and demographical consequences associated with early motherhood, one can observe the following ones: instability of marriages among adolescents, single motherhood, material poverty and also connected with it social burdens in the form of benefits for single mothers.

Complications during pregnancy among adolescents include: higher risk of anemia, gestosis and arterial hypertension as well as higher incidence of the cases of miscarriage in subsequent pregnancies. Health consequences for the babies include: low birthweight, higher risk of preterm labour, higher perinatal mortality and higher infancy mortality.[15,37,38]

In addition, early sexual initiation can contribute to various risky sexual behaviours such as: having sexual relations with many partners, frequent changes of partners, casual sexual contacts, sexual preference, sexual violence, sponsorship as well as heterosexual and homosexual prostitution.[17,39,40,41,42]

Conclusions

1. The average age of sexual initiation is gradually decreasing in each age group.
2. The respondents most often declare having one sexual partner.
3. The respondents from big cities more often begin sexual relations.
4. Condoms are the most commonly used method of contraception among the respondents in each age group.

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ORIGINAL PAPER

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Distribution of public funds on physiotherapy in the Podkarpacie province

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ABSTRACT

Introduction. The Constitution of 1997 of the Republic of Poland guarantees all citizens the equal right to healthcare benefits financed from public funds. The National Health Fund (NFZ), being the main payer in the system, is responsible for contracts with both public and private healthcare providers. Patients with healthcare insurance are entitled to guaranteed healthcare benefits in accordance with the current medical knowledge within the limits of NFZ funds available.

The aim of the thesis is to analyze the availability of the guaranteed healthcare benefits in medical rehabilitation in the Podkarpacie province.

Materials and methods. The research includes information and data on amounts of money for healthcare contracts related to medical rehabilitation in the Podkarpacie province from July 1, 2014 to June 30,2017. The information is posted on the website of the Rzeszow Podkarpacie Branch of The National Health Fund.

Results. The analysis conducted indicates that in the Podkarpacie province there are significant statistical differences in the distribution of funds for ambulatory physiotherapy and medical rehabilitation care in individual districts.

Conclusions. It is necessary to increase investment funds and a change in the distribution, increasing access to rehabilitation to those in need

Keywords. availability, funding, rehabilitation

Introduction

Therapeutic rehabilitation has become an important component of the economic development of every country and plays an increasingly important role in the healthcare system. Rehabilitation is a set of measures aimed at restoring or achieving the lost optimal biological, family and social functions in a disabled person. Professor Wiktor Dega and Professor Marian Weiss were the authors of the Polish model of rehabilitation. It was accepted and recommended by the World Health Organization in the session of the Regional Office for Europe in 1970, and it has the following objectives and features: [1,2,3,4]

— early introduction,
— universality,
— continuity,
— comprehensiveness.

In accordance with the Constitution of the Republic of Poland of 1997, all citizens are entitled to equal

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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access to healthcare services financed from public funds. The central health insurance fund – the National Health Fund (NFZ) is the main payer in the system, responsible for concluding contracts for the provision of health services with public and non-public providers. [5]

Within the scope of health insurance every insured patient is entitled to guaranteed services which are in accordance with current medical knowledge and within the financial resources held by the National Health Fund. In accordance with the statutory list, everyone is entitled to therapeutic rehabilitation. The general right of an insured individual to healthcare services is governed by the Act on healthcare services financed from public funds, and in particular by the Regulation of the Minister of Health of 16 December 2016, amending the regulation on guaranteed services in the field of therapeutic rehabilitation. Pursuant to section 4 of the aforementioned regulations, the guaranteed services are provided in the following conditions: [6,7]

1. outpatient, including:
   a. outpatient medical rehabilitation services in the form of medical advice
   b. outpatient physiotherapy in the form of:
      — physiotherapy visit
      — physiotherapy treatment
2. domiciliary, including:
   a. medical advice
   b. home-based physiotherapy in the form of:
      — physiotherapy visit
      — physiotherapy treatment
3. day care center or ward, including:
   a. systemic rehabilitation, including one for specific groups of patients
   b. rehabilitation of children with developmental disorders
   c. people with hearing and speech impairment
   d. people with visual impairment
   e. cardiac or hybrid cardiac telerehabilitation
   f. pulmonary using a subterraneotherapy
   g. cardiac or hybrid cardiac telerehabilitation as part of comprehensive care after myocardial infarction
4. stationary, including:
   a. systemic rehabilitation
   b. neurological
   c. pulmonary
   d. cardiac or hybrid cardiac telerehabilitation
   e. cardiac or hybrid cardiac telerehabilitation as part of comprehensive care after myocardial infarction.[8]

The aim of the study is to analyze the division of public funds for physiotherapy in the Podkarpackie Voivodeship.

Sources and methods

Source material consists of information and data on the values of contracts for therapeutic rehabilitation services in the Podkarpackie Voivodeship between 1.07.2014 - 30.06.2017, published on the website of the Podkarpackie Branch of the NFZ (National Health Fund) in Rzeszów. [9]

Also statistical data by GUS (Central Statistical Office of Poland) was used on the number of inhabitants in particular poviats in 2013.[10]

A one-sample Student's t-test was used for statistical analysis.

Analysis concerned guaranteed services provided in the following conditions:

1. outpatient
   — outpatient physiotherapy
   — medical rehabilitation services
2. domiciliary
   — home-based rehabilitation
3. day care centre or ward
   — systemic rehabilitation in a day care center or ward
   — rehabilitation of children in a day care center or ward
4. stationary
   — systemic rehabilitation in stationary conditions
   — neurological rehabilitation in stationary conditions

Results

The contracting of services between 2014-2017 in the field of rehabilitation in the context of outpatient physiotherapy and medical rehabilitation services was done in particular poviats. Domiciliary rehabilitation, systemic rehabilitation in a day care center or ward, rehabilitation in a day care center or ward for children and rehabilitation in stationary conditions were contracted in groups of poviats.

Outpatient physiotherapy

Table 1 summarises information on particular poviats and cities in terms of the number of inhabitants, total amount allocated to given regional units for outpatient rehabilitation, amount per person and the percentage this amount represents of the total sum of money provided for outpatient physiotherapy.

Taking into account the total amount of money allocated to outpatient physiotherapy and the total number of inhabitants of the above-mentioned poviats and cities, the average amount which should fall per one inhabitant was supposed to be about PLN 15.55. The average values per person in subsequent cities and counties (PLN/ person) were compared against the calculated average of PLN 15.55. These average val-

ues ranged in individual regional units from the lowest value of about PLN 13.28/ person to the highest value of about PLN 30.41/ person. The average values were statistically analysed using the one-sample Student's t-test.

It has been showed that there are 11 poviats in which the amount allocated to physiotherapy per one inhabitant was statistically significantly ($p<0.05$) different from the established average as it was lower (successively from the smallest amount: the Lubaczowski poviat, Bieszczady poviat, Tarnobrzeski poviat, Leski poviat, Leżajski poviat, the Jarosławski poviat, Jasielski poviat, Niński poviat, Strzyżowski poviat, Kolbuszowski poviat, Przeworski poviat). On the other hand, they differed significantly from the average amount – the amounts allocated per person in poviat cities (Rzeszów, Krosno, Tarnobrzeg, Przemyśl). These amounts were statistically significantly higher than PLN 15.55/ person ($p<0.001$***). The remaining poviats were within the established average, however, a significant number of them was close to the threshold of statistical significance (e.g., the Łańcucki poviat $p=0.0534$). The nearest to the accepted average was the Brzozowski poviat, with the amount of PLN 13.74 per person.

Outpatient medical rehabilitation services

Table 2 summarizes the characteristics of poviats and cities in terms of the number of inhabitants, total amount allocated to a given regional unit for medical rehabilitation services, amount per person and the percentage this amount constitutes of the total sum of money allocated to medical rehabilitation services.

Taking into account the total amount of money allocated to medical rehabilitation and the total number of inhabitants of the mentioned poviats and cities, the average amount which should fall per one inhabitant was supposed to be about PLN 0.45. The average amounts per person in particular cities and poviats (PLN/ person) were compared against the calculated average of PLN 0.45. The average amounts ranged in individual regional units from the smallest value of about PLN 0.04/ person to the highest value of about PLN 1.75/ person.

Table 1. Division of funds for outpatient physiotherapy

Poviat	Number of inhabitants [N]	Amount [PLN]	Amount per person [PLN]	Percentage of the total [%]	Student's t-test	
					t	p
Przeworski	79,355	1,061,402	13.38	3.21	2.07	0.0497*
Jarosławski	122,677	1,637,533	13.35	4.95	2.10	0.0463*
Kolbuszowski	62,846	840,397	13.37	2.54	2.08	0.0486*
Leżajski	70,230	937,020	13.34	2.83	2.11	0.0452*
Krośnieński	111,874	1,498,682	13.40	4.53	2.04	0.0521
Dębicki	135,090	1,811,821	13.41	5.47	2.03	0.0534
Strzyżowski	62,318	833,108	13.37	2.52	2.08	0.0486*
Sanocki	96,174	1,313,210	13.65	3.97	1.76	0.0920
Stalowowolski	109,502	1,501,039	13.71	4.54	1.69	0.1047
Ropczycko-Sędziszowski	73,166	983,884	13.45	2.97	1.99	0.0586
Mielecki	136,179	1,824,763	13.40	5.51	2.04	0.0521
Łańcucki	79,623	1,067,927	13.41	3.23	2.03	0.0534
Przemyski	73,778	992,592	13.45	3.00	1.99	0.0586
Rzeszowski	163,859	2,212,915	13.50	6.69	1.93	0.0657
Jasielski	115,789	1,547,354	13.36	4.68	2.09	0.0474*
Lubaczowski	57,635	765,211	13.28	2.31	2.18	0.0391*
Leski	26,950	359,025	13.32	1.08	2.14	0.0431*
Tarnobrzeski	54,280	722,593	13.31	2.18	2.15	0.0421*
Brzozowski	66,502	913,885	13.74	2.76	1.65	0.1116
Bieszczadzki	22,396	297,383	13.28	0.90	2.18	0.0391*
Niżański	67,721	905,187	13.37	2.74	2.08	0.0486*
Przemyśl	64,728	1,439,775	22.24	4.35	-8.15	0.0000***
Krosno	47,348	1,062,405	22.44	3.21	-8.38	0.0000***
Tarnobrzeg	48,636	1,087,942	22.37	3.29	-8.30	0.0000***
Rzeszów	180,031	5,475,600	30.41	16.55	-17.56	0.0000***
Total	**2,128,687**	**33,092,644**	**15.55**	**100.00**		

(Statistical significance level *$p<0.05$; **$p<0.01$; ***$p<0.001$)

The average values were statistically analysed using the one-sample Student's t-test.

It has been showed that in 8 poviats the amounts allocated to medical rehabilitation per person were statistically significantly lower than the average (from the smallest amount respectively: the Przemyski poviat ($p<0.01^{***}$), the Krośnieński poviat ($p<0.001^{***}$), the Rzeszowski poviat ($p<0.001^{***}$), the Kolbuszowski poviat ($p<0.01^{**}$), the Bieszczadzki, Leski poviats ($p<0.01^{**}$), the Tarnobrzeski poviat ($p<0.01^{**}$), the Ropczycko-Sędziszowski, Dębicki poviats ($p<0.05^{*}$) and the Jaroslawski/ Przeworski poviats ($p<0.05^{*}$). The amounts allocated to medical rehabilitation of one inhabitant were statistically significantly higher than the average in Rzeszów ($p<0.001^{***}$), in the Jasielski poviat ($p<0.001^{***}$), Krosno ($p<0.001^{***}$), Mielec ($p<0.001^{***}$), Przemyśl ($p<0.01^{**}$), and in the Łańcucki poviat ($p<0.01^{**}$). The remaining poviats – the Leżajski, Tarnobrzeski, Lubaczowski, Strzyżowski, Stalowowolski/ Niżański, Sanocki and Brzozowski poviats – were within the limits of the established average.

Domiciliary rehabilitation

Table 3 presents the division of funds for home-based rehabilitation by groups of poviats. Both medical advice given in a non-institutional setting and home-based physiotherapy were analyzed.

The average amount allocated to home rehabilitation was supposed to be about PLN 0.41/ person. It was compared against the average amounts allocated to the poviats of the four groups. All of the amounts obtained amounted to approximately PLN 0.41/ person. Hence, they were in line with the established average.

Systemic rehabilitation in a day care center or ward

Table 4 shows the division of funds for systemic rehabilitation in a day care center or ward by groups of poviats.

The average amount that was allocated to systemic rehabilitation in a day ward was supposed to be about PLN 2.55/ person. Average amounts allocated to the poviats of the four groups were compared against it. The lowest amount per person was recorded in the Bieszczadzki, Brzozowski poviats (...) PLN -1.36/ person, while the highest in the Dębicki, Kolbuszowski poviats (...) PLN- 4.29/ person. These average values were not significantly different at the level of $p<0.05$ from the established amount of PLN 2.55/ person, but they were very different. The highest amount

Table 2. Division of funds for outpatient medical care

Poviat	Number of inhabitants [N]	Amount [PLN]	Amount per person [PLN]	Percentage of the total [%]	Student's t-test	
					t	p
Jarosławski, Przeworski	202,032	53,573.04	0.27	5.58	2.29	0.0332*
Kolbuszowski	62,846	9,623.7	0.15	1.00	3.65	0.0016**
Lubaczowski	57,635	22,131.18	0.38	2.30	10.4	0.3118
Leżajski	70,230	36,889.74	0.53	3.84	-0.67	0.5126
Krośnieński	111,874	5,541.12	0.05	0.58	4.79	0.0001***
Strzyżowski	62,318	22,217.76	0.36	2.31	1.26	0.2205
Sanocki	96,174	30,622.68	0.32	3.19	1.72	0.1010
Stalowowolski, Niżański	177,223	57,009.6	0.32	5.94	1.72	0.1010
Ropczycko-Sędziszowski, Dębicki	208,256	48,211.74	0.23	5.02	2.74	0.0126*
Mielecki	136,179	117,928.62	0.87	12.28	-4.53	0.0002***
Łańcucki	79,623	60,659.28	0.76	6.32	-3.28	0.0037**
Przemyski	73,778	3,050.28	0.04	0.32	4.90	0.0001***
Rzeszowski	163,859	22,094.55	0.13	2.30	3.88	0.0009***
Jasielski	115,789	104,928.3	0.91	10.92	-4.98	0.0001***
Tarnobrzeski	54,280	10,323	0.19	1.07	3.20	0.0045**
Brzozowski	66,502	20,239.74	0.30	2.11	1.95	0.0658
Bieszczadzki, Leski	49,346	9,197.46	0.19	0.96	3.20	0.0045**
Przemyśl	64,728	50,576.04	0.78	5.27	-3.51	0.0022**
Krosno	47,348	41,112.18	0.87	4.28	-4.53	0.0002***
Tarnobrzeg	48,636	24,415.56	0.50	2.54	-0.33	0.7480
Rzeszów	180,031	315,033.54	1.75	32.80	-14.53	0.0000***
Total	**2,128,687**	**960,555.73**	**0.45**	**100.00**		

(Statistical significance level *p<0.05; **p<0.01; ***p<0.001)

Table 3. Division of funds for home rehabilitation

Poviat	Number of inhabitants [N]	Amount [PLN]	Amount per person [PLN]	Percentage of the total [%]	Student's t-test	
					t	p
Mielecki, Niżański, Stalowowolski, Tarnobrzeski, Tarnobrzeg	416,318	169,199	0.41	19.49	0.92	0.410
Bieszczadzki, Brzozowski, Jasielski, Krośnieński, Sanocki, Leski, Krosno	487,033	198,245	0.41	22.84	0.94	0.406
Jarosławski, Lubaczowski, Przemyski, Przeworski, Przemyśl	398,173	161,736	0.41	18.63	0.90	0.407-
Dębicki, Kolbuszowski, Leżajski, Łańcucki, Ropczycko-Sędziszowski, Rzeszowski, Strzyżowski, Rzeszów	827,163	338,820	0.41	39.03	1.09	0.406
Total	**2,128,687**	**868,000**	**0.41**	**100.00**		

(Statistical significance level *p<0.05; **p<0.01; ***p<0.001)

Table 4. Division of funds for systemic rehabilitation in a day care center or ward

Poviat	Number of inhabitants [N]	Amount [PLN]	Amount per person [PLN]	Percentage of the total [%]	Student's t-test	
					t	p
Mielecki, Niżański, Stalowowolski, Tarnobrzeski, Tarnobrzeg	416,318	626,061.09	1,50	11.52	0.94	0.4176
Bieszczadzki, Brzozowski, Jasielski, Krośnieński, Sanocki, Leski, Krosno	487,033	662,783.22	1,36	12.19	1.14	0.3388
Jarosławski, Lubaczowski, Przemyski, Przeworski, Przemyśl	398,173	599,294.55	1,51	11.02	0.92	0.4238
Dębicki, Kolbuszowski, Leżajski, Łańcucki, Ropczycko-Sędziszowski, Rzeszowski, Strzyżowski, Rzeszów	827,163	3,547,925.19	4,29	65.27	-3.00	0.0578
Total	**2,128,687**	**5,436,064.05**	**2,55**	**100.00**		

(Statistical significance level *p<0.05; **p<0.01; ***p<0.001)

Table 5. Division of funds for rehabilitation of children in a day care center or ward

Poviat	Number of inhabitants [N]	Amount [PLN]	Amount per person [PLN]	Percentage of the total [%]	Student's t-test	
					t	p
Mielecki, Niżański, Stalowowolski, Tarnobrzeski, Tarnobrzeg	416,318	2,309,547.03	5.55	26.19	-2.92	0.0616
Bieszczadzki, Brzozowski, Jasielski, Krośnieński, Sanocki, Leski, Krosno	487,033	1,864,508.07	3.83	21.14	1.05	0.3722
Jarosławski, Lubaczowski, Przemyski, Przeworski poviats, Przemyśl	398,173	1,646,076.72	4.13	18.66	0.36	0.7460
Dębicki, Kolbuszowski, Leżajski, Łańcucki, Ropczycko-Sędziszowski, Rzeszowski, Strzyżowski, Rzeszów	827,163	2,999,660.67	3.63	34.01	1.51	0.2288
Total	**2,128,687**	**8,819,792.49**	**4.14**	**100.00**		

(Statistical significance level *p<0.05; **p<0.01; ***p<0.001)

(PLN 4.29/ person) was near the statistical significance threshold of p=0.0578.

