RATIO CHANGES OF SELECTED COMPONENTS OF BODY COMPOSITION AFTER LYMPHATIC MASSAGE

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BACKROUND: The application of lymphatic massages has a highly preventive effect as it reinforces the drainage and transport functions of the lymph pump and thus activates the lymphatic flow and helps detoxify the body.

OBJECTIVE: This pilot report inquires into the effect of lymphatic massages on selected components of body composition.

METHODS: We conducted an examination of body composition using the InBody 720 device (multifrequency bioelectrical impedance analysis) in a population of 30 women before and after having received practical training in lymphatic massages. Our study has pilot features due to professional selection and the low number of participants. We have presented a data analysis which defines the population anthropometrically (in terms of body height and weight and body mass index), waist hip ratio, body fat mass, skeletal muscle mass, rate changes in body water (total body water, intracellular water, extracellular water), proteins, total minerals, bone mineral content and changes to Edema indexes.

RESULTS: A significant reduction of total body water ($p = 0.042$, $\varphi = 0.0$) and Edema 2 ($p = 0.021$, $\varphi = 0.1$) was indicated in the massaged area. In the case of Edema 1, significant effects of lymphatic massage were determined in both the right ($p = 0.042$, $\varphi = 0.4$) and the left ($p = 0.012$, $\varphi = 0.2$) upper extremity, and the left lower extremity ($p = 0.014$, $\varphi = 0.2$). Significant differences in Edema 2 were found in both the upper and lower extremities ($p < 0.05$) between the 1st and 2nd examination. A reduction and equilibration to the standard deviation values was also shown.

CONCLUSIONS: Our results suggest the necessity of repeating the experiment in a different time frame.We confirm the positive intervention of lymphatic massage on the interstitium and cellular body environment.

Keywords: InBody 720, body water, reconditioning, women.

INTRODUCTION

The lymphatic system provides drainage, transportation and immunological functions to the organism. The adequate function of the lymphatic system is a principle of balance preservation between the absorption and transport capacity of lymphatic circulation and tissue proteolysis. Lymphatic capillaries originate at the capillary lymphatic pump in the intercellular spaces which are suffused with extracellular water. Almost every tissue cell receives oxygen and nutrients (carbohydrates, lipids and amino acids) from the extracellular water (ECW) and drains carbon dioxide and metabolism products within it. Cells, molecules and possibly microorganisms sized 20 μm pass through the endothelium of the lymphatic capillaries. Blood capillaries also continuously transmit up to 200 mg of blood proteins daily into the interstitial tissue and lymphatic circulation is essential for its return to the blood circulation path. An impairment of the given balance results in the congestion of proteins and other macromolecular substances in the tissues. Proteins bind water osmotically and thus cause oedemas to develop (Benda et al., 2007).

ECW represents on average 16% to 20% of the body weight; approximately 20 litres of ECW is produced within 24 hours; the absorbed amount in the capillary blood circulation system presents approximately 80% of ECW. The residual 20% must be drained by lymphatic circulation. Lymphokinetic factors (such as muscle contractions, subcutaneous tissue movement, changes in intraabdominal pressure, respiratory movements of the thorax, pulse wave, etc.) help the lymph flow. Intracellular water is the principal metabolically active component of the cellular cytoplasm (Johnston, 2008).

Hypokinesis presents one of the most serious pathological factors which result in excessive stress on the lymphatic system. The application of a lymphatic massage has highly preventive effects as it reinforces the functions of the lymph pump and thus activates lymph flow and helps the body detoxify. It is suitable as a preventative measure for restoring immunity, for faster regeneration after physical stress and surgical procedures, for the improvement of skin conditions and cellulitis and serves to prevent the development of varices. Massage over lymph nodes can speed recovery from damage resulting from adhesions, and has been shown to be particularly effective in relieving postsurgical swelling and pain and for enhancing the rate and the quality of healing (Premkumar, 2003). It has had a positive effect during the recovery of and physiotherapy treatment for sportspeople. Sports therapists are concerned with promoting healing, restoring normal function following injury and achieving optimum performance from their clients. Massage can assist with each of these processes by acting upon arterial and venous blood flow, the blood clotting process, oedema, lymphatic drainage and the properties of connective tissue and muscle (Goats, 1994).