Rehabilitation of children in a day care center or ward

Table 5 shows the division of funds allocated for rehabilitation of children in a day care centre or ward by groups of poviats.

The average amount allocated to rehabilitation of children was supposed to be about PLN 4.14/ person. Average amounts allocated to the poviats of the four groups were compared against it. The lowest amount per person was recorded in the Dębicki, Kolbuszowski and Leżajski poviats (...) PLN - 3.63/ person, while the highest in the Mielecki, Niżański, Stalowowolski poviats (...) PLN - 5.55/ person. These average values were not sig-

Table 6. Division of funds for systemic rehabilitation under stationary conditions

Poviat	Number of inhabitants [N]	Amount [PLN]	Amount per person [PLN]	Percentage of the total [%]	Student's t-test	
					t	p
Mielecki, Niżański, Stalowowolski, Tarnobrzeski, Tarnobrzeg	416,318	1,973,957.4	4.74	25.60	-2.81	0.0675
Bieszczadzki, Brzozowski, Jasielski, Krośnieński, Sanocki, Leski, Krosno	487,033	1,822,184.88	3.74	23.63	-0.03	0.9765
Jarosławski, Lubaczowski, Przemyski, Przeworski, Przemyśl	398,173	1,303,814.88	3.27	16.91	1.27	0.2931
Dębicki, Kolbuszowski, Leżajski, Łańcucki, Ropczycko-Sędziszowski, Rzeszowski, Strzyżowski, Rzeszów	827,163	2,611,039.68	3.16	33.86	1.58	0.2129
Total	**2,128,687**	**7,710,996.84**	**3.62**	**100.00**		

(Statistical significance level *p<0.05; **p<0.01; ***p<0.001)

Table 7. Division of funds for neurological rehabilitation

Poviat	Number of inhabitants [N]	Amount [PLN]	Amount per person [PLN]	Percentage of the total [%]	Student's t-test	
					t	p
Mielecki, Niżański, Stalowowolski, Tarnobrzeski, Tarnobrzeg	416,318	804,095.1	1.93	10.48	2.29	0.0838
Bieszczadzki, Brzozowski, Jasielski, Krośnieński, Sanocki, Leski, Krosno	487,033	1,101,000.12	2.26	14.35	1.74	0.1566
Jarosławski, Lubaczowski, Przemyski, Przeworski, Przemyśl	398,173	1,350,901.08	3.39	17.61	-0.14	0.8947
Dębicki, Kolbuszowski, Leżajski, Łańcucki, Ropczycko-Sędziszowski, Rzeszowski, Strzyżowski, Rzeszów	827,163	4,415,608.86	5.34	57.56	-3.4	0.0273*
Total	**2,128,687**	**7,671,605.16**	**3.60**	**100.00**		

(Statistical significance level *p<0.05; **p<0.01; ***p<0.001)

nificantly different at the level of p<0.05 from the established amount of PLN 4.14/ person.

Systemic rehabilitation in stationary conditions

Table 6 shows the division of funds for systemic rehabilitation by groups of poviats.

The average amount allocated to systemic rehabilitation in stationary conditions was supposed to be about PLN 3.62/ person. It was compared against average amounts allocated to the poviats of the four groups. The lowest amount per person was recorded in the Dębicki, Kolbuszowski, Leżajski poviats (...) - 3.16 PLN/ person, while the highest in the Mielecki, Niżański, Stalowowolski poviats (...) PLN - 4.74/ person. These average amounts were not statistically significantly differrent at the level of p<0.05 from the established amount of PLN 3.62/ person.

Neurological rehabilitation in stationary conditions

Table 7 shows the division of funds for neurological rehabilitation in stationary conditions by groups of poviats.

The average amount allocated to neurological rehabilitation was supposed to be about PLN 3.60/ person. It was compared against the average amounts allocated to the poviats of the four groups. The lowest amount per person was recorded in the Mielecki, Niżański poviats (...) PLN - 1.93/ person, while the highest in the Dębicki, Kolbuszowski poviats (...) PLN - 5.34/ person. This amount was significantly different from the average level of p<0.05*; it was substantially higher. The remaining values were close to the average, although the lowest value was close to the significance threshold of p=0.0838.

Discussion

With an aging population the demand for rehabilitation services is increasing significantly. Between 1990 and 2005 the share of the population aged 65 years and more increased from 10.1% to 13.2% in the overall social structure. In 2001 there were 5.6 million people at the post-working age in Poland. According to GUS demographic forecasts, the number of people at retirement age will increase to 9.6 million in 2030. These people are affected by various types of health problems result-

ing from progressing degenerative diseases that increase morbidity. Age-related illnesses and impairment of functional ability and motor function limitations contribute to a large extent to the decline in physical activity and force the sick to live sedentary lifestyles.[11] Medical rehabilitation programs on ageing populations should have two main streams of action. The first should be addressed to the elderly. By providing patients with better access to rehabilitation services, they are able to participate in social life longer, which also reduces the need for other health services, e.g., hospital treatment or long-term care services. The second should be addressed to those who are not yet in older age, and is mainly preventive. The prophylactic nature of rehabilitation is an important element of healthy aging programs and should be noted in increasing outlays on health.

In spite of an increase in financial outlays on therapeutic rehabilitation between 2010 – 2013, the availability of services decreased by about 15%. The report of Najwyższa Izba Kontroli [the Supreme Audit Office of Poland] critically assesses the complex and complicated by the NFZ model of financing medical rehabilitation. One of the conditions for effective medical rehabilitation is its early initiation. The findings of the audit show that in Poland this assumption is not fulfilled. In 11 voivodeships, despite an increase in outlays in 2012, the number of people expecting to receive service within the scope of therapeutic rehabilitation increased, and the actual waiting time for the service lengthened, compared to 2011. There were also significant regional differences in availabiliy of the services.[12,13,14]

In the budget of the Podkarpackie Branch of the National Health Fund, the amounts allocated for therapeutic rehabilitation are as follows: 2014 – PLN 138,560; 2015 – PLN 148,074; 2016 – PLN 145,897. For 2017 the financial plan of 28 July 2016 assumes outlays for therapeutic rehabilitation in the amount of PLN 140,212.

From research on availability of particular types of guaranteed services in the field of medical rehabilitation in the Podkarpackie Region with respect to outpatient physiotherapy there is an observed differentiation in the division of funds between particular poviats. Amounts allocated for one inhabitant in poviat towns in connection with the contracting of services for outpatient physiotherapy for 2014–2017 (Rzeszów PLN 30.41/ person, Krosno PLN 22.44/ person, Tarnobrzeg PLN 22.37/ person, Przemyśl PLN 22.24/ person), were statistically significantly higher than PLN 15.55/ person ($p<0.001^{***}$). As far as the amount per person in outpatient care is concerned, the differences ranged from PLN 0.04 to about PLN 1.75. In 8 poviats, the amounts allocated to medical rehabilitation per one inhabitant was shown to be statistically significantly lower than the average, while in 5 poviats the amounts were higher than the average.

In the other types of home-based rehabilitation, systemic rehabilitation in a day care center, stationary and neurological rehabilitation, the amounts per one inhabitant were comparable to the average, and there were no statistically significant differences. However, competitions for these services were announced in certain, connected regionally, groups of poviats, which made difficult a more detailed analysis which would take into account individual poviats.

In the NIK report on the availability and financing of therapeutic rehabilitation services, regional differences were also noted, e.g., the ratio of settled units per one inhabitant in the case of medical outpatient rehabilitation services in the Mazowieckie Voivodeship amounted to 2.3 in 2011, while in the Wielkopolskie and Lubuskie Vivodeships it was 0.3, i.e., 87% lower. Outpatient physiotherapy was highest in Mazowieckie Voivodeship and amounted to 27.2, the lowest in the Zachodniopomorskie Voivodeship - 12.6, i.e., 53.7% lower.[15] As of 31 May 2013, in Poland there were 1,547 professionally active consultants in therapeutic rehabilitation. There are large disparities in the number of specialists in particular voivodeships. The Ministry of Health did not specify any indicators for the number of professionally qualified doctors in relation to the number of residents.

Conclusions

1. In the Podkarpackie Voivodeship there are statistically significant differences in the division of funds for outpatient physiotherapy and therapeutic rehabilitation services between particular poviats.
2. Services contracted between 2014–2017 for systemic rehabilitation in a day care center, rehabilitation in a day care center or ward for children, rehabilitation in stationary conditions, home-based rehabilitation and neurological rehabilitation are done in groups of poviats, which makes it difficult to accurately analyse the availability of services for patients in individual poviats.

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ORIGINAL PAPER

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Effects of an abdominal drawing-in manoeuvre on stabilometric and gait parameters in adults: a pilot study

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ABSTRACT

Introduction. To our knowledge, no studies have checked the effect of the abdominal drawing-in maneuver (ADIM) on gait and stabilometric parameters in lower back pain (LBP) and pain-free subjects

Aim. To assess the effect of sustained ADIM on a) gait pattern and b) stabilometric parameters with opened eyes and closed eyes in an adult population.

Material and Methods. A group of 20 adults were invited to participate in the study. The Oswestry Disability Index was used for assessing LBP. Gait analysis was performed on a treadmill ZEBRIS FDM-T. The static balance assessment was performed on a stabilometric platform ZEBRIS FDM-S.

Results. There were no significant differences in all tests conducted on the stabilometric platform. Results of gait analysis showed between-group differences in the main effect of group (Non-LBP vs. LBP) for the difference in maximal vertical ground reaction force during the terminal stance (GRFts). The mean GRFts value in the Non-LBP group was greater by 14.8 N (95% CI 9.55–20.1) compared with the LBP group (Table 3).

Conclusions. ADIM has no immediate effects on selected stabilometric and gait parameters in the study group. No effect was seen in subjects with and without pain during the examination.

Keywords. gait, stabilometric parameters

Introduction

Previous studies have attempted to determine the role of the lateral abdominal muscles in lower back pain (LBP) or scoliosis conditions.[1–6] In these type of studies, the most common assessment variables are the resting thickness of the transversal abdominal muscle (TrA), abdominal oblique internal (OI) and external (OE) muscles or their change in thickness during an 'abdominal drawing-in maneuver' (ADIM), which is used to evaluate lateral abdominal muscle function.[2,7–9] The

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ADIM is also the basic exercise of a spine stabilization program, where the goal is to restore proper neuromuscular control by re-educating deep abdominal muscle function.[10,11] Biomechanically, the ADIM increases abdominal pressure, sacroiliac joint stability and thoracolumbar fascia tension, because the TrA and OI are voluntarily contracted. Some studies have demonstrated that the ADIM is effective in the treatment of LBP and should be implemented in scoliosis.[2,7,12]

However, the use of the ADIM has also received some criticism, because it may be considered as an artificial movement task with no reflection in activities of daily living.[8] This, in turn, may hypothetically create inappropriate effects on daily activities, such as walking or standing. Some rehabilitation protocols for deep abdominal muscles consist of the ADIM performed in different body positions and intervals.[13] Thus, it could also be possible to advise patients with LBP to sustain an ADIM for a longer time, while walking or standing.

To our knowledge, no studies have checked the effect of the ADIM on gait and stabilometric parameters in LBP and pain-free subjects. Hence, the aim of the study was to assess the effect of sustained ADIM on a) gait pattern and b) stabilometric test parameters with opened and closed eyes in an adult population.

Material and Methods

Setting and study design

This was an experimental study conducted in the Department of Biomechatronics at the Technology University in Zabrze. The study was designed according to the Declaration of Helsinki. All participants received oral and written information about all procedures and gave their signed informed consent to participate.

Study population

A group of 20 adults were invited to participate in the study (mean age = 20.6 ± 0.8 years; mean body weight = 63.1 ± 13.4 kg; mean body height = 170.2 ± 9.2 cm) from randomly chosen laboratory groups at the University. Individuals who had had a surgical procedure on the thoracic cage, abdominal cavity, pelvic girdle and/or spine were excluded. All participants who have claimed to participate in stability training (or other physiotherapy program) 6 months prior to or during the study were also excluded.

LBP assessment

All participants completed an Oswestry Disability Index (ODI), which is used for assessing LBP. The ODI contains 10 questions, each one having six possible choices scored from 0 to 5, with higher values indicating a more severe condition. The sum of the scores for all questions gives a total score ranging between 0 and 50. To calculate the LBP disability level of the participants, expressed as a percentage, the total score is multiplied by 100 and divided by 50.[15] To clarify the LBP definition, it was defined for participants as a pain between the last rib and lower gluteal fold, which is severe enough to limit or change your daily routine or physical activity level for more than 1 day.

If the participants marked the minimum score for the first question of the ODI (I have no pain at the moment), they were treated as free from LBP (Non-LBP group) during the study procedures. However, if the participants reported anything other than the minimum value for the first question (the pain is mild, moderate, etc.), they were treated as the LBP group.

Static balance assessment

The static balance assessment was performed on a stabilometric platform ZEBRIS FDM-S (Zebris Medical GmbH, Germany), and the following parameters were analysed: general force distribution, ellipse area and path length. These parameters were assessed during the Romberg test (standing position with eyes closed and open for 30 seconds).

Gait analysis

Gait analysis was performed for 60 seconds on a treadmill ZEBRIS FDM-T (Zebris Medical GmbH, Germany). The treadmill was placed on a flat surface, the gait speed was 4.5 km/h and the slope was equal to 0 degrees. The following parameters were measured: GLL – difference in gait line length (|right-left|); GRFts – difference in maximal vertical ground reaction force during the terminal stance (|right-left|); GRFlr – difference in maximal vertical ground reaction force during the loading response (|right-left|).

Protocol

At the beginning, all participants performed an analysis of body balance under both conditions (open and closed eyes) as well as gait analysis while walking on the treadmill. Immediately after, all participants were instructed on how to perform the ADIM according to the procedures described by Hides et al.[14] and with the use of ultrasound imaging as a biofeedback tool (detailed information about the application of ultrasound imaging was explained elsewhere[15–18]). A total of six contraction attempts, each with a 10-second hold, were performed in supine and standing positions. After the training, participants underwent body balance assessment and gait analysis while holding the ADIM (Figure 1).

Statistical analysis

Differences in demographic data between the Non-LBP and LBP groups were examined using an independent-samples *t*-test. Stabilometric and gait data were analysed using analysis of variance (ANOVA) for re-

peated measurements with the between-subjects factor being group (Non-LBP vs. LBP) and the within-subjects factor being abdominal muscle condition (rest vs. ADIM). The results are presented as mean difference and 95% confidence interval (CI). For all analyses, results were considered significant at $p < 0.05$.

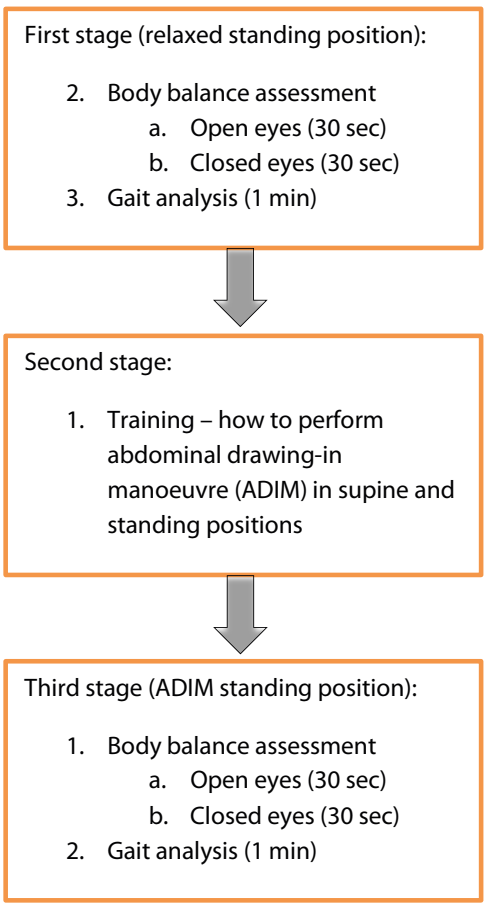

Figure 1. Study protocol

Results

Participants

Out of 20 participants, 18 were included in the final analysis. Two participants did not fulfil the protocol (they were unable to perform the ADIM correctly). Out of 18 participants, 9 of them marked the minimum score for the first question on the ODI (I have no pain at the moment), and they were treated as free from LBP (Non-LBP group). The remaining nine participants reported a value greater than the minimum for the first question (the pain is mild, moderate, etc.); they were treated as the LBP group. The complete characteristics of the study population, divided into groups, are presented in Table 1. The subjects from Non-LBP group were heavier, taller and had lower ODI scores than the group who had pain during the study.

Static balance assessment

There were no significant differences in all tests conducted on the stabilometric platform. The mean values and corresponding *P* values from ANOVA are presented in Table 2.

Gait analysis

Results from the treadmill only showed between-group differences in the main effect of group (Non-LBP vs. LBP) for the GRFts parameter. The mean GRFts value in the Non-LBP group was greater by 14.8 N (95% CI 9.55–20.1) compared with the LBP group (table 3).

Discussion

In this report, the effects of the ADIM on gait and stabilometric parameters in young adults are presented. This is also the first report to evaluate the effects of the ADIM in LBP and pain-free subjects. In the study population, compared to the relaxed condition, static balance test results during the ADIM were not statistically different, indicating that the ADIM did not affect the stabilometric parameters during the Romberg test (closed eyes and open eyes). Additionally, no significant difference was shown in LBP incidence during the examination (Non-LBP vs. LBP). Regarding gait analysis, only the Non-LBP group had higher GRFts values by almost 15 N compared with the LBP group, and there were no differences in gait parameters between the relaxed and contracted (ADIM) conditions.

Table 1. The mean ± SD of groups and the mean (95% CI) differences between groups and the t-test result for independent samples

Characteristic	Groups		Difference between groups	
	Non-LBP (n = 9)	LBP (n = 9)	Non-LBP minus LBP	test t
Age (*yr*)	20.5 ± 0.5	20.7 ± 1.09	-0.22 (-1.07 to 0.63)	-0.59
Weight (*kg*)	69.1 ± 14.6	54.8 ± 6.22	14.3 (-3.10 to 25.6)	2.71*
Height (*cm*)	175.1 ± 10.7	165.4 ± 5.13	9.66 (1.27 to 18.1)	2.44*
ODI (%)	2.42 ± 5.02	10.7 ± 7.81	-8.32 (-14.9 to -1.75)	-2.69*

* Significant difference ($p < 0.05$)

Table 2. Mean ± SD values of stability parameters at rest and during ADIM in Non-LBP and LBP groups

	Non-LBP group		LBP group		P value from ANOVA		
	Rest	ADIM	Rest	ADIM	Main effect Group	Main effect Condition	Interaction
Static balance assessment (open eyes)							
Elipse area ($mm^{2)}$	58.1 ± 73.3	65.4 ± 56.3	29.1 ± 16.5	42.5 ± 31.6	0.27	0.07	0.57
Path length (mm)	412 ± 84	409 ± 71	389 ± 74	433 ± 74	0.99	0.37	0.29
Force[a] (%)	5.88 ± 3.98	6.95 ± 4.89	8.31 ± 4.51	8.22 ± 4.86	0.33	0.68	0.62
Static balance assessment (closed eyes)							
Elipse area ($mm^{2)}$	40.4 ± 24.2	57.9 ± 38.9	34.5 ± 20.6	41.8 ± 32.7	0.38	0.10	0.49
Path length (mm)	489 ± 109	444 ± 71	423 ± 69	463 ± 104	0.46	0.94	0.15
Force[a] (%)	5.64 ± 3.38	6.15 ± 5.28	7.55 ± 3.39	9.73 ± 5.56	0.13	0.36	0.57

[a] force distribution = |ride side-left side|;

Table 3. Mean ± SD values of stabilometric parameters at rest and during ADIM in Non-LBP and LBP groups

	Non-LBP group		LBP group		P value from ANOVA		
	Rest	ADIM	Rest	ADIM	Main effect Group	Main effect Condition	Interaction
Gait analysis							
GLL (mm)	9±14	7±13	5±5	6±4	0.55	0.60	0.11
GRFts (N)	20.7±7.32	20.7±70.9	6.25±5.73	5.47±2.57	>0.001*	0.88	0.86
GRFlr (N)	20.7±7.33	25.4±26.1	6.25±5.73	18.4± 6.9	0.09	0.10	0.46

GLL – differences in gait line length (|right-left|); GRFts – difference in maximal vertical ground reaction force during the terminal stance (|right-left|); GRFlr – difference in maximal vertical ground reaction force during the loading response (|right-left|); *significant difference

Considering that ADIM is effective in LBP rehabilitation, the above-mentioned results are a cause for optimism, because it can be stated that a sustained (no longer than 1 minute) ADIM has no side-effects on stabilometric and gait parameters during normal standing and walking.[7,12] There were also no significant differences between the Non-LBP and LBP groups. Thus, it can be said that in a short period of time, ADIM had no effect on parameters such as ellipse area, path length, general force distribution, GLL, GRFts and GRFlr.

The ADIM engages TrA and OI muscle activity (increases the thicknesses of those muscles) relative to the OE. Some studies revealed that an increase in deep abdominal muscle thickness (TrA and OI) is correlated with lumbo-pelvic neutral posture in erect standing and that improper posture diminished stabilographic variables.[19,20] Studies have also confirmed that core stability exercises (focusing on the trunk muscles) improve balance ability.[21,22] Thus, from the results of our study and others, it could be suggested that balance ability and gait pattern are not related to deep abdominal muscle thickness. In our study, participants in the ADIM condition supposedly had significantly thicker TrA and OI muscles compared with those in the relaxed state. Most studies have confirmed this observation.[23–25] However, such a condition (supposedly higher muscle thickness during ADIM) had no effect on stabilometric and gait parameters. This means that factors other than deep abdominal muscle thickness are important for changing stabilometric and gait parameters.

The study has also limitations, which advise careful interpretation of the results. The most important is the lack of control in the lateral abdominal muscle in the ADIM condition during the examination. It was impossible to control muscle thickness by ultrasound imaging without disturbing the participants. In future studies, it could be worthwhile to use a belt to fix a transducer to the body.[26] The second limitation is the relatively small sample size and the criteria for inclusion in the Non-

LBP group (pain-free on the day of the examination), which may have included some participants who had occasional lower-back problems. Additionally, some of the standard deviation (SD) values presented in the Table 2 and 3 are relatively big comparing to their mean values, this may indicate high variability and abnormal statistical distribution of these parameters.

Conclusions

ADIM has no immediate effects on selected stabilometric and gait parameters in the study group. No effect was seen in subjects with and without pain during the examination.

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REVIEW PAPER

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Clinical aspects of protein glycation

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ABSTRACT

Introduction. Glycation is a post-translational modification of proteins that depends on the non-enzymatic linkage of a ketone or aldehyde group of sugar with a free amino group of protein. Pathological effects of this process are observed in many disease states under conditions of hyperglycemia, in diabetic complications, and neurodegenerative diseases such as multiple sclerosis.

Aim. In this paper we present the characteristics of the glycation process, its consequences, as well as a review of current knowledge about the role of glycation in multiple sclerosis.

Material and methods. The databases EBSCO, PubMed, ScienceDirect and SpringerLink were used to search the literature.

Analysis of the literature. Intermediate glycation products form a number of derivatives that contribute to oxidative stress and structural changes in the proteins, including induction of aggregation or reduction of affinity for drug proteins. Glucose products may contribute to neurodegenerative changes in patients with multiple sclerosis. Determination of protein glycation products can be successfully used to evaluate the course of multiple sclerosis as a diagnostic marker.

Keywords. AGEs, glycation, advanced glycation end products, multiple sclerosis.

Introduction

Glycation is a non-enzymatic process of linking a ketone or aldehyde sugar group, mainly glucose, with amino group of a protein, resulting in formation of stable advanced glycation end products (AGEs). This reaction was first described by Louis Maillard in 1912.

AGEs are a heterogeneous, complex group of compounds formed in three stages of the Maillard reaction.

Initially, during the first few hours, glucose is bound reversibly to free amino groups of proteins (mainly lysine or arginine residue) leading to the formation of a Schiff base. In turn, the Schiff base is relegated to more stable Amadori products, termed early glycation products, and their formation can last up to several days, while still being reversible. Early stage glycation products undergo further modifications - reduction, oxidation, condensation, fragmentation or hydration. These reactions lead to protein cross-linking that are irreversible and last for several weeks to several months. The final products of these rearrange-

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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ments are stable AGEs, which can accumulate in tissues (Fig. 1).[1-3]

Aim

The aim of this paper is to review the consequences of glycation of proteins and to determine the contribution of glycation in multiple sclerosis.

Material and methods

The following databases were searched: EBSCO, PubMed, ScienceDirect, SpringerLink (from 2003 to 2017) using the keywords: glycation, glycoxidation, advanced glycation end products, AGEs, multiple sclerosis.

Analysis of the literature

Advanced glycation end products

During the course of non-enzymatic glycation, reactive oxygen species (ROS) are generated and for this reason the reaction is often called glycoxidation.[4] The most important glycoxidation products of the AGEs group are pentosidine and carboxymethyllysine.[5] Peroxides generated by the mitochondria play an important role in the formation and accumulation of AGEs in tissues, resulting in oxidative stress and inflammation.[6] The reactive oxygen species generated during glycation are able to oxidize the amino acid residues of the proteins to form carbonyl derivatives and disulfide bridges between the various protein molecules that result from the oxidation of thiol groups.[7] Glucose is also affected by highly reactive sugar derivatives such as 1-oxoaldehydes, including glyoxal and methylglyoxal. These aldehydes are important precursors of AGEs and can develop in the body as a result of glucose degradation and early glycation product formation. Glyoxal is synthesized by lipid peroxidation, monosaccharide degradation and glycated proteins. In turn, methylglyoxal under physiological conditions is generated by non-enzymatic dephosphorylation of phosphodihydroxyacetone and 3-phosphoglycerol aldehyde as well as DNA degradation.[8,9] Elevated concentrations of methylglyoxal is observed in the plasma of patients with diabetes and may be a marker for predicting progression of diabetic microangiopathy.[10] Methylglyoxal is an inducer of glycation on arginine residues, resulting in formation of adducts of hydroimidazolone while glucose reacts with lysine residues or with N-terminal amino acid residues resulting in the formation of fructosamine adducts. In this reaction, glycated hemoglobin is formed.[11] AGEs are formed under physiological conditions, although pathological formation occurs under hyperglycaemia, diabetic complications, and progresses with age and in various disease such as Alzheimer's disease, Parkinson's disease, cataract, cystic fibrosis or multiple sclerosis.[12-18]

Consequences of protein glycation

Glycation induces a number of structural changes in proteins, including increase in molecular weight, resistance to proteolytic enzymes, reduction in microbial polarity, hydrophobicity, protein affinity for many drugs, and induction of protein aggregation.[19,20] The literature indicates that AGEs gradually accumulate in the lens and retina resulting in the formation of high molecular weight protein aggregates that diffuse light and restrict the field of vision. Accumulation of AGEs causes diabetic retinopathy and age-related macular degeneration and progression of cataracts is exacerbated in patients with diabetes mellitus.[21] Proteins such as collagen, lens crystalline, ferritin, apolipoprotein and albumin are glycated *in vivo*. The amino acid residues that are most susceptible to glycation are lysine, arginine and cysteine due to strong nucleophilic properties. Lysine at position 525. in human albumin and lysine at position 524. in bovine albumin are considered to be the most reactive glycation sites of albumin in native conformation.[22,23] Cysteine thiol is a potent nucleophile that can be glycated to S-carboxymethylcystine, suggesting involvement of cysteine at position 34. in this process.[24] Glycation of plasma proteins, including albumin, fibrinogen and globulin can cause adverse effects including changes in

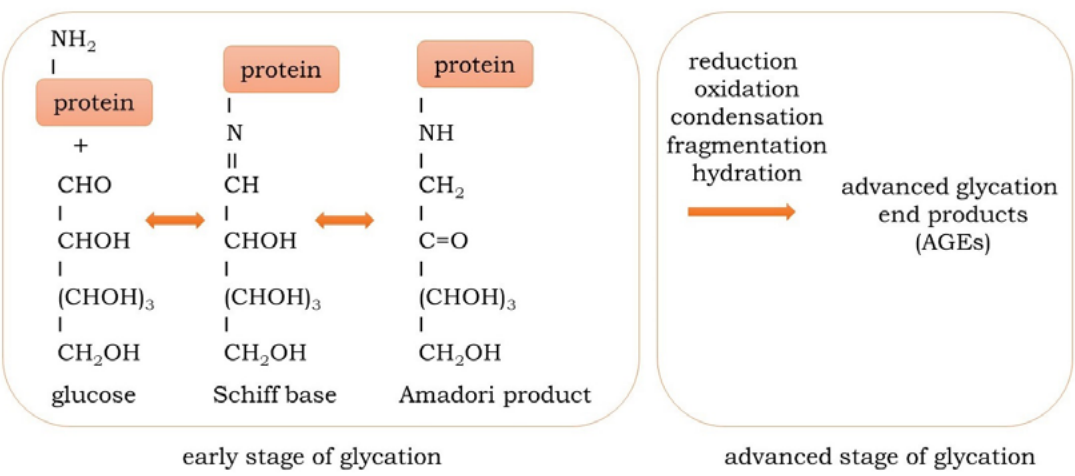

Figure 1. The steps of the formation of advanced glycation end products

platelet activation, ROS formation, fibrinolysis or immune system dysfunction.[12]

Glycated albumin has significant clinical effects as it has been confirmed participation glycated albumin in diabetic retinopathy and coronary diseases related to diabetes.[25,26] It was shown a correlation between the level of glycated albumin and renal failure and diabetic microangiopathy.[27] The results of studies indicate that glycated albumin, due to a shorter half-life than hemoglobin, can be used as an alternative marker for glycemic control.[28] Moreover, the marker more accurately reflects plasma glucose changes even in patients with hematological disorders.[29] Some researchers hypothesize that with age or in various pathological conditions, there is an imbalance between generation and removal of AGEs. Increased endogenous formation of AGEs and the provision of AGEs in the diet leads to a deterioration of renal function. Accumulation of AGEs in tissues results in organ dysfunction.