METHODS

Research group

We conducted an examination of body composition using the InBody 720 device (multifrequency bioelectrical impedance analysis) in the second half of two courses which were dedicated to practical training of lymphatic massages during which the students should have mastered stroke technique. Thus we worked with already partially optimized body environment conditions. We examined 30 women across a wide age range (22 to 59 years of age); this population was professionally selected (physiotherapists, masseuses). The examination was conducted in the morning prior to beginning the massage teaching and before the end of the teaching day. *The 1st and the 2nd examination were separated by 8 hours*. All participants performed mutual lymphatic massages to the neck and upper extremity. The acquired data was subsequently processed collectively and by decenniums due to the diverse age range. In the latter case, the population was divided into 4 sub-populations with a low number of participants.

Aim and Proceedings

We monitored the effect of lymphatic massages on body composition and examination stability. We have presented a data analysis which anthropometrically defines the population (in terms of body height and weight, body mass index – BMI), waist hip ratio (WHR), absolute and relative amount of the body fat mass (BFM), skeletal muscle mass (SMM), rate changes of body water (total body water – TBW, intracellular water – ICW, extracellular water – ECW), proteins, total minerals, bone mineral content (BMC) and changes to Edema 1 and Edema 2.

Fat is the principal and a highly variable component of the human body. To diagnose obesity, we used BMI (a value of 30 kg/m^2 and more units was considered to be a risk margin), fat percentage (a value above 28% was considered to be the risk margin in women; Heyward & Wagner, 2004), WHR (a value above 0.85 units was considered to be a risk margin in women; Riegerová, Přidalová, & Ulbrichová, 2006), visceral fat area (VFA) and obesity degree. Visceral fat predicates abdominal obesity. Accumulation of fat in the visceral region plays an important role in the ethiopathogenesis of serious non infectious diseases of collective incidence such as diabetes mellitus, ischemic heart disease, myocardial infarction, hypertension, etc. The abdominal obesity risk margin is above 100 cm^2 (moderate risk: 100–150 cm^2, high risk: > 150 cm^2; Biospace, 2008).

Proteins qualify the absolute representation of proteins in the body, whereas minerals qualify the absolute representation of minerals. They are part of dry body mass. Minerals can be further divided into bone minerals and non bone minerals.

Edema 1 presents information on the amount of water in the extracellular environment. Standard values of Edema 1 (ECW/TBW) range between 0.36–0.40; the formation of oedema can occur if the index value exceeds 0.40. Edema 2 relates to the determination of ECW/TBW ratio with added proteins and minerals in a 2:1 ratio. Values exceeding 0.36 again predicate the formation of oedemas.

Statistical processing

The acquired data has been processed collectively and by decenniums due to the varied age range. In the latter case, the population was divided into 4 sub populations with a low number of participants. The data was analysed using Statistica 8 software (StatSoft, 2008). The differences were analysed using the pair t-test, Wilcoxon test, and the effect size. (Cramer's phi) was used for the determination of effect size between two variables. In terms of Cramer's phi we distinguish among small ($0.10 < \varphi < 0.29$), medium ($0.30 < \varphi < 0.49$) and large effects ($\varphi > 0.50$). Our study has pilot features.

RESULTS AND DISCUSSION

Due to pair t-test sensitivity, the whole population showed significant differences in their small increment of weight ($p = 0.008$, $\varphi = 0.0$), BMI ($p = 0.007$, $\varphi = 0.0$), body fat mass ($p = 0.008$, $\varphi = -0.1$) and percent body fat mass ($p = 0.026$, $\varphi = -0.1$). This phenomenon is conditioned by the increased intake of liquid during the day and the short time frame for them to be utilised in the tissues as well as by the sensitivity of bioimpedancy measurement. Mean BMI value is located within the normal weight range and fat fraction percentage was also under the risk margin. WHR was located just past the risk margin even though the mean values of the visceral fat area were by far too close to the risk margin of 100 cm^2.