About 70% of consumed AGEs remain in the body and accumulate in tissues, while the remaining 30% is excreted within three days after ingestion.[30] Diets of populations from developed countries is particularly rich in advanced glycation end products, and products especially rich in AGEs are processed products and food of animal origin.[31]

It is known that consumption of foods rich in AGEs in patients with diabetes mellitus type I and II contribute to the generation of proinflammatory cytokines which leads to tissue damage, and insulin resistance.[32,33] Moreover, studies carried out *in vitro* on cell lines and *in vivo* indicate that exogenous AGEs cause damage to pancreatic β cells.[34] Currently, many studies focus on finding effective glycation inhibitors that could be used in future diabetes therapy. Effective glycation inhibitors include aminoguanidine and pyridoxine, polyphenols and nitroxides, i.e synthetic organic radicals that have an unpaired electron located on the nitroxyl group.[35-37] Increasingly, the attention of researchers are turning to natural products or even natural ingredients of food due to the high availability and effectiveness of inhibiting the generation of AGEs. Effective inhibitors of glycation with plant origin include rutin, quercetin, genistein, kaempferol, naringin, caffeic acid and ferulic acid.[36]

It is known that antioxidants can quench free radicals generated by glycation, and also prevent autoxidation of monosaccharides and Amadori products. It is also claimed that these compounds may prevent cross-linking of proteins by AGEs.[38]

Multiple sclerosis and glycation

Multiple sclerosis (MS) is a chronic, autoimmune, inflammatory disease of the central nervous system which causes demyelination and destruction of axons. The immune response mainly involving autoreactive T lymphocytes, is directed against myelin, which is recognized as a foreign substance. In addition, microglial cells and macrophages release inflammatory mediators and leukocyte stimulating activity in support of damage within the central nervous system.[39]

The course of the disease is very diverse and unpredictable. In most patients, the disease initially causes reversible neurological deficits often accompanied by progressive deterioration of the neurological state over time.[40] About 85% of patients suffer from the relapsing-remitting form of MS characterized by the appearance of relapses, which are emergency signs of damage to the nervous system including periods of relative stability.[41]

It is estimated that about 2.5 million people suffer from multiple sclerosis in the world.[42] MS is a complex disease that is caused by the interaction of environmental factors and genetic predisposition. In recent years, factors involved in the etiology of the disease include oxidative stress, which is defined as the imbalance between the generation of ROS and the mechanisms that are responsible for their elimination. It has been suggested that enhanced generation of ROS as well as reactive nitrogen forms leads to oxidative and nitrosative stress that damages mitochondria, myelin, causes oligodendrocyte apoptosis and astrocyte dysfunction.[43] It seems that increased oxidative stress in patients can promote the progress of glycoxidative damage proteins, and determination of glycation end products can be a marker for assessment of the clinical status of patients with MS. In patients with multiple sclerosis, elevated plasma pentosidine levels as well as carboxymethylylsin were detected by immunohistochemical techniques in posthumous hippocampal preparations.[44,45] On the other hand, no significant difference in the concentrations of AGEs and pentosidine was observed in the cerebrospinal fluid and serum of patients with MS as compared to the control group in a study carried by Kalousová et al.[46] Studies conducted by Sternberg indicate that the determination of AGEs, especially the glycation product – carboxyethyl lysine, may be useful for assessing the severity of the disease. Moreover, in these studies it was demonstrated that the use of disease-modifying drugs (interferon β, glatiramer acetate, and natalizumab) reduces glycation end products in the plasma of patients.[17]

Studies conducted by Sadowska-Bartosz indicate that despite elevated blood glucose levels, elevated AGEs levels in serum were detected in newly diagnosed and previously untreated patients compared with healthy subjects. The level of AGEs in cerebrospinal fluid did not significantly differ between patients with MS and the control group.[18] Many studies have shown that in MS patients, increased glycolysis and lipid peroxidation occurs which causes an increased synthesis of AGEs derived from methylglyoxal.[47,48] Literature data suggest that in MS patients, astrocytes and oligodendrocytes

are the main source of reactive dicarbonyl compounds which are precursors of AGEs.[49]

In patients with MS, decreased levels of reduced glutathione, which is a co-factor of glyoxalase involved in the detoxification of methylglyoxal, was observed. In turn, it was noted that the enzyme activity of glyoxalase is reduced which leads to accumulation of aldehyde in the cells, which promotes increased production of AGEs.[50,51] Studies conducted by Andersson show that the expression of receptors for advanced glycation end products changes in animal models of MS.[52] Similarly, overexpression of these receptors was observed in phagocytes and CD4 + T cells in samples from the brains of experimental animal model of MS.[53] The impact of methylglyoxal on endothelial cells of the blood-brain barrier leads to the glycation of proteins of the basal membrane and intercellular structural proteins, leading to loss of a tight junction between cells and promotes increased permeability of immune system cells.[54] It seems that treatment with glycation inhibitors can be included in therapeutic methods for MS for prevention of AGEs formation, which may be a new and improved therapeutic tool for patients with multiple sclerosis.

Conclusions

— Glycation of proteins causes many structural and functional changes in proteins.
— The process of glycation increases with age, as well as in a number of disease states.
— In MS patients, increased generation of AGEs is observed.
— Determination of glycation products can be used to assess the course of MS and the effectiveness of therapy.

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REVIEW PAPER

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Complex relationships between endocrinopathies and obstructive sleep apnea syndrome

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ABSTRACT
Sleep-related disordered breathing (SRDB) is a term covering a heterogeneous group of conditions with a similar clinical picture yet different pathogenesis. Nocturnal episodes of obstructive apnoea, leading to repeated periods of desaturation and re-oxygenation, activate chemoreceptors and increase the activity of the sympathetic as well as renin-angiotensin-aldosterone system. Moreover, the generation of free radicals and proinflammatory cytokines increases. All the above mentioned disturbances interfere with the function of endocrine glands. On the other hand, many endocrine disorders are associated with an increased risk of obstructive sleep apnoea syndrome (OSAS). In this paper, we discuss relationships between selected endocrinopathies and OSAS.
Keywords. obstructive sleep apnea, endocrinopathies, diabetes

Introduction

Sleep-related disordered breathing (SRDB) is a term covering a heterogeneous group of conditions with a similar clinical picture yet different pathogenesis. They are connected not only with a worse than normal quality of life but also with a substantial risk of numerous cardiovascular and metabolic complications that can lead to premature deaths.[1] Obstructive sleep apnoea syndrome (OSAS) is the most common type of breathing disorder during sleep. The syndrome is characterised by repeated episodes of apnoea and/or hypopnoea with preserved respiratory effort (which differentiates obstructive from central apnoea). The structure of sleep is impaired - lack of deep and rapid eye movement phases. Thus, the quality of sleep is poor and does not provide full rest, which results in excessive daytime sleepiness and chronic fatigue. One of the major factors predisposing to the development of obstructive breathing disorders is obesity and resultant accumulation of adipose tissue around the neck.[2]

Nocturnal episodes of apnoea, leading to repeated periods of desaturation and re-oxygenation, activate chemoreceptors and increase the activity of the sympathetic as well as renin-angiotensin-aldosterone system. Moreover, the generation of free radicals and proinflammatory cytokines increases. All the above mentioned

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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disturbances interfere with the function of endocrine glands.[3] On the other hand, many endocrine disorders are associated with an increased risk of OSAS.

Aim

The main aim of the study was to review the literature on relationships between selected endocrine disorders (i.e., dysfunction of thyroid, parathyroid, adrenal glands, acromegaly, diabetes mellitus) and OSAS.

Description of the study literature

Comprehensive searches of the MEDLINE (accessed by PubMed) database was performed. The following key words were use: obstructive sleep apnea, thyroid, parathyroid, vitamin D, osteoporosis, adrenal, Cushing's disease, diabetes). Articles published between January 2000 and June 2017 were included.

Analysis of the literature

Epidemiology of obstructive sleep apnoea

The prevalence of OSAS in the adult population is estimated at 4% among men and 2% among women.[4] In Poland, OSAS affects almost 1.5 million individuals. In view of the increasing prevalence of obesity in developed countries, a further increase in OSAS incidences can be expected.

Disorders of thyroid function

OSAS is likely to develop in up to 30% of patients with newly diagnosed hypothyroidism.[5] Its incidence at concomitant hypothyroidism increases, which is associated with obesity, macromegaly, impaired upper airway function, tissue deposition of mucopolysaccharides and disturbed respiratory drive regulation.[6]

The findings reported by Rest et al. have demonstrated frequent cases of subclinical hypothyroidism in patients with obesity and breathing sleep disorders. The incidence of undiagnosed subclinical hypothyroidism in the population studied was 11.5%.[7]

According to Petrone et al., thyroid dysfunction was found in almost 1/5 of patients with moderate and severe OSAS (subclinical hypothyroidism was diagnosed in 8% and low triiodotyronin syndrome in 10.4%). In patients with low concentration of fT3, lower mean values of nocturnal saturation were observed; after the 5-month continuous positive airway pressure therapy, the concentration of fT3 normalised. The beneficial effect of CPAP therapy was also found in patients with subclinical hypothyroidism - a substantial decrease in TSH levels. Interestingly, in patients with OSAS and normal thyroid function, the CPAP therapy did not cause significant changes in concentrations of THS and thyroid hormones.[8]

Jha et al. analysed the incidence of OSAS in patients with the diagnosis of primary hypothyroidism. OSAS defined as the apnoea-hypopnoea index (AHI) ≥ 5, was present in 15 patients (30%) at the beginning of the study and was reversible in 10 out of 12 patients evaluated after levothyroxine treatment ($p = 0.006$). The substitutive treatment with levothyroxine was associated with improved airway patency associated with reduced tongue enlargement (4 [33%] vs. 1 [8%], $p = 0.083$), mucous oedema (5 [42%] vs. 1 [8 %], $p = 0.046$) and facial oedema (10 [83%] vs. 1 [8%], $p = 0.003$).[9] The authors have concluded that reversible OSAS is common among patients with primary hypothyroidism and the hypothyroidism-induced changes in the upper airway anatomy are likely to contribute to the development of OSAS in such patients.

Disorders of parathyroid function, vitamin D_3 and calcium-phosphate metabolism

The episodes of hypoxaemia and hyperoxia occurring cyclically in OSAS patients can cause metabolic acidosis, negatively affect bone tissue metabolism and impair bone micro-architecture. The studies have demonstrated that hypoxaemia can favour the development of osteoporosis by blocking the growth and differentiation of osteoblasts and simultaneously stimulating the formation of osteoclasts.[10,11]

Analyses have shown significantly lower values of bone mineral density (BMD) and T-scores in the femoral neck of patients with OSAS. The serum level of β-CTX (C-terminal telopeptide of the alpha chain of type 1 collagen) was found to be statistically significantly higher in the group of OSAS patients ($p = 0.017$). The findings of meta-analyses have demonstrated that the mean levels of SpO2 were significantly correlated with the levels of osteocalcin and BMD. Therefore, patients with OSAS may represent a risk group with respect to loss of BMD and bone resorption.[12]

A large-scale population-based study carried out by Chen et al. has shown that OSAS is independently related to osteoporosis. Having considered age, gender, hypertension, coronary disease, obesity, stroke, hyperlipidaenia, chronic renal disease, gout, incomes and geographical regions, the OSAS patients were found to be 2.7-fold more prone to the risk of osteoporosis (adjusted HR 2.739 at 95% CI 1.690 to ~ 4.437).[13]

Recent studies have demonstrated lower concentrations of vitamin D_3 and higher levels of parathyroid hormone (PTH) in OSAS patients. Obesity affecting the majority of OSAS patients is in itself the factor favouring vitamin D_3 deficiency.[14] The available data suggest a reverse correlation of 25(OH)D with diabetes mellitus and metabolic syndrome and a positive correlation of PTH with obesity and arterial hypertension in OSAS patients.[15]

According to Liguori et al., patients with OSAS had significantly lower concentrations of vitamin D_3

and elevated levels of PTH at unchanged differences in calcaemia, compared to the control group. In the multi-factorial analysis, once disturbing variables (e.g. obesity) were accounted for, an independent correlation was observed between the level of vitamin D_3 and minimum nocturnal saturation. The short-term CPAP therapy (seven nights) resulted in a significant increase in vitamin D_3 concentrations, as compared to baseline values. Intriguingly, however, this beneficial effect was observed only in the subgroup of male patients responding to CPAP therapy (defined as AHI <5/h), and not in the subgroup of female patients, even when the CPAP treatment outcomes in them were good.[16]

Chronic vitamin D deficiency can increase the risk of OSAS by favouring tonsil hypertrophy, airway myopathy, and chronic rhinitis. Moreover, the available study findings suggest that low levels of vitamin D increase the risk of cardiovascular diseases, diabetes mellitus and autoimmune diseases. Therefore, proper concentrations of vitamin D in serum of OSAS patients can alleviate this syndrome and prevent the risk of cardiovascular diseases and diabetes mellitus.[17]

Disorders of hypothalamic-pituitary-adrenal axis

The results reported by Kritikou et al. suggest that OSAS in non-obese men and slightly overweight women is associated with the hypothalamic-pituitary-adrenal axis activity (as in obese patients with OSA). The short-term CPAP treatment substantially reduced the level of cortisol compared to the baseline values, which suggests that CPAP is likely to have protective effects in such cases.[18]

The aim of the study by Carneiro et al. was to analyse the function of the hypothalamic-pituitary-adrenal axis and results of ambulatory blood pressure monitoring (ABPM). A 24-hour ABPM and cortisol suppression testing with 0.25 mg of dexamethasone were carried out in 16 obese male patients with OSAS and 13 male individuals without OSAS. After the 3-month CPAP therapy, nine patients with OSAS were re-evaluated. The baseline decrease in systolic pressure at night in OSAS patients was lower ($p = 0.027$) and heart rate higher ($p = 0.022$), as compared to controls; moreover, the level of cortisol in saliva was found to be higher after inhibition with dexamethasone ($p = 0.001$). However, no difference in arterial blood pressure was observed ($p = 0.183$). Higher cortisol suppression was positively correlated with improved apnoea/hypopnoea indices during CPAP therapy ($r = 0.799$, $p = 0.010$).[19]

According to Wang et al. research, patients with Cushing's syndrome are at high risk of OSAS develepoment (HR = 2.82; 95% CI: 1.67–4.77) in later life.[20]

Acromegaly

Acromegaly has been recognised a risk factor for OSAS.[21-23] In the study by Weiss et al., the incidence of OSAS in patients with acromegaly was 75%. The independent predictors of OSAS included increased activity of acromegaly, older age and larger neck circumference. There was no correlation found between OSAS versus BMI and abnormal ENT results.[24] In turn, Sesmilo et al. found that patients diagnosed with OSAS had symptoms of acromegaly (1.35 cases per 1000).[25] Acromegaly may be a factor influencing the low effectiveness of CPAP.[26]

Furthermore, Grunstein et al. analysed the effects of octreotide therapy on OSAS with concomitant acromegaly. During the therapy, the indices of apnoea severity improved. As the study results show, sleep apnoea can either persist in some patients despite normalisation of growth hormone levels or significantly improve at only partial biochemical remission.[27]

Diabetes mellitus

OSAS very commonly coexists with type 2 diabetes. In the study by Foster et al., OSAS with AHI ≥ 5 events/h was confirmed in over 86% of patients with type 2 diabetes. The mean AHI was 20.5 ± 16.8 events/h. In total, 30.5% of patients had moderate OSAS (15 ≤ AHI <30) and 22.6% – severe OSAS (AHI ≥ 30). The waist circumference (OR 1.1 at 95% CI 1.0–1.1, $p = 0.03$) was significantly correlated with OSAS. The risk of severe OSAS was significantly higher in individuals with higher BMI (OR1.1 at 95% CI 10.–1.2, $p = 0.03$)[28].

OSAS is associated with enhanced insulin resistance, impaired glucose tolerance and increased risk of type 2 diabetes.[29, 30] Peng et al. showed that patients with OSAS had higher postprandial glucose concentrations than controls without sleep apnoea.[31]

From the clinical point of view, observations suggesting acceleration of microangiopathic complications are essential in patients with diabetes and OSAS, especially nephropathy and diabetic retinopathy.[32-35] Chang et al. have demonstrated that the incidence of severe OSAS is associated with increased risk for advanced stages of diabetic retinopathy (proliferative retinopathy, macular edema).[36] Altaf et al. have observed that OSAS is an independent risk factor for progression to proliferative retinopathy.[37] In recent years, the relationship between OSAS and the risk of diabetic neuropathy has also been observed.[38]

According to Babu et al., CPAP can be an effective therapeutic tool in patients with diabetes coexisting with OSAS. In their study, the duration of CPAP therapy was 83 ± 50 days, on average. In 17 patients with baseline concentrations of glycated hemoglobin above 7%, its level significantly decreased (from 9.2% ± 2.0% to 8.6% ± 1.8%). Moreover, in patients with CPAP used for more than 4 h/d, reduced levels of glycated hemoglobin were significantly correlated with the use CPAP. There was no such a correlation found in patients with CPAP used ≤ 4 h /day.[39]

Harsch at al. performed their study to determine whether OSAS is an independent risk factor for enhanced insulin resistance and whether CPAP therapy can improve insulin sensitivity. Prior to CPAP therapy, 2 days after its initiation and 3 months after effective CPAP treatment, patients were evaluated using euglycaemic clamps. The sensitivity to insulin substantially increased after 2 days ($p = 0.003$) and maintained at a stable level after 3 months of treatment. Improved insulin sensitivity after 2 days was significantly higher in patients with BMI below 30 kg/m2 than in obese patients.[40] The authors suggest that increased insulin sensitivity observed after 2 days of treatment may reflect decreasing sympathetic activity.