TABLE 1
The basic statistical characteristics of selected body composition data (InBody 720, n = 30)

Characteristic		1st examination		2nd examination	
		M	SD	M	SD
Age (years)		39.75	11.33	39.75	11.33
Height (cm)		168.00	6.45	168.00	6.45
Weight (kg)	*	68.02	15.81	68.29	15.81
BMI (kg/m²)	*	23.89	4.19	23.98	4.19
BFM (kg)	*	18.82	8.94	19.34	9.51
BFM (%)	*	26.50	6.23	26.98	6.84
WHR		0.86	0.05	0.86	0.05
VFA (cm²)		79.76	38.98	79.92	38.18
SMM (kg)		27.05	4.43	26.88	4.12
Proteins (kg)		9.63	1.47	9.56	1.36
Minerals (kg)		3.52	0.61	3.50	0.58
BMC (kg)		2.91	0.52	2.91	0.50
Recommended BMC (kg)		2.62	0.20	2.62	0.20
ICW (l)		22.27	3.41	22.15	3.17
ECW (l)		13.79	2.13	13.75	2.03
TBW (l)	*	36.06	5.52	35.90	5.18

Legend:
differences between 1st and the 2nd examination were analysed by pair t-test (* $p < 0.05$)

This is related to the significance of changes in the reduction of TBW ($p = 0.042$, $\varphi = 0.0$). Intracellular water passed through greater reduction than extracellular, but those differences did not reach statistical significance. The reduction of the standard deviation values of all body water components also supports the claim that lymphatic massages have a positive effect on the interstitium and cellular environment of the body.

The weight amount of the muscle component, proteins and total minerals encountered a small reduction in relationship to TBW reduction, but without any statistical significance of those differences. Skeletal muscles have a 39.76% share in the total weight.The amount of bone minerals remained stable and at a good level. In terms of quantities which underwent rate reductions, the standard deviation value was also reduced. The increment of average values was accompanied by stability or by an increase in standard deviation values (TABLE 1).

The same trend in increments and decrements of monitored quantities was shown even in the division into sub populations according to age and therefore we do not consider this to be a measurement error, but rather to be the effect of introducing the massage. In TABLE 2, the low values of differences serve to present only the principal statistical characteristics of the data from the 1st examination. The significance of differences prior to and after massages was confirmed in the popu-

TABLE 2
The basic statistical characteristics of the selected data concerning body composition (InBody 720) – division according to decenniums; women aged 20 to 50 years (n = 30)

Characteristic	20 years old women (n = 7)		30 years old women (n = 8)		40 years old women (n = 10)		50 years old women (n = 5)	
	M	SD	M	SD	M	SD	M	SD
Age (years)	24.33	3.20	33.71	2.29	46.00	3.66	56.25	4.14
Height (cm)	168.67	5.32	165.93	6.22	170.05	7.63	165.00	4.24
Weight (kg)	* 63.72	7.14	63.54	8.52	74.64	21.93	64.06	12.26
BMI (kg/m²)	* 22.41	2.44	23.01	1.99	25.39	5.74	23.49	4.00
BFM (kg)	15.82	3.87	* 16.31	3.64	22.97	12.46	16.30	6.78
BFM (%)	24.60	3.93	* 25.53	3.50	28.75	8.03	24.83	7.23
WHR	0.80	0.03	0.84	0.01	0.88	0.04	0.92	0.03
VFA (cm²)	* 51.37	14.99	62.21	13.58	100.73	49.27	95.36	23.84
SMM (kg)	26.46	2.73	26.03	3.43	28.35	5.85	26.10	4.04
Proteins (kg)	9.43	0.90	9.29	1.14	10.06	1.94	9.33	1.31
Minerals (kg)	3.41	0.31	3.32	0.43	3.73	0.84	3.42	0.46
BMC (kg)	2.85	0.24	2.74	0.35	3.09	0.72	2.81	0.38
Recommended BMC (kg)	2.64	0.17	2.55	0.19	2.68	0.24	2.53	0.13
ICW (l)	21.80	2.10	21.50	2.65	23.27	4.48	21.55	3.12
ECW (l)	13.25	1.20	13.14	1.61	14.60	2.76	13.50	1.97
TBW (l)	35.05	3.25	34.64	4.22	37.87	7.24	35.05	5.09

Legend:
differences between 1st and the 2nd examination in the sub populations were analysed by Wilcoxon test (* $p < 0.05$)

lation of women 20 years of age in case of increased weight (p = 0.046), BMI (p = 0.042) and amount of visceral fat (p = 0.028), in the population of women 30 years of age in the case of an increased fat fraction in both absolute (p = 0.028) and relative values (p = 0.043) in the population of women 40 years of age in the case of decrement of Edema 1 (p = 0.005) and Edema 2 (p = 0.007) values on the right upper extremity. The results correspond with those recorded for the analysis for the whole population.