Conclusions

The results discussed above explicitly prove the complexity of relations between OSAS and the endocrine system. The coexistence of OSAS and endocrine disorders can mask a typical clinical image, interfere with laboratory results and make the appropriate diagnosis difficult. The CPAP therapy can affect the function of endocrine glands while the treatment of endocrinopathies can diminish the severity of OSAS.

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REVIEW PAPER

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Review of surgical techniques for the reconstruction of the maxillofacial region used in the Department of Maxillo-Facial Surgery in Rzeszów

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ABSTRACT

Postoperative reconstruction of tissue loss within the head and neck after extensive resections due to malignant neoplasms or traumas has always been a challenge for maxillo-facial surgeons or ENT physicians. Due to the complex anatomical structure of the head and neck region, every patient requires an individual approach and there is no standard method of management appropriate for all patients. The number of patients treated for malignancy is increasing year by year. The possibility of performing extensive resections in the head and neck region are conditioned by appropriate reconstruction.

Aim. The aim of the paper is to present the reconstructive methods used in the Clinical Department of Maxillofacial Surgery, F. Chopin Hospital No. 1 in Rzeszow. A short review of the most commonly used flaps is presented, taking into account their advantages, disadvantages and surgical technique in terms of their usefulness in daily clinical practice.

Keywords. reconstructive surgery, microsurgery, surgical flaps, cancer of head and neck

Introduction

Year by year, an increase in the number of serious injuries associated with damage or loss of tissue following extensive oncological surgery is observed resulting in searches for new methods of reconstruction. Reconstructive methods known for centuries are still used in modern clinical practice, but new methods are still being sought, as evidenced by the development of surgical techniques and transplant surgery.

Reconstruction of head and neck tissue defects caused by traumas or extensive surgery of malignant tumours in this area is a significant challenge for surgeons with knowledge and skills in reconstructive surgery and modern reconstruction techniques. Understanding topographic and functional anatomy and physiology and connections with head and neck pathologies provided researchers with the opportunity to develop state-of-the-art surgical techniques to help

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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patients recover, return to their normal lives and function in family and social life. Advances in reconstructive surgery ensure reconstruction of lost tissue with previously prepared autograft transplants, flaps, and various implants that allow reconstruction with a tissue block best suited to the structure and volume of a given defect or deformity.

Different, often simple surgical techniques i.e. free skin grafts or flaps adjacent to lost tissues and organs have been used in the reconstructive surgery of maxillofacial region for centuries. The oldest references present the experiences of Indians 3–4,000 years BC, who already at that time presented a high level of reconstructive surgery, especially in the reconstruction of the nose. The interest in reconstructive surgery was spread probably by Arabs from India through Egypt to Europe. In the Middle Ages, the interest in reconstructive surgery was reduced, only the great battles of the nineteenth century and the first and second World War became an experimental training ground for reconstructive surgery. Massive and extensive damage combined with loss and the amputation of tissues and organs forced the necessity of searching for reconstruction solutions and progress in this field of surgery.

The Russian surgeon Fiłatov introduced in 1916 a rolled up flap formed with abdominal tissues which became the breakthrough in reconstructive surgery. A cylindrical flap was independently developed and described in 1917 by the English surgeon Gilles. In Eastern Europe, this flap is referred to as Fiłatov's flap, while in the Anglo-Saxon countries as Gilles's flap. This flap allowed for many decades to reconstruct extensive defects even in areas of the body remote to the donor site.

Modern reconstructive techniques also allow for transfer of tissues from distant regions of the body to the recipient area as pedicled or free flaps anastomosed with the recipient site using microsurgical techniques. The 1970s and 1980s were characterized by a flourishing of new flap techniques. In 1978, Yang introduced a radial forearm flap, in 1984 Song et al. developed the anterolateral thigh flap and in 1989 Hidalgo developed a fibula free flap.[1-3] Knowledge of flap techniques gained during the past four decades using microsurgical anastomoses and technological advances in medicine have contributed to a significant improvement in the effectiveness of reconstructing defects with free flaps. Nowadays, vascularized grafts may contain soft tissues (skin, fascia, muscle) and bone. Each of the mentioned tissues can be used as a single graft, e.g. cutaneous, muscular, bone flap or as a flap composed of several tissues, such as fascial-cutaneous and osteo-myo-cutaneous flaps. It is possible to combine two or more independent flaps as so called chimeric flaps, which additionally increase the reconstructive potential.[4]

Characteristics of selected methods of reconstruction

Pedicled flaps

Sternocleidomastoid (SCM) flap

The first reconstruction using SCM muscle was described by Jianu in 1908.[5] The SCM flap was used to reconstruct facial expressions in patients with facial nerve damage. Since 1955, when Owens first applied a myo-cutaneous flap based on SCM, numerous modifications have been made regarding the vascularisation, the location and length of the pedicle.[6] In 1970, the first flap was described, which included a clavicular fragment and was used to reconstruct the loss in the mandibular shaft resulting from the surgical excision of a malignant tumour.

SCM muscle along with the platysma belongs to the superficial muscles of the neck. The name of the muscle is derived from the insertions. The origin of the muscle are two heads attaching to the sternal manubrium and the sternal end of the clavicle. The distal insertion is the surface of the mastoid process of the temporal bone and the superior nuchal line.[7]

Due to the innervation of the flap by the external branch of the accessory nerve (XI) and preserving SCM muscle function, it was initially used to reconstruct the tongue after glosectomy, lip reconstruction and the bottom of the oral cavity. Poor vascularization of this flap, which in the upper part is supplied by the occipital artery and in the lower by inferior thyroid artery and the branches of auricularis posterior artery, limited its practical use. According to the Mathes and Nahai classification, the flap has a type II vascularization.[8]

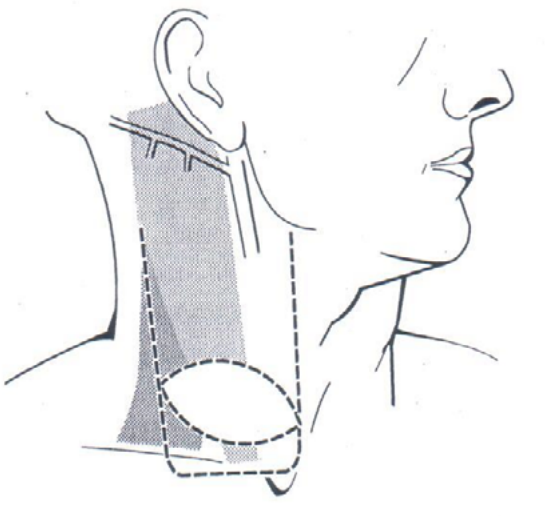

Figure 1. A pattern of SCM flap

In 1994, a study was conducted describing 120 patients with SCM flap. Total flap necrosis occurred in 7.3% of patients, while superficial skin necrosis in 22.7%. Fistulas of the oral cavity and neck were reported

in 11.8% of patients. The authors highlighted more frequent necrotic lesions in patients previously irradiated.[9]

Restrictions in using this flap are due to i.e. the size of myo-cutaneous island, closeness of cervical lymph nodes and internal jugular vein as potential lymph pathway from primary lesion, which limit the oncological purity of surgery, poor vascularisation of the type II lymph nodes, and the harmful effect of radiotherapy on its vascularization.

SCM flaps were mainly used to reconstruct small tissue defects following the removal of malignant neoplasms of the retromandibular triangle, lower gingiva, and the bottom of the oral cavity.

Deltoid-pectoral flap

In 1965, Bakamjian described a cutaneofascial flap with axial arterial vascularisation from intercostal arteries 2 to 4. In the 1960s it was the most commonly used flap to reconstruct neck tissue and the lower face defects. Since the 1970s, it has been gradually replaced by myocutaneous flap and free tissue grafts with micro-surgical anastomosis. Currently, the range of indications for the use of the deltoid-pectoral flap has been significantly reduced, as more beneficial reconstructive methods are more suitable in most cases.[10] Since the beginning of the use of the deltoid-pectoral flap, many modifications have been made, with the most research being devoted to the technique of flap elongation. In 1974, Harii presented the deltoid-pectoral flap as a free microsurgical flap, but due to the short pedicle and difficulty in the recipient site supply, it was not the most commonly used solution.[11] The most common indication for the deltoid-pectoral flap is currently the large tissue defects in the lower floor of the face, in cases where there are contraindications to the use of microsurgical techniques.

The advantages of Bakamjian's flap are its good vascularization, adequate size and great flap vitality, the ability to connect with the great pectoral muscle flap. The most common complication in the flap is necrosis of its distal part. Kirkby observed total necrosis of the flap in 26% of the patients treated.[10] In other studies, the incidence ranged from 9 to 16%.[12,13] The greatest drawback of the deltoid-pectoral flap is the need for multi-stage treatment. In the first stage, flap needs to be formed and grafted in the donation site. About 4 weeks after the revascularisation of the displaced flap occurred, it is necessary to cut off its pedicle. The transplant site is covered by a free skin graft.

Myocutaneous flap of the pectoralis major

The theoretical bases of the pectoralis major flap were described for the first time by Pickerel in 1947.[14] While in the late 1970s, Arriyan and Cuono introduced it in reconstruction of tissue defects in the head and neck. The

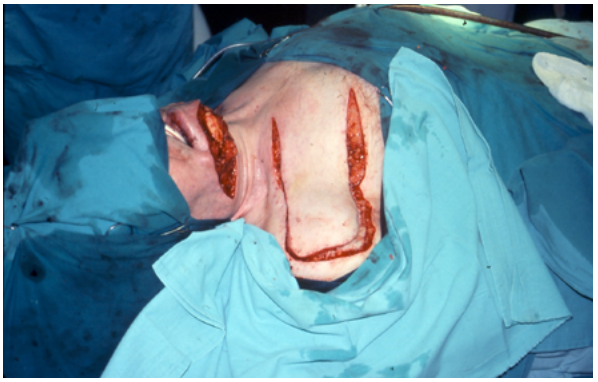

Figure 2. Range of flap preparation

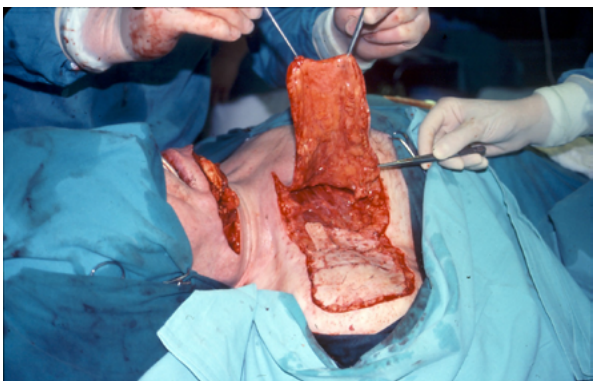

Figure 3. The deltoid-pectoral flap is dissected and lifted into recipient site

Figure 4. First stage of treatment with a deltoid-pectoral flap grafted into the receipt site

Figure 5. The final result of the treatment with a deltoid-pectoral flap

technique of reconstruction with the pectoralis major has become one of the most basic and most often applied in reconstructions of defects within the head and neck.

Pectoralis major is a triangular muscle belonging to the superficial muscles of the chest. It superior origin is at the medial part of the clavicle, the anterior part of the sternum and the cartilage of the ribs I-VI, anterior lamina of rectus sheath, laterally on the crest of the greater tuberosity of the humerus.[7]

Classically, the myocutaneous flap consists of the cutaneous island and a part of the pectoralis major. It is possible to enrich the flap with a piece of rib to reconstruct bone defects. The flap is grafted in the orofacial region with muscular pedicle under the skin of the neck.

Figure 6. Planned range of pectoralis flap dissection

Figure 7. Status post flap transplant in the chin area

Flap vascularisation mainly consists of: thoracoacromial artery, branches of internal thoracic artery and lateral thoracic artery, vascularisation is defined as type V according to Mathesand Nahai. This flap is supplied by C5–C7 lateral thoracic nerve and the medial thoracic nerve C8, Th1. Axial muscle vascularisation and perforating branches which supply underlying skin allow rapid healing of the rotated flap even in the previously irradiated or infected field. Since its first description, many modifications, improvements and extensions of clinical indications have been made. Elongated flap or a flap with elongated external pedicle have been used to reconstruct deficits in the upper face. On the other hand, a double-sided flap covered on the internal part with a free skin graft or a sandwich flap are useful for reconstruction of the full thickness of the cheek.[15] The donor site on the can be closed initially. Pectoral flaps are usually well tolerated, in a variety of studies total flap necrosis have occurred in 1%, 1.5%, 3%, 7% of the cases.[16-19] Partial necrosis was much more common – in 14% of patients over 50% of the flap was subject to necrosis in Schusterman's studies.[20]

The advantages of the pectoralis major flap is its size, strong axial blood supply, the possibility of simultaneous use with other flaps and a small number of complications in the donor site. This flap also has disadvantages: in men the hairy part of the flap is inserted into the mouth cavity, different coloration than the skin of the face, postoperative scars and deformation of the chest and breast in women, loss of respiratory function, especially with simultaneous damage to the XI nerve.[21,22]

Free forearm flap

The cutaneo-fascial flap supplied by the radial artery often referred to as the Chinese flap, it was first described in 1981 by Yang.[1] The radial flap is a thin plastic flap that is perfect for reconstructing soft tissue loss in the mouth and throat. In addition, it is possible to enrich it with a fragment of radial bone, tendon, radio-brachial muscles and nerve fragments, which enhances its benefits.[23] Reconstructing the sensory nerve allows much faster and better rehabilitation of speech, swallowing and chewing. The major disadvantages of this flap are partial limitation of the upper limb function, the necessity of taking free skin grafts to provide the receiving place and the possibility of pathological fractures after the grafting from the radial bone. The arterial vascularization originates from the radial artery, venous drainage is done via the radius vein or two veins that accompany the radial artery.[1] Before the formation of the flap, an Allen test should be performed to assess the function of the superficial artery, which provides good vascularization of the hand after radial artery excision. Allen's test consists of simultaneous compression of the radial and ulnar arteries, after pressure release on the ulnar artery, the circulation should return in the whole hand.[24]

At the recipient place of the arterial anastomosis is performed, usually end to end type, in the first place with neck vessels: facial artery, laryngeal artery. Depending on the vein diameter, end to end anastomosis is performed, e.g. with facial vein or end to side if there are large differences in the diameter of the vein, e.g. internal jugular vein. Planning and preparation of the flap, anastomosis and grafted flap in the recipient site are presented in the figures.

Figure 8. Range of flap dissection

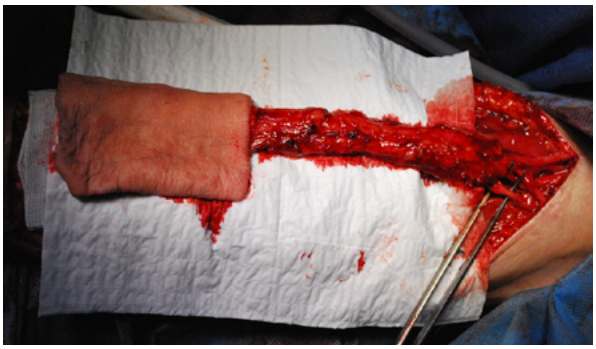

Figure 9. Dissected Chinese flap with marked radial artery on the tweezers

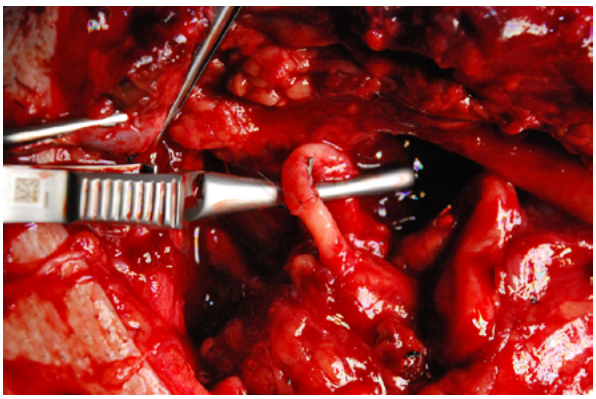

Figure 10. End to end anastomosis of the radial and facial arteries

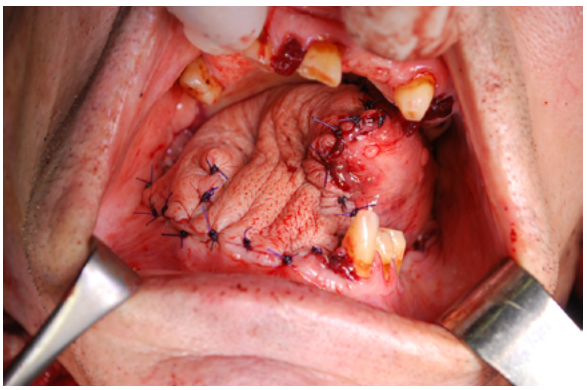

Figure 11. Grafted flap after hemiglossectomy with the resection of the bottom of the oral cavity

Conclusion

The choice of the right reconstructive method should be done individually taking into account the location, volume and structure of the tissue defect, donor sequelae and surgeon experience. Modern surgical techniques and technological advances have contributed to a significant improvement in the effectiveness of tissue reconstruction in patients after extensive resections in the head and neck. The use of microvascular free flaps is an effective and versatile reconstructive method in head and neck surgery.