The low frequency of sub population and professional selection of probands underline the pilot nature of this research. With regard to age changes, we dedicated our attention to TBW value changes, visceral fat and to estimated changes in minerals representation in the whole organism and in bones.

Total body water consisted of 55.00%, 54.52%, 50.74% and 54.71% of the body weight in the monitored panel and 53.01% of the whole population. The ECW range was rather stable between 19.56% and 21.07% with the highest mean value in group of women aged 50 years. The ICW ranged from 31.17% to 34.21% with the highest rate in the group of women aged 20 years which then decreased with age.

Schoeller (1989) reports an incidence of 49% of TBW in women aged 30 and 40 years and 48% in women aged 50 years. Riegerová, Přidalová, Valenta and Dostálová (2008) present the following values in women aged 62 years ICW 29.00%, ECW 23.94% and TBW 52.53% (measured using QuadScan 4000); Gába, Riegerová and Přidalová (2008) present the following values in seniors aged 64 years ICW 28.92%, ECW 18.36% and TBW 47.28% (measured using InBody 720). Our highest ICW values are probably connected with the already optimized ratio of body fluids after lymphatic massages.

Values of visceral fat increase with age; an extreme increase in the sub population of 40 year old women was caused by a proband weighing 111.32 kg with a body height of 179 cm. The value of her visceral fat was highly risky (200.18 cm^2). Women of 50 years of age have rather a high amount of visceral fat even when weighing relatively little (95.36 cm^2, 64.01 kg). The mean value of the weight amount of total mineral and bone minerals did not show a significant regressive trend with increasing age. The recommended level of bone minerals was always lower than the actual value.

Riegerová, Gába, Přidalová and Langrová (2009) published a suggestion of risk value for the estimate of total minerals and bone minerals when measurement was performed using the InBody 720 – 3.08 kg a lower and 2.55 kg and lower.

Results of 4 women were found under this risk margin. Their case reports:

E. K., 50 years, BMC 2.15 kg, minerals 3.16 kg, height 160 cm, weight 49.15 kg, BMI 19.20;

T. G., 50 years, BMC 2.06 kg, minerals 2.54 kg, height 158 cm, weight 45.46 kg, BMI 18.21;

L. P., 33 years, BMC 2.23 kg, minerals 2.77 kg, height 160 cm, weight 53.15 kg, BMI 20.76;

D. H., 22 years, BMC 2.45 kg, minerals 2.97 kg, height 166 cm, weight 51.42 kg, BMI 18.66.

Fig. 1
Percentage formulation of changes of body water fractions with age

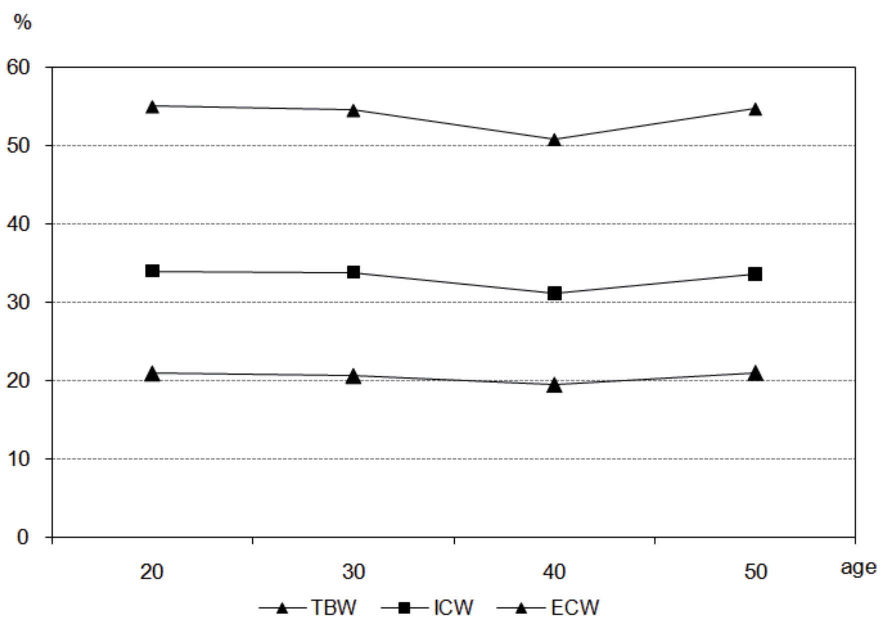


TABLE 3
The basic statistical characteristics of Edema 1 and Edema 2 (n = 30)