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CASUISTIC PAPER

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A renal abscess in the isthmus of horseshoe kidney

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ABSTRACT
Horseshoe kidney (HSK) is the renal fusion anomaly caused by disturbances in embryonic development when the kidneys are fused together in the lower or upper pole forming an isthmus. The most common disorders in urinary tract related to horseshoe kidney are ureteral pelvic junction obstruction, urinary tract infection and urolithiasis. In our study, we present a rare case of an abscess in the isthmus of horseshoe kidney after extracorporeal shockwave lithotripsy on the right kidney was performed. The patient has had recurrent urolithiasis and underwent 4 treatments on the left kidney in the past without complications.
Keywords. horseshoe kidney, renal fusion, urinary tract infection, renal abscess

Introduction

Horseshoe kidney (HSK) is one of the most common renal fusion anomalies. It occurs in approximately 1 of 400 women and occurs twice as frequently in men.[1,2] This abnormality is caused by disturbances in embryonic development. The kidneys are fused at their lower or, more rarely, upper poles.[4] The kidneys are connected by an isthmus formed of either parenchyma (80–85% of cases) or fibrous tissue (15–20%).[2]

There are three anatomical anomalies that characterize HSK: ectopia – the kidneys are located more inferiorly than a normal, malrotation – the renal pelvis is forward facing; vascular changes – the HSK is supplied by additional arteries, originating from the abdominal aorta or the common iliac arteries.[1,4] HSK is associated with certain urinary tract disorders. The most common are ureteral pelvic junction (UPJ) obstruction (35%), urolithiasis (20–60%) and infection (27–41%).[2] A rare complication of upper urinary tract infections are purulent lesions of the kidney. In fact, urinary tract infections occur in approximately 30% of patients with horseshoe kidney.[2]

In our work we present a rare case of abscess formation in the isthmus of a horseshoe kidney after performing extracorporeal shockwave lithotripsy (ESWL).

Case report

A 65 year old patient with recurrent urolithiasis in a HSK came to the emergency room with a fever increasing to 40°C over 3 days. He reported being at 12 days post-ESWL of the right kidney. ESWL were carried out using a Dornier Compact Sigma device with an electromagnetic shock wave generator. During the pro-

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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Balawender K, Orkisz S, Biela P, Sęk-Mastej A. *A renal abscess in the isthmus of horseshoe kidney*. Eur J Clin Exp Med. 2017;15(3):279–281. doi: 10.15584/ejcem.2017.3.13

cedure, 3000 pulses with 14.2 J of energy were used with a 1 Hz pulsation frequency. Four successful ESWL's of the left kidney were performed in the patient over the two previous years with no complications. The size of crushed stones in both kidneys did not exceed 10 mm.

In the physical examination at admission there were no significant deviations from the norm. In laboratory studies there was no significant changes except slightly elevated procalcitonin (0.59 ng/ml) and C-reactive protein (10.30 mg/L). Urine culture with 10^2 CFUs/mL of Streptococcus spp. blood was negative. Transabdominal ultrasonography (TAUS) revealed several 4–6 mm stones in the right kidney and a 5 mm stone in the middle calyx of the left kidney. Abdominal obesity of the patient (BMI 26) and intestinal gases prevented assessment of isthmus using TAUS.

Empirical antibiotic therapy (1500 mg cefuroxime twice a day), painkillers and hydration therapy were initiated on the day of admission.

Due to persistent fever, a CT scan of the abdomen was performed. CT revealed horseshoe kidney (renal merging with each lower pole), with a hypodense area in the isthmus 38 × 25 mm in size, undergoing heterogeneous contrast enhancement, a finding corresponding with abscess formation (Fig.1–2). CT angiography showed supernumerary renal vessels of both kidneys. On the right side two renal arteries and renal veins were visualized, while on the left side early division of the renal artery trunk was observed.

Based on the results of laboratory tests and CT scans, the antibiotic therapy was modified. The patient received 1000 mg of cefotaxime 3 times a day for 7 days and after 3 days, gentamicin 160 mg once a day for four days. Hydration therapy and painkillers were also used. The patient's condition improved as a result of treatment – the pain subsided and the fever abated.

After 4 months, follow-up tests were performed. CT scans show HSK with a few stones, an isthmus areas without contrast enhancement and a total regression of the abscess.

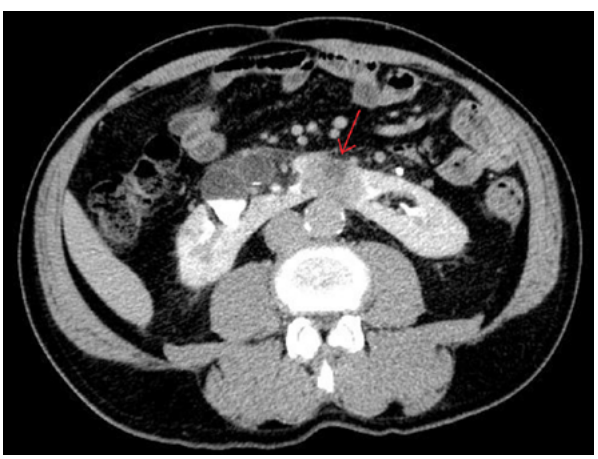

Figure 1. CT scans of the horseshoe kidney

Discussion

Horseshoe kidney is an asymptomatic developmental anomaly, which is usually detected incidentally during imaging studies performed for other indications.[1] 20–60% of patients develop nephrolithiasis.[2,19] An increased risk of infection is the result of vesicoureteral reflux, urinary obstruction and nephrolithiasis.[1]

The basic diagnostic test to assess nephrolithiasis is TAUS. The limitations of ultrasound as a diagnostic test in HSK include difficult test conditions (for example, obesity) and an isthmus composed of fibrous connective tissue.[1] In the presented case, the density of the isthmus was the same as that of the renal parenchyma. The patient's abdominal obesity (BMI 26) made it impossible to precisely evaluate the isthmus using TAUS.

Digital subtraction angiography, MRI, CT and especially CT- 3D, are considered the best imaging methods for horseshoe kidney.[1,3] In our case, the diagnosis was performed on the basis of enhanced CT.

HSK may be formed by midline fusion (42%) or lateral fusion (58%, with 70% on the left).[4] In the presented case, the horseshoe kidney showed asymmetrical, left-sided fusion of the lateral part of the kidney with the external pelvis of the right kidney. Presumably, this could have caused the complications after ESWL on right kidney, while the 4 previous treatments performed on the left kidney did not cause any complications.

Minimally invasive treatment methods of nephrolithiasis on horseshoe kidney include ESWL,PCNL and RIRS.[17,18]

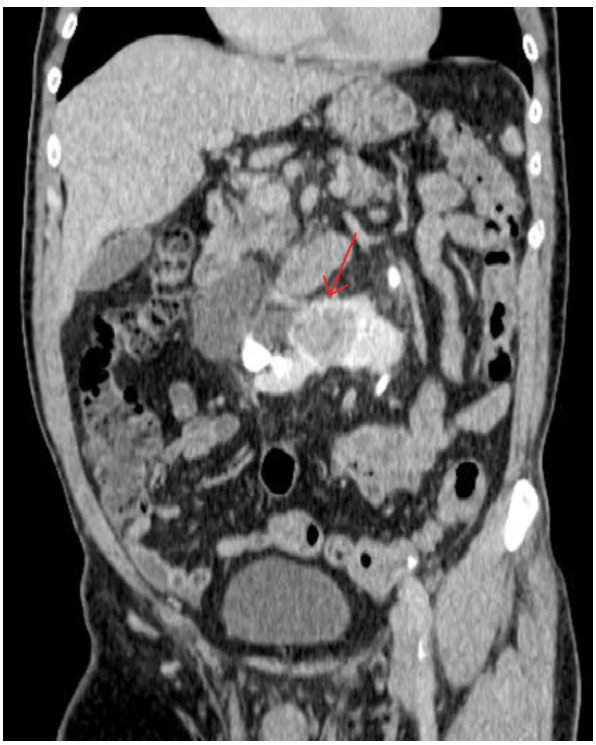

Figure 2. CT scans of the horseshoe kidney

A factor significantly limiting the effectiveness of ESWL and other endourologic treatments is the structure of the renal collective system – this is especially significant in horseshoe kidney. In the case described above, ESWL treatment was effective, stone-free rate (SFR) of the individual treatments based on ultrasound follow-up was high at >60–70%. An alternative to extracorporeal lithotripsy for the treatment of kidney stone disease in HSK is Retrograde intrarenal surgery (RIRS), especially in the case of calculi in the lower pole calyces (SFR for ESWL ranges from 25–95%).[9,14,15]

Urinary tract infections occur in approx. 30% of patients with horseshoe kidney.[1] The most important contributing factors to infection in HSK are reflux disease, stasis and stone formation.[2] Post-ESWL infection affect 7% to 23% of patients.[8,16] Suppurative infections of the kidney are uncommon. Renal abscesses are three time more common in males.[10-12] Another predisposing factor for the development of purulent changes in the kidneys during the course of infection is impaired glucose levels.[5] In our case we observed impaired fasting glucose (118 mg / dL).

Successful treatment of renal abscess requires prolonged intravenous and oral antibiotics while surgical or percutaneous drainage is reserved for non-responders.[10] In our case due to anatomical anomaly of the kidney and atypical localization of abscess the first choice treatment was empirical antibiotic therapy. The duration of antibiotic treatment is determined by the patient's clinical response and the current recommendations are to continue parenteral antimicrobial therapy for at least 24 to 48 hours after clinical improvement and oral antibiotic therapy (an additional two weeks of therapy).[13,20]

Conclusions

Horseshoe kidney (HSK) is one of the most common renal fusion anomalies. HSK is associated with urinary tract disorders especially urolithiasis and infection. A rare complication of upper urinary tract infections are purulent lesions of the kidney. A renal abscess in the kidney after ESWL is an unusual case with need immediately intervention. Successful treatment of renal abscess requires prolonged antibiotics or surgical percutaneous drainage. In our case due to anatomical anomaly of the kidney and atypical localization of abscess the first choice treatment was empirical antibiotic therapy.

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CASUISTIC PAPER

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Care and nurture patient with Multiple Sclerosis, mechanically ventilated at home – a case report

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ABSTRACT

Mechanical ventilation at home is one of the methods of treatment of respiratory failure, but it is not yet widespread in Poland. Domestic ventilation can increase quality of life of patients who can remain at home under the care of a therapeutic team. Multiple sclerosis is one of the diseases that require mechanical ventilation. This disease, leds in many cases to respiratory failure. Here, we describe a case of the patient who has suffered from multiple sclerosis for 23 years and is now mechanically ventilated at home. The paper presents the current state of the patient, problems that affected her and her family, and what changes have occured since the time of her diagnosis with MS.

Keywords. case report, mechanical ventilation at home, respiratory failure, multiple sclerosis

Introduction

Home mechanical ventilation is a way of long-term care, which in recent years has been widely recognized and used in Poland.[1-3] It is a system that has become extremely important for people with respiratory failure in the course of various diseases. Thanks to home ventilation, the patient has the ability to stay in his or her environment, which increases his or her mental comfort and avoids the complications associated with hospital infections.[1,4,5] The task of medical staff, in addition to physical care, is also to motivate the patient to make an effort to maintain mental fitness.

In addition, training is provided for the families of patients, increasing the number of people taking care of home ventilated patients.[1,6,7] The number of young people affected by multiple sclerosis (MS) is increasing worldwide.[8-11] It is estimated that in Poland there are about 50-60 thousand patients with MS.[12] Authors of the study attempted to analyze the problems of MS with mechanically ventilated patients in home conditions using the individual case method.

A case report

Twenty-three years ago, the patient was diagnosed with multiple sclerosis, but initially it was unknown whether SM was a cause for growing health problems. According to the interview, two months after the birth of her daughter in 1990, the patient began to suffer from hypopituitarism, which she described as "leg confusion". Due to the fact that the patient experienced a difficult child-

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Participation of co-authors: A – Author of the concept and objectives of paper; B – collection of data; C – implementation of research; D – elaborate, analysis and interpretation of data; E – statistical analysis; F – preparation of a manuscript; G – working out the literature; H – obtaining funds

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birth, the doctor considered that this was a symptom of postpartum fatigue.

However, a neurological consultation was commissioned. Despite the suspicion that this may be the beginning of multiple sclerosis, the diagnosis of the disease was concealed. The patient was started on hormone treatment, however, she was not informed what side effects the drugs may have for her and her child.

The patient again became pregnant. The doctor considered that the only solution to this situation was abortion, because hormone therapy can damage the fetus and its abstinence can lead to more severe symptoms. The patient refused the abortion and stopped taking hormones for the care of the baby. Despite treatment at the beginning of pregnancy, the patient gave birth to a healthy son. A year after this, a lumbar puncture was performed and she was finally diagnosed with MS. The patient accepted the diagnosis from the beginning. Unfortunately, neither doctors nor nurses taking care of her at the hospital provided information on what multiple sclerosis is and how the life of the patient and her family can change. She inquired about MS from hospitalized patients who had been suffering from the disease for a long time. In April 2011, mechanical ventilation was started for the patient because of exacerbations of respiratory failure. Neither the patient nor her family were able to determine how often hospitalization was necessary. The last hospitalization took place about a year ago due to the need to replace her tracheostomy tube. However, it is important to mention that her anestesiologist visited her home every week and he checked that the respirator was operationg properly. Currently, according to the recommendations of the doctor, the patient should be ventilated 30-40 hours per week. For the patient, the most comfortable ventilation time is at night. Currently, the patient is taking the following drugs: Furagine (due to recurrent urinary tract infections associated with the catheter), Dexamethasone (due to muscle spasms), and Clexane (low molecular weight heparin due to continuous immobilization of the patient and thromboembolic disease diagnosed in the past). The most severe respiratory problems occur during respiratory tract infections, but this does not happen frequently. One year ago, the patient had had a respiratory viral infection with persistent wheezing. The patient has breathing problems on a daily basis. Due to surgery in the past (pulmonary thrombotic thrombosis due to pulmonary embolism in 2010), during which a sternotomy was necessary, the patient has a feeling of tightness in the chest. The major problem is mucus build up in the patient's airways. Sometimes the patient's husband has to aspirate her every 5 minutes, however, there are days when aspirating is needed less than 3 hours. The patient feels the presence of respiratory secretions, but because of tracheotomy, she can not cough. Common respiratory ailments common are felt when the patient lies on her side, so usually she sleeps on the back. The probe is changed on average every 1.5 months. Currently, the patient is trying to take a small amount of fluids orally and she is fed 3 or 4 servings a day by Nutrison (750 ml). The patient believes that she is well nourished and has recently gained weight. Despite the probe in the stomach, the patient has not forgotten the taste of some dishes. Her favorite food is pizza and she hopes to taste it again in the future. Due to the progressive form of the disease, many actions can not be carried out by herself, such as bathing, feeding by the probe, dressing, preparing medicines, etc. If weather allows, the patient is happy to spend time outside on the terrace. The patient is not able to use the toilet herself. She could not care for her children in the past because she needed care herself. The patient sometimes feels pain from the tracheotomy tube. This pain depends on the position of the tube and the oppression of neighboring structures. Pain occurs at different times and passes when the tube itself "sets itself up" in a convenient position. The patient does not feel pain in her bones or joints and does not require to use of painkillers. One of the symptoms that accompanies the patient is constipation which is probably due to limited physical activity. Our patient does not complain about bloating, and she does not have diarrhea. The patient also does not feel any cardiovascular discomfort. One main problem is periodic swelling of her lower limbs. However, the the patient has nystagmus which prevents her from reading. Nystagmus appeared in the past before the thrombarteriectomy operation in 2010. The patient lies down to sleep around 23:00 and sleeps up to 5:00 hours, but later stays in bed after waking up. Her husband prepares breakfast and helps her with going to the toilet at around 10:00 hours. During the day, the patient does not sleep. For a half a year in the past, she had to stay in bed when rehabilitation was taking place. For the past eight years, she has been using a wheelchair. In the past, she moved with two orthopedic balls. At present, she is unable to move independently, and thanks to her family, she can spend several hours a day on the terrace in front of her house. The patient is not able to stand up or to stand alone. She can not sit on a bed or in a trolley. The patient uses a diaper pad and she has Foley's catheter inserted into the bladder. Since the patient is completely immobilized, home and financial affairs are dealt with by the patient's husband. During the interview the patient communicated verbally without any problems. She can also talk on the phone, provided she has a superimposed "plug" on the tracheotomy tube. Sometimes the patient has to take longer breaks in the conversation. During the interview, the patient admitted that physical fatigue is felt with changing aura. In the past (October 2010), she was found to have a bedsore on the bone. During hospitalization, the bedsore reached