Characteristic		1st examination M	1st examination SD	2nd examination M	2nd examination SD
Edema 1		0.3354	0.06	0.3361	0.01
Edema 2	*	0.3823	0.07	0.3830	0.01
Right upper extremity Edema 1	*	0.3313	0.04	0.3298	0.01
Left upper extremity Edema 1	*	0.3324	0.04	0.3316	0.01
Trunk Edema 1		0.3356	0.06	0.3364	0.01
Right lower extremity Edema 1		0.3354	0.07	0.3354	0.01
Left lower extremity Edema 1	*	0.3366	0.08	0.3383	0.01
Right upper extremity Edema 2	*	0.3779	0.04	0.3776	0.01
Left upper extremity Edema 2	*	0.3791	0.04	0.3784	0.01
Trunk Edema 2		0.3826	0.06	0.3834	0.01
Right lower extremity Edema 2	*	0.3837	0.08	0.3853	0.01
Left lower extremity Edema 2	*	0.3823	0.08	0.3828	0.01

Legend:
Edema1– information on the amount of water in the extracellular enviroment
Edema 2 – relates to the determination of ECW/TBW ratio added proteins and minerals at a 2:1 ratio
Differences between the 1st and the 2nd examination were analysed by means of the pair t-test (* $p < 0.05$).

There were women with gracilis skeleton and low weight. BMI signalized participants to be underweight in the case of T. G. and D. H. All other probands were of normal weight. Women were informed about their state and they were advised to seek a specialist. We received feedback in three cases. T. G. was diagnosed with osteoporosis and a clinical level of osteopenia was found in E. K. and L. P.

The mean of Edema 1 values was lower than the lower limit of the standard range 0.36–0.40. They fluctuated evenly within the 0.33–0.34 unit range. The reason for that could be the practical training of lymphatic massages during the week prior to the examination. The statistically significant decrease appearing in the upper extremities (which were massaged) included an Edema 1 mean value (right upper extremity – $p = 0.042$,

Fig. 2
A box diagram of means and standard deviations of the right upper extremity Edema 1

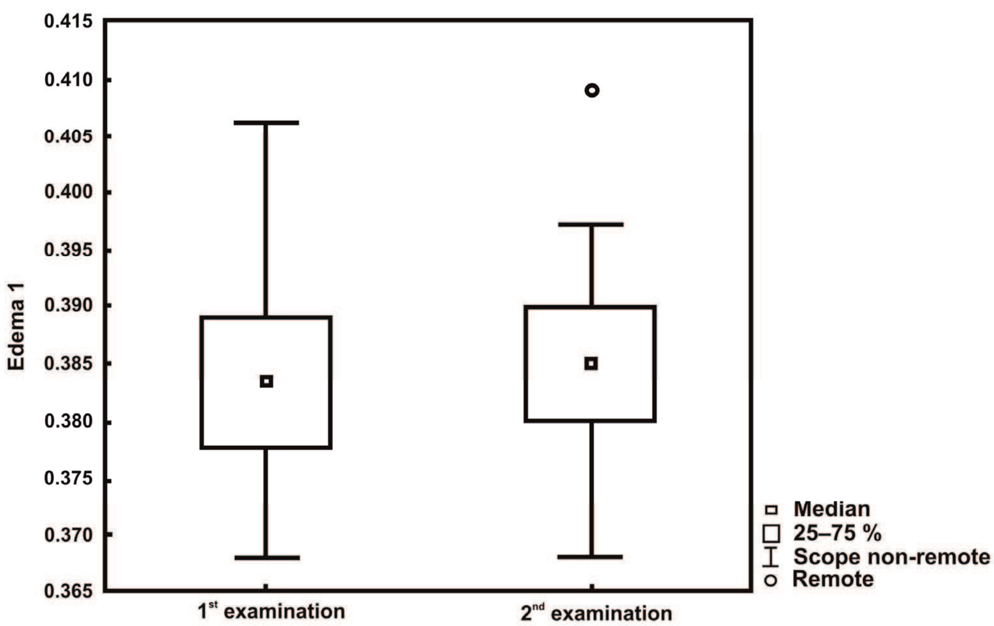
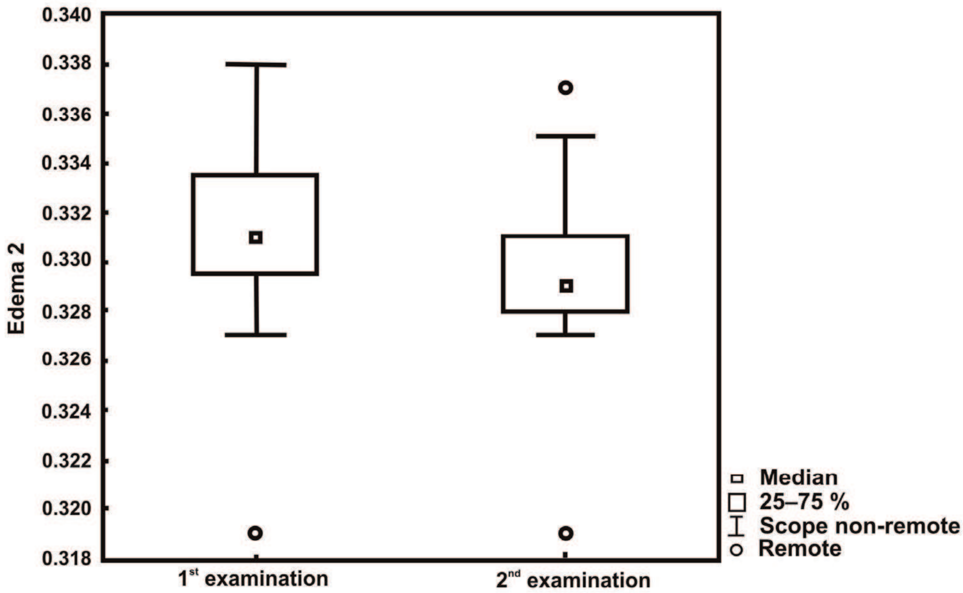


Fig. 3
A box diagram of means and standard deviations of the right lower extremity Edema 2



φ = 0.4; left upper extremity – p = 0.012, φ = 0.2) and was found by repeated measurements after carrying out a lymphatic massage. The reduction and equilibration of standard deviation values was also shown. A moderate increase in mean values occurred in the case of the total index, trunk index and lower extremities index. A significant increase occurred only in the case of the left lower extremity (p = 0.014, φ = 0.2). Mean Edema 2 values were higher than the given limit value by 0.02 units. A statistically significant decrease in the index was found after massaging the upper extremities (right upper extremity – p = 0.008, φ = 0.3; left upper extremity – p = 0.009, φ = 0.2). A significant increment of both lower extremities and trunk indexes was reported. Significant differences rise from the figure 2 and 3 past the decimal point, but they do not play an important role from a general perspective. The medium effect was confirmed for Edema 1 and Edema 2 for the right upper extremity based on effect size test results (φ = 0.4). Low effect size was shown on the left upper extremity (φ = 0.2) as well as in other Edema indexes (φ = 0.2–0.1).

Our results confirmed the hypothesis of positive body composition changes. However, they suggest the necessity to repeat the experiment following a different time frame. Currently, we have not registered any studies that focused on specific changes in body composition after lymphatic massage intervention. Therefore, we consider this pilot study, despite some limits (e.g. small sample size, age variability), beneficial to both theory and practice.

CONCLUSION

We confirm the positive intervention of lymphatic massage on the interstitium and cellular body environment based on data analysis using InBody 720.

The whole population showed significant differences in small weight, BMI and body fat mass increments which were probably conditioned by the increased liquid intake and short time period after their utilization. This fact is also related to the significant decrease in TBW mean values, the decrease in ICW and ECW and the decrease in standard deviations in the case of all body water components.

The same increments and decrements trend of monitored quantities was demonstrated even when dividing the population into sub populations according to age. Values of visceral fat increase with age, meaning that the estimated values of the weight amount of total minerals and bone minerals did not experience a significant decrease with age.