IV° in the Torrance scale. After the patient was discharged home, the only drug that did not cause an allergic reaction was Solcoseryl. Currently she has a bedsore on the right buttock I Torrance's scale. Other sores do not occur. As mentioned earlier, the patient has accepted the disease. There is no problem with expressing emotions, but she does not need to talk about the disease because she thinks she is healthy enough not to have to think about it. According to the interview, the patient now gets angry faster, which is not comfortable for her, because she knows that she hurts her family the most. The patient tries not to think about "what could have been", and lives from day to day. She does not want to hold on to bad thoughts and hopes that she will always remain positive in the fight against her illness. Health is the most important value for the patient, and she feels no emptiness in her life because she is surrounded by a loving family. At home she feels safe. The patient does not compare herself to her peers, and the only thing she wants is to have good care and a normal life as far as possible allowing for the disease. Despite the great care that the family provides, the patient feels limited socially. Holidays, birthdays and name days are spend at home with family rather than visiting family and friends due to her condition. She has a son and a daughter who are already adults and despite the illness she does not feel like a bad parent. She believes that her children have witnessed her illness from the beginning and remember their mother as always sick. Not only work, but also daily life has changed since the onset of the illness. The biggest support for her is her family. In the past, the patient was a member of the MS Society. Due to the severe financial situation, she was unable to pay contributions to the association and she was discharged. Before the onset of MS, one of her favorite activities was to knit and read books. Because of the disease, she can no longer enjoy these hobbies. The patient does not have any pets and enjoys relaxing on the terrace with her family. She is interested in nature (she likes to watch nature films), she also likes to listen to music. At the beginning stages of the disease, the patient was able to handle official affairs by telephone. The disease did not affect her religious practices. Prior to the onset of symptoms, the patient attended church regularly. Both in the past, and currently, the patient does not use the Internet. She does not like to read and listen about her illness from others. She also does not read information from the "forums" dedicated to people with MS. Currently, the patient is very happy with the treatment and care by medical staff. She does not feel that her condition has improved, but she does not think she is getting worse either. Sometimes she feels like her breathing is getting worse. Treatment continues as directed by her doctor. It was very helpful for her to have rehabilitation, thanks to which the patient does not have contracting muscles, and she is able to raise her hand slightly. According to the patient, the therapeutic team fully fulfills their obligations. The only problem related to the treatment are problems with the device for suctioning secretions from the bronchial tree. The problem occurs when there is a temporary lack of electrical current. At present the family is trying to organize a device for suctioning secretions from the bronchial tree that could work regardless of whether or not the current is on. The data in the information sheets show that the patient was originally diagnosed for non-infectious gastroenteritis and colitis. Also, that a concomitant pulmonary embolism was reported. The patient was admitted to the unit due to diarrhea with a fever of up to 40 °C, which lasted for a week. After the surveys, viral and bacterial etiology of diarrhea was excluded and had subsided after treatment.

During hospitalization, the results of gasometrics were as follows:

pH = 7.46; pCO_2 = 21.5 mmHg; pO_2 = 60.5 mmHg; HCO_3 = 14.6 mmol/L; BE = 6.9 mmol/L ; arterial blood saturation was 92.9%.

Computer tomography showed pulmonary embolism and after consultation, the patient was transferred to a pulmonology department. In the pulmonology department respiratory failure was reported. Oxygen therapy was applied with an oxygen mask at 6 L/min. Echocardiography showed pulmonary hypertension of about 100 mmHg with features of right heart overload. Included in the treatment was Fraxiparin at a dose of 0.8 ml/d. During hospitalization, there were problems with the intake of fluids (choking). For this reason, the supply of fluids was supplemented with intravenous infusion under controlled central venous pressure. Despite the applied treatment, no improvement was made and the patient continued to require oxygen therapy. Saturation ranged between 85-89%. The patient was transferred in stable condition to the Silesian Heart Disease Center in Zabrze. Before discharge from hospital, saturation was 94% at 5 L/min oxygen supply. Upon admission to the Silesian Center for Heart Diseases, pulmonary embolism, pulmonary hypertension, respiratory failure in pulmonary embolism deep vein thrombosis was diagnosed. The patient was consulted by a cardiologist and was qualified for the treatment of pulmonary embolism (healing doses of Fragmin). After consultation, the patient was again transferred to the Department of Pulmonology at the University Hospital in Cracow. During admission to the hospital the patient needed oxygen therapy with a flow of 4-5 L/min. The patient was treated with pulmonary thrombosis therapy for pulmonary embolism with clinical features of pulmonary hypertension with

respiratory failure requiring oxygen supply through an oxygen mask of approximately 8 L/min. After surgery, the patient was intubated on controlled breath. The patient was extubated after 14 hours. In the 3rd day after surgery, during oral feeding trials, she choked on food and then began to develop respiratory failure with atelectasis. The patient was again intubated and mechanically ventilated. On the day of discharge, the patient was conscious and breathing on her own. It was decided to install a tracheotomy tube through which passive oxygen therapy was performed. During the next visit in the hospital the patient was in stable condition but required chronic oxygen therapy. On the sixth day, a general worsening condition of the patient occurred with fever and vomiting. After surgery consultation, parenteral nutrition was ordered. In addition, it was decided to implement a fluid supply through the gastric tube. Before the discharge to home, the patient was informed about the need for mechanical ventilation at home. It was recommended to use passive oxygen therapy for the tracheotomy tube with 4 L / min oxygen, periodically connected to ventilator. A stable, uncontrollable patient has been at home for many days and the family has been trained how to provide home-based care. After a month, the patient was re-admitted to the Pulmonary Clinic, where a tracheotomy tube was exchanged during the visit. The condition of the patient has improved significantly in recent months. Before discharge to home, the Foley catheter was changed to silicone. The patient was discharged in good condition to home. Both the patient and her family have been trained about respiratory system treatment and toilet use. If necessary, they can be in immediate contact with the physicians and people responsible for the mechanical ventilation of patients at home. The study was conducted with a patient aged 48 years who resides in the Małopolska area. Currently, the only source of income is a pension of about 1000 PLN. In the past, the family was additionally dependent on the salary of the patient's husband, but 2 years ago he had to resign from work to provide his wife with constant care. The patient lives with her family at home.

Discussion

Despite the many benefits of mechanical ventilation, it is associated with the risk of complications. People who have recently started home ventilation often feel anxiety and fear about their own health and well-being, as well as their dependence on respirators. Families of patients are worried about whether they will be able to handle the situation.[4,5] The problems of mechanically ventilated patients are complex. Patients report gastrointestinal complaints (nausea, vomiting) related to, among other factors, with a swelling stomach. In many cases dysphagia occurs, which in consequence involves the need to insert a probe into the stomach. In addition, tracheostomy infection may occur, so special attention is paid to the care of the tracheostomy tube. In ventilated patients, there are problems with communication because the tube interferes with speaking and causes disturbed contact with the environment. Besides, there are problems related to maintaining personal hygiene. The sick do not have the strength to go to the toilet on their own, clean their whole body or dress up in clean clothes. Over time, this disability deepens and the patient needs "permanent" care. It is not possible that the patient can go to the toilet alone, and she can not control excretion. Patients who have been diagnosed with multiple sclerosis have to get used to the "new life". Thanks to home mechanical ventilation, patients improve their comfort of living through a more friendly environment created by family members and friends.[13-15] When the disease has a progressive character, there are new problems every day. When acute respiratory failure becomes acute (passing through chronic), patients become suddenly addicted to respirator treatment. Few people have the opportunity to use home respirator treatment, so these patients are condemned to hospital treatment. This is related to the fact that the patient has to give up many things. A respirator does not give one the opportunity to leave home, meet friends or enjoy most hobbies. It must be borne in mind that patients with MS often fall into depression, which is related to dysfunction in the social and occupational roles. The problem is also the cost of care and treatment. Patients need to constantly use diapers, preparations for skin care etc. It is considered necessary to insert a catheter into the bladder, which is related to further problems, like urinary tract infection. In MS, the problem may be excess secretion from bronchi due to weakness and loss of respiratory muscles. Other problems include paresis, muscle cramps, muscle weakness and fatigue, and pain associated with it. These symptoms worsen with the progress of the disease.[16-20] It is important for a patient in the advanced stage of multiple sclerosis to prevent bedsores to which he or she is exposed as one spends the most time in bed or in a wheelchair. Despite many studies conducted by scientists, no drug was developed that could cure patients with MS.[21] Considering the above problems, we can see that patients in the advanced phase of the disease are heavily dependent on their family and/or friends.[4,13] Literature indicates that smoking is a major problem for people with MS, as Fijalkowski mentioned in his article.[22] An important issue in these people is rehabilitation. According to Woszczak, rehabilitation should be carried out in such a way that it also covers the social and psychological problems of the sick person.[23] In patients with MS it is very important to show respect and concern to them.[24]

Summary

Patients who suffer from Multiple Sclerosis are exposed to many of the dangers associated with the onset of the disease. Mechanical ventilation at home is an important contributor to mobilizing patients and, in addition, allows them to enjoy every day despite the progression of the disease. Patient ventilation at home has a positive effect both on the convalescence of patients and their families and the desire to care for patients with MS.

Conclusions

1. Multiple sclerosis (SM) is a serious disease that has led to respiratory failure requiring mechanical ventilation at home, which allows life in a friendly environment.
2. The patient now tolerates mechanical ventilation well and the family is able to look after her and help meet her daily needs. However, a large deficit exists in self-care due to the advanced disease.
3. Despite the progressive of the disease, the patient is in good mental condition and accepts her state of health.

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CASUISTIC PAPER

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Assessment of the effects of Proprioceptive Neuromuscular Facilitation therapy on the improvement of motor function in a patient after total hip replacement – a case study

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ABSTRACT

Hip osteoarthritis is a serious clinical and social problem. The number of patients who suffer from degenerative changes in the hip joints and require endoprosthesis-plasty is constantly increasing. This paper presents physiotherapeutic activities based on Proprioceptive Neuromuscular Facilitation (PNF) which optimize a patient's mobilization using the reserves in their body fully to make improvements in movement and to regain lost functions for achieving beneficial therapeutic effects. The aim of the study was to evaluate the influence of PNF therapy on changes in muscle strength, mobility, and gait pattern in patients after Total Hip Arthroplasty. The case described here regards a 63-year-old woman diagnosed with left hip osteoarthritis who had Total Hip Arthroplasty. The patient was examined twice before and after PNF therapy. The range of mobility of hip joints, level of pain, muscular strength and gait were assessed. Applied PNF therapy, including dynamic (eccentric, concentric) and static muscle training, post-isometric relaxation, stabilization and control in the stance phase, resulted in improved hip joint mobility, muscle strength, gait pattern and pain reduction in the patient. The case study demonstrates that a short (two-week) but intensive (over two hours per day) PNF therapy positively influenced selected motor functions after Total Hip Arthroplasty.
Keywords. hip joint, osteoarthritis, endoprosthesis plasty, PNF method, total hip arthroplasty

Introduction

Osteoarthritis is one of the most common motor disorders in people over 40. According to the World Health Organization, 10% of the world population aged 60 or over have symptoms of osteoarthritis, although only 25% complain of it. Deformities and degenerative changes of the hip joints are caused by congenital and acquired defects, traumas, metabolic diseases, excessive joint overload, being overweight, too little or a lack of physical activity, bad body posture and many others causes.[1,2]

The condition is often accompanied with severe pain in the groin area, sometimes in the buttocks, and pain in the knee might also occur. Pain occurs during gait and on exertion, and when condition progresses, the symptoms occur also at rest, sometimes at night.[3,4]

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The aggravation of the disease limits active and passive range of motion (ROM) in the joint, affects the strength of extensors and abductors. At later stages, muscle atrophy in the lower limb and limping may also appear. The consequence of pathological gait pattern in the elderly are falls, with most frequent complications being fractures in the upper femoral segment. The increasing number of these fractures in elderly people poses a significant medical and social problem and are a heavy burden for institutions taking care of the sick.[5-7]

An effective treatment for hip problems due to degenerative changes or fractures is endoprosthesis plasty (alloplasty), considered one of the greatest advances of medicine during the last century. This surgery allows patients to regain the ability to independently perform activities of daily living, gives independence and significantly improves the quality of life. Endoprosthetic surgery is one of the most common operations on the hip joint.[8-9] According to National Health Fund (NHF) statistics in Poland, 46,685 hip joint endoplasties were performed in 2015, of which 37,126 were total hip endoprosthesis, 8,898 were partial endoprosthesis, and the largest population of patients were people aged 60-69.[10] This procedure is successful in 90-95% of cases and the patient returns to normal functioning after several months. The main aim of the surgery is to relieve pain and restore proper joint function, correct the disturbed joint axis and restore stability, which leads to an improved quality of life for patients. Endoprosthesis plasty is one of the most extensive orthopedic surgeries in which permanent elements of the prosthesis are set to restore, as closely as possible, normal joint function.[11-13] Depending on the type of bone binding, cement and cement-free endoprosthesis can be distinguished. In cement-free endoprosthesis, an acetabular cup is inserted by pressing (Press-fit, Eco-fit) or screwed to the bone, the stem is attached to the femur by means of a wedge. Both elements of the endoprosthesis are metal with a porous surface, which causes the accretion of the prosthesis to the bone of the patient over time. In cemented endoprostheses there is a polyethylene pan, a metal stem and a metal or ceramic head, and the elements are attached to the bone with a bone glue called cement.[14-16]

The Proprioceptive Neuromuscular Facilitation (PNF) concept was used in this study which focuses on proprioception and joint mechanics to facilitate movement similar to natural movements in the activities of daily living. Proprioceptive Neuromuscular Facilitation therapy implies a multi-faceted therapeutic approach, emphasizing the essence of motor control as a determinant of optimal function restoration.[17-18] In the PNF concept, it is important to develop appropriate motor strategies, a positive approach with minimal pain, attainment of tasks, and use of a patient's physical and mental resources and to maintain motivation for further activity. Proprioceptive Neuromuscular Facilitation therapy, through optimal patient mobilization and full use of body reserves, allows for faster and more efficient return of lost functions and thus achieves very good therapeutic effects.[19-21]

The aim of the study was to evaluate the influence of PNF therapy on the change in muscle strength, mobility and gait pattern in the patient after Total Hip Arthroplasty.

Case study

The presented case concerns a 63-year-old woman who was diagnosed with left hip osteoarthritis in 2008. In July 2015, she had left hip arthroplasty with EcoFit endoprosthesis with posterio-lateral approach and subarachnoid anaesthesia (up to 2 hours). On the second day after the operation, a hip joint X-ray was performed which indicated that the components of the prosthesis were correctly positioned in the joint. A drain was also visible in this area. The operation went without complications and medication was administered according to recommendations. Rehabilitation was implemented starting from the first day after surgery and included respiratory exercises to improve lung ventilation, isometric exercises to strengthen the muscles of the operated limb, and safely sitting on the bed with legs down. On the second day after the procedure, the patient stood with the assistance of a walker and took her first steps. After rehabilitation, the patient walked with crutches without loading the operated limb. She was discharged in good general and local condition on the fourth day after the surgery. Due to the condition of the patient, she was referred for home rehabilitation, which took place in September 2015, two months after the surgery.

The rehabilitation program included PNF training aimed at improving the range of motion in the joint, muscle strength, pain reduction, and gait training. The patient was given two weeks of PNF therapy in the following areas: 1) a combination of isotonics, using dynamic (eccentric, concentric) and static muscle contraction to improve muscle coordination, strength and endurance; 2) hold relax post-isometric muscle relaxation - using the phenomenon of muscle relaxation after tension to improve ROM, reduce pain and promote relaxation (Photo 1, Photo 3); 3) stabilizing reversal and rhythmic stabilization – to promote stability, balance, and to increase muscle strength by pelvis control while sitting (sagittal plane) and standing (frontal plane); 4) trunk stabilization through shoulder and pelvic girdle (Photo 2, Photo 3, Photo 4) gait training with pelvis and trunk control (Photo 3) and walking with high knee lift and training for control in the support phase of the lower limb using approximation - to improve stability, facilitate balance reactions, muscle stimulation and irradiation (the spread of the response to stimulation)

Photo 1. Post-isometric relaxation of the iliopsoas

Photo 2. The control of pelvis position in sitting (sagittal plane)

Photo 3. Stabilization of the pelvis in standing (frontal plane) in the phase of support on the operated lower limb

Photo 4. The training of the phase of support on the operated lower limb using the phenomenon of approximation and irradiation through the upper limbs

Photo 5. Gait assessment using the patient's walk test

through the upper limbs (Photo 4). The rehabilitation program was implemented two months after the operation. In the first week, the focus was mainly on dynamic and static muscle work, pain reduction and pelvic control, while in the second week on regaining a normal gait pattern. The training was performed daily in the afternoon, the time of therapy was more than 2 hours a day. The patient had no other physiotherapeutic treatment during two week training program.

The patient was assessed twice, before and after PNF therapy, under the same conditions and with the same tests. Measurements used in the patient were: assessment of ROM with a goniometer, pain assessment using the Laitinen scale, assessment of muscle strength using the Lovett scale, and evaluation of patient's gait with a patient's walk test. Assessment of ROM was performed in both hip joints according to the principles established by Skolimowski, [22] without measuring adduction and external rotation in the operated joint due to the risk of dislocation of the prosthesis. Laitinen Scale (The Laitinen Modified Questionnaire Indicators of Pain) is a subjective and point-based tool for assessing the level of pain, based on the interpretation of specific factors directly related to pain. The scale provides information about both the quality of the pain and its intensity. Patient had four indicators assessed including pain intensity, pain frequency, frequency of analgesia, and restriction of motor activity. Each indicator was assigned a score from 0 to 4, where 0 means no problem, and 4 is the most problematic . The maximum score for a patient is 16, which is a very negative result, and the lower the score in Laitinen scale, the higher the improvement recorded in rehabilitation.[23,24] A detailed description of the score is presented in Table 1.

The patient's muscle strength was measured with Lovett's scale in terms of extensors (gluteus maximus and muscles co-working when knee is in extension:

Table 1. The Laitinen scale - detailed scoring system

Indicator	Problem assessment	Score
Intensity	Painless	0
	Mild	1
	Moderate	2
	Severe	3
	Unbearable	4
Pain frequency	Absence	0
	Infrequent	1
	Frequent	2
	Very frequent	3
	Constant pain	4
Analgesics	Not applied	0
	Sporadically	1
	Regularly – little	2
	Regularly - lots	3
	Regularly - huge	4
Motor activity limitation	None	0
	Partial	1
	Limitation in professional activity	2
	Preventing professional activity	3
	Preventing independent existence	4

semimembranosus, semitendinosus and biceps femoris), flexors (iliopsoas and rectus femoris of quadriceps), and abductors (gluteus medius and tensor fasciae latae) in the operated hip joint.[25] The adductor test was omitted due to the risk of dislocation of the prosthesis. The gait test was performed using a walk test developed by the author (Photo 5). To perform the test, a stopwatch, tape to determine the starting point of the distance and a meter stick to measure the distance covered by the patient were used. The test consisted of going forward 10 steps at the patient's own pace. The patient normally used a crutch in her daily life, so it was also used for the test (before and after therapy). The time and the distance were measured for quantity assessment. Qualitative assessment included pelvic alignment, pelvic balance during movement, symmetry, step lengths, equal loading of each limb in the support phase (Trendelenburg sign +), and proper coordination of the upper limbs and the trunk with the lower limbs.

Discussion

The analysis of the obtained results showed that after the therapy there was an increase in ROM in all the planes both in the left hip (operated) and the right (normal) hip. The greatest improvement was observed in a 12° increase in flexion and a 9° increase in abduction in the operated hip joint. Extension improved by 4°, while internal rotation increased by 3°. A detailed comparison of ROM in both hip joints before and after the treatment is presented in Table 2.

Comparing the results of the pre-treatment and post-treatment assessment of pain in the subjective Laitinen scale, it occurred that the first and third indicator of this scale remained unchanged. In the second and fourth indicators regarding the frequency of pain and limitations in motor activity a decrease was found by 1 pt (Table 3).

The analysis of the results in terms of muscle strength in the Lovett's scale, showed improvement after treatment in each of the muscular groups of the oper-

Table 2. A comparison of ROM in the hip joints before and after the treatment

Type of movement	Test I	Test II	Difference
Extension in the operated hip joint	7	11	4
Extension in the other (normal) hip joint	11	12	1
Flexion in the operated hip joint	77	89	12
Flexion in the other (normal) hip joint	87	91	4
Abduction in the operated hip joint	20	29	9
Abduction in the other (normal) hip joint	30	33	3
Adduction in the operated hip joint	----------	- ----------	----------
Adduction in the other (normal) hip joint	23	26	3
External rotation in the operated hip joint	----------	- ----------	----------
External rotation in the other (normal) hip joint	28	30	2
Internal rotation in the operated hip joint	16	19	3
Internal rotation in the other (normal) hip joint	26	28	2

Table 3. Comparison of assessment of pain in the Laitinen scale before and after the therapy

Indicator [pts]	Test I	Test II	Difference
Intensity	1	1	0
Pain frequency	1	0	1
Analgesics	0	0	0
Motor activity limitation	1	0	1

Table 4. Comparison of obtained values of muscle strength in the operated hip in the Lovett's scale before and after the therapy

Lovett's scale	Test I	Test II	Difference
Flexion	4.5	5	0.5
Extension	3.5	4	0.5
Abduction	3.5	4.5	1.5

Table 5. Comparison of distance and time in the walk test before and after the therapy

Walk test	Test I	Test II	Difference
Distance [m]	5.6	6.4	0.8
Time [s]	31	27	4

ated hip joint. The greatest increase in muscle strength was found in the abductors by as much as 1.5 degrees. Flexors and extensors improved by 0.5 degree. The obtained values of muscle strength before and after the therapy are presented in Table 4.

Observational assessment of the patient's gait before the therapy showed significant deviations from the normal pattern. The patient's gait pattern was characterized by limping, a positive Trendelenburg sign, abnormal upper limbs and trunk rotations combined with lower limbs, patient's steps were short. Due to excessive caution and fear of pain, the patient limited the load on the operated limb and fixed the pelvis in an abnormal position. In the quantitative test after the therapy, the gait length improved by 80 cm while the time decreased by 4 seconds (Table 5). After treatment, it was also observed that the patient's gait became more confident, more symmetrical, and steps became longer.

The results suggest that short but intensive PNF therapy, including eccentric, concentric, static muscle training, post-isometric muscle relaxation and stabilization, positively influenced hip mobility, muscle strength, and gait. Numerous studies are available in the literature, among different patient groups, which also indicate beneficial effects of PNF.[17,18,26-28] Kabat and Knott were the first to describe the method as successful for in rehabilitating patients with paresis in Polio.[17] Song et al. reported that PNF method significantly increases flexibility, mobility, muscle strength and self-care in the elderly.[26] Ribeiro et al. demonstrated that PNF training improved motor function and functional efficiency in patients with hemiparesis after stroke.[27] Areas et al. reported that PNF therapy was also effective in increasing muscle volume and inducing muscle fibre modification,[18] therefore, this method is widely used in physiotherapeutical and sport training.[28]

Our studies showed that extension in the operated hip joint prior to PNF therapy was the most restricted. It can be assumed that this was due to the fixation of pathological pre-operation gait pattern. The observation of gait showed that the patient's pattern of gait was typical for the elderly, and that the patient's posture indicated a positive Trendelenburg sign. Weakening of the gluteus medius and minimus caused the pelvis to drop on the unloaded side. The patient's gait was cautious, uncertain with the small steps and flexion in the hips. The patient was anxious to load the operated leg, so she shortened the support phase on the operated limb, resulting in improper pelvic alignment and lack of upper and lower limb work. Likewise, Wrzosek et al. reported that the most common problems encountered in the gait after hip replacement surgery are fear to contact with the ground of the operated limb, the inclination to flexion body posture and incorrect work of the crutches and limbs.[29] Limitation of muscle function after hip arthroplasty involves i.e. hip flexors. This group includes the iliopsoas and quadriceps femoris, while the contracture of the quadriceps also leads to problems in ROM in the knee joint. As a consequence of the late implementation of rehabilitation, there may be flexion contracture and consequently an abnormal gait pattern.[30] Therefore, the patient had relaxation techniques of post-isometric muscle relaxation, using the phenomenon of muscle relaxation after their work under tension, to treat pain.[20] The PNF training program presented in this study had a positive effect on the improvement of ROM on the hip joints, increased muscle strength, reduced pain and improved the gait of the patient. O'Hora et al. stated that even a single session of PNF stretching technique is beneficial because it is based on active involvement and active participation of the patient in therapy.[31] It can, therefore, be assumed that the relaxation technique of post-isometric muscle relaxation is beneficial to reduce the tension of the contracted muscle groups, resulting in an improvement in ROM in the patient's operated hip joint. We found that ROM in the operated hip joint increased by as much as 9° after therapy. Also, Popławski et al. demonstrated that after applied therapy, the greatest improvement in mobility was observed in abduction of the operated hip joint, which was probably due to the fact that the muscles responsible for this movement were strengthened by resistance exercises using a Theraband.[32] Ridan et al. pointed to the usefulness of relaxation applied on the contracted muscles and increasing muscle strength in the patients after arthroplasty of the hip joint. [30] Our studies showed the greatest increase in muscle strength was in the abductors group, which may be due to eccentric, concentric and static muscle work, using a combination of isotonic technique to strengthen the weakened abductors and extensors of the hip joint. An important part of the therapy were muscular coordination exercises and stabilization using stabilization reversal, rhythmic stabilization and combination of isotonics. These exercises were mainly based on the control of pelvis position in the sagittal and frontal plane, and the stabilization of the trunk. Training of the phase of support on the operated lower limb was also performed using approximation and irradiation, to improve stability, facilitate balance reactions, and stimulate the lower limb muscles. After PNF therapy concentrating on work on a stable trunk and pelvis alignment as well as adjusting the height of the crutches, we observed that the patient's gait became more confident and symmetrical with longer steps.

Conclusion

Applied PNF therapy, including dynamic (eccentric, concentric) and static muscle training, post-isometric relaxation, stabilization and control in stance phase, has resulted in improved mobility of the operated hip joint,

muscle strength, gait pattern and pain reduction in the patient. The case study demonstrated that a short (two-week) but intensive (over two hours per day) PNF therapy positively influenced selected motor functions after Total Hip Arthroplasty. A greater study group with more tests are required to draw far-reaching conclusions.

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It is required to present a written consent for reprint from a previous publisher for any materials that were published previously (tables, figures). If information in the case description, illustrations or the text allow for identifying any people, their written consent should be delivered.

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Technical requirements:
The text of a work: interline 1.5, font Times New Roman, 12 points.
Save your file in docx format (Word 2007 or higher) or doc format (older Word versions).
Volume of original, systematic reviews/ reviews papers should not exceed 20 pages, and of clinical observations - 8 pages of a standard computer text (1800 signs on a page).

THE TITLE PAGE

The following information should be given on the **TITLE PAGE:**

- A complete title of the article (max 50 words), titles and subtitles should not be put into quotation marks and ended with a full stop.
- Abbreviated title of the article (*Running Head*).
- Names, last names of the Authors (without degrees and titles).
- Affiliations and participation of all of the Authors (according to a pattern below**).
- Detailed data: name, last name, address, telephone, and email address of the person responsible for preparation of the paper for publication and contact with the Editor.
- The title page should also give information about a source of funding the research (grants, donations, subventions etc.) and conflict of interest.

** A participation in preparation of the article should be determines in accordance with the following categories:
A. Author of the concept and objectives of paper
B. collection of data
C. implementation of research
D. elaborate, analysis and interpretation of data
E. statistical analysis
F. preparation of a manuscript
G. working out the literature
H. obtaining funds

Example:
Jan Kowalski[1 (A,B,C,D,E,F,G)], Anna Nowak[1,2 (A,B,C,E,F)], Adam Wisniewski[1 (A,B,E,F)]
1. The Institute of Physiotherapy, University of Rzeszow, Poland
2. Centre for Innovative Research in Medical and Natural Sciences', Medical Faculty of University of Rzeszow, Poland

The **MAIN BODY** of the manuscript should contain:

- A full title of the article.
- 3–6 keywords, chosen in compliance with the MeSH system (Medical Subject Headings Index Medicus http://www.nlm.nih.gov/mesh/MBrowser.html). Keywords cannot be a repetition of the title. Give a list of Abbreviations in alphabetical order.
- Abstract, which should be maximum 200 words and present a structural construction.

ARRANGEMENT OF TEXT

An original article should contain the following elements:

- Introduction
- Aim of the study
- Material and methods
- Results (used statistical methods should be described in detail in order to allow for verifying the results)
- Discussion
- Conclusion
- References

Case study should contain the following elements:

- Introduction
- Case description
- Discussion
- A summary
- References

Systematic review should contain the following elements:

- Introduction
- Description of the subject literature (a source of publication, data range)
- Analysis of the literature
- A summary
- References

Review article should contain the following elements:

- Introduction
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- Conclusion
- References

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Examples:

- The degree of respiratory muscles fatigue depends on the applied exercise protocol and the research group's fitness level. [1, 2] The greatest load with which a patient continues breathing for at least one minute is a measure of inspiratory muscles strength.[3]
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A citation should contain a maximum of 6 authors. Wnen an article has more than six authors, only the first three names should be given by adding 'et al.'. If the source

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Journal titles should be given in brief according to the Index Medicus standard.

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Article from a journal, number of authors more than 6	Gonzalez ME, Martin EE, Anwar T, et al. Mesenchymal stem cell-induced DDR2 mediates stromal-breast cancer interactions and metastasis growth. Cell Rep. 2017;18:1215-28. Jordan J, Toplak H, Grassi G, et al.Joint statement of the European Association for the Study of Obesity and the European Society of Hypertension: obesity and heart failure. J Hypertens. 2016;34:1678-88.
Article from an online journal	Coppinger T, Jeanes YM, Hardwick J, Reeves S. Body mass, frequency of eating and breakfast consumption in 9-13-year-olds. J Hum Nutr Diet. 2012;25:43-9. doi: 10.1111/j.1365-277X.2011.01184.x. Cogulu O, Schoumans J, Toruner G, Demkow U, Karaca E, Durmaz AA. Laboratory Genetic Testing in Clinical Practice 2016. Biomed Res Int. 2017;2017:5798714. doi: 10.1155/2017/5798714.
Websites	Cholera in Haiti. Centers for Disease Control and Prevention Web site. http://www.cdc.gov/haiti-cholera/. Published October 22, 2010. Updated January 9, 2012. Accessed February 1, 2012. Address double burden of malnutrition: WHO. World Health Organization site. http://www.searo.who.int/mediacentre/releases/2016/1636/en/. Accessed February 2, 2017.
Book	Naish J, Syndercombe Court D. Medical Sciences. 2nd ed. London, Elsevier;2015. Modlin J, Jenkins P. Decision Analysis in Planning for a Polio Outbreak in the United States. San Francisco, CA:Pediatric Academic Societies;2004.
Chapter in a book	Pignone M, Salazar R. Disease Prevention & Health Promotion. In: Papadakis MA, McPhee S, ed. Current Medical Diagnosis & Treatment. 54th ed. New York, NY: McGraw-Hill Education; 2015:1-19. Solensky R. Drugallergy: desensitization and Treatment of reactions to antibiotics and aspirin. In: Lockey P, ed. Allergens and Allergen Immunotherapy. 3rd ed. New York, NY: Marcel Dekker; 2004:585-606.

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