Edema 1 indexes values were lower on average (optimized) than the lower limit of the standard range and the values equally fluctuated within the 0.33–0.34 unit range. After a lymphatic massage of the upper extremities, we noticed a significant reduction of Edema 1 and Edema 2 indexes in the massaged area. A reduction and equilibration of the standard deviation values was also indicated. A small increment of Edema indexes occurred in non massaged body areas with significance in the case of Edema 1 for the left lower extremity and Edema 2 for both lower extremities. The effect size analysis confirmed a medium effect in the case of Edema

1 and Edema 2 on the right upper extremity and only a small effect on the left upper extremity.

Our results confirmed the presumption of positive changes in body composition. This hypothesis comes from a partially optimized state and it suggests the need for repeating the experiment repetition using a different time frame.

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ZMĚNY POMĚRŮ VYBRANÝCH SLOŽEK TĚLESNÉHO SLOŽENÍ PO LYMFATICKÉ MASÁŽI

(Souhrn anglického textu)

Na dvou výukových kurzech lymfatických masáží jsme ve druhé polovině kurzu provedli vyšetření složení těla přístrojem InBody 720. Vyšetření jsme realizovali ráno před zahájením výuky a před koncem výukového dne, mezi prvním a druhým vyšetřením uplynula časová pauza 8 hodin. Vyšetřili jsme 30 žen, nízká četnost a profesní selekce probandek podtrhují sondážní charakter výzkumu. V předložené pilotní studii jsme sledovali vliv lymfatické masáže na vybrané složky složení těla a stabilitu vyšetření. Získaná data jsme zpracovali souhrnně a vzhledem k věkovému rozpětí i po decéniích programem Statistica 8, diference jsme testovali párovým t-testem. Věcná významnost byla posuzována pomocí koeficientu φ (Cramer's phi).

Potvrzujeme pozitivní intervenci lymfatické masáže na intersticium a buněčné prostředí těla. U souboru se projevila signifikance ($p < 0{,}05$) rozdílů v malém nárůstu hmotnosti, BMI a tukového podílu, což bylo zřejmě podmíněno zvýšeným přísunem tekutin a krátkou dobou pro její utilizaci. S tím souvisí i signifikantní snížení průměrných hodnot TBW ($p = 0{,}042$; $\varphi = 0{,}0$), úbytek ICW i ECW a snížení hodnot směrodatných odchylek u všech složek tělesné vody.

Stejný trend přírůstků a úbytků sledovaných veličin se projevil i při rozdělení na subsoubory podle věku. Hodnoty viscerálního tuku narůstaly s věkem, průměrné hodnoty váhového množství celkových minerálů a kostních minerálů neprojevily ve věkové řadě výraznější sestupný trend.

Hodnoty indexů Edema 1 byly ve svém průměru nižší (optimalizované) než dolní hranice standardního rozpětí. Po lymfatické masáži horních končetin se pro-

jevilo signifikantní snížení indexu Edema 2 (p = 0,021; φ = 0,1) pro masírovanou oblast. Projevilo se také snížení a vyrovnání hodnot směrodatných odchylek. Test věcné významnosti potvrdil účinek malé a střední úrovně u indexu Edema 1 a Edema 2 pro pravou horní končetinu, pro levou horní končetinu pouze efekt malého účinku. Naše výsledky potvrdily předpoklad pozitivních změn ve složení těla, vychází však z již částečně optimalizovaného stavu v druhé polovině kurzu a naznačují nutnost opakování experimentu v jiném časovém rozvržení.

Klíčová slova: InBody 720, tělesná voda, rekondice, ženy.

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1987–1990 – associate professor, Department of Zoology and Anthropology, Faculty of Natural Science, Palacký University, Olomouc.

1991–2000 – associate professor, Department of Functional Anthropology and Physiology, Faculty of Physical Culture, Palacký University, Olomouc.

Since 2001 – professor, Department of Functional Anthropology and Physiology, Faculty of Physical Culture, Palacký University, Olomouc.

Scientific orientation

Functional anthropology, kinesiology, enviromentalism of human, massage.

First-line publications

Until now she has published 160 papers and research studies in Czech as well as in foreign literature, 1 monograph, 7 instructional texts and 2 popular books.

Riegerová, J., Szotkowská, J., Přidalová, J., & Krejčí, J. (2006). Vliv čínského léčebného cvičení na posturu a pohybový aparát seniorek. *Med Sport Boh Slov, 15(5),* 212–216.

Riegerová, J. a kol. (2007). *Rekondiční a sportovní masáže.* Olomouc: Univerzita Palackého.

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