Journal of Physical Education and Sport ® (JPES), Vol.20 (1), Art 12, pp. 97 - 101, 2020
online ISSN: 2247 - 806X; p-ISSN: 2247 – 8051; ISSN - L = 2247 - 8051 © JPES

Original Article

Body composition of trainees undergoing EMS training with respect to their nutrition

JÁN JUNGER[1], ANDREA JUNGER[2], PAWEL OSTROWSKI[3]
[1]Institute of Physical Education and Sport, Pavol Jozef Šafarik University in Košice, SLOVAK REPUBLIC
[1,3]Faculty of Physical Education, University of Rzeszow,POLAND
[2]XBody Prešov, SLOVAK REPUBLIC

Published online: January 31, 2020
(Accepted for publication: December 29, 2019)
DOI:10.7752/jpes.2020.01012

Abstract
Objective: The aim of research was to broaden knowledge about the influence of EMS training on changes in the physical composition of trainees, both with modified eating habits and without.
Material and method: The research group consisted of 86 trainees divided into two groups. Group one comprised39 trainees participating in EMS training program twice a week for 20 minutes applying an XBody device, without diet modification. The second, experimental group consisted of 47 trainees who, in addition to undergoing the same form of EMS training, underwent eating habit modification. The initial diagnosing of the body composition of both groups was performed using InBody 120,prior to the first EMS training unit.
Results: Trainees who underwent solely EMS training, generally reduced their average body weight by 2.45 kg, while those who in addition agreed to have their eating habits modified reduced their overall body weight by 4.30 kg, corresponding to a loss of 1kg per week. The threefold higher visceral fat reduction (11.15 cm^2) is considered the scientifically most valuable result.
Conclusion: The results of the 4-week EMS training intervention program confirmed the generally anticipated assumption that performance of such physical activity would result in a reduction of overall bodyweight as well asbring about favorable changes in body composition of the female trainees. In case ofa more complex intervention (combining modified diet and physical activity), the results are up to three times more substantial.
Keywords:physical activity, obesity, diet, research, body weight

Introduction

Our genotype contains encoded instructions on how to efficiently utilize the energy intake, when and how to create particular enzymes, how to modify individual functions or the structure of organs to facilitate survival in unfavorable living conditions [1]. The history of phylogenetic evolutionproves that unfavorable living conditions accompanied us at every stage in history.Such condition has been adapted to by the appearance of the humans, the structure and functionality of the individual organs and the whole body as such. For the sake of survival, an efficient metabolic mechanism has been built into the human genome, which Neel [2,3] calls the "thrifty gene". The "thrifty gene" represents a serious personal and cross-society problem in the present way of life. The era of activity has been replaced by the now sedentary life. We sit down everywhere. Risk factors for obesity development include, in particular, high energy diet, low physical activity, adopting to sedentary lifestyle and irregular eating schedule[4,5,6,7].

Most of authors present that for solving the problem of overweight exist just right diet. In the case of common, very frequently kept diet**s** applied in practice together with relative inactivity, there is prevailing loss of total weight, albeit more than 35-40% of it is active muscle mass and about 40% water. Thus, fat loss itself is represented by less than 25%. In addition, basal metabolism is reduced and the maximum oxygen consumption is decreased[8]. Furthermore, after coming offa diet, the body starts to collect fast energy reserves in the form of fatty tissue, which contradicts the sense of the dietary decision [9].

An ideal diet, either in terms of weight reduction, muscle gain, or maintaining overall health requires, among other things, maintenance of a suitable ratio of macro-nutrients (carbohydrates, proteins and fats). And that is where the biggest problem lies. Trying to prefer one of them also brings along a number of secondary problems. In the case of fat preference, respectively fat and protein preferred, several studies highlighted their negative effect [e.g.10, 11].

Kevin Hall, a physicist who has become a renowned researcher of human metabolism (National Institute of Diabetes and Digestive and Kidney Diseases -NIDDKD), has since 2003 been processing data from a multitude of controlled studies carried out for decades to build a mathematical model focused on how different nutrients affect human metabolism and body weight. His computer aided simulation has shown that while reducing carbohydrates promotes fat burning, an even greater loss of total body fat can be achieved by

Corresponding Author: JÁN JUNGER, E-mail: jan.junger@upjs.sk

reducingone's fat intake [12]. This fact is further supported by the conclusions of the clinical practice byBukovský[13], who considers the intake of macronutrients: 50-65% carbohydrates, 10-15% protein and 15-30% fats to bethe optimal model of diet with a lifelong positive effect on maintaining healthy body weight and good health.

EMS trainingis one of the most effective forms of exercise. It is elicitation of muscle contraction using electric impulses, thereby controlling muscle work without intentionalmovement by the trainee[14]. Conclusions of research by[15]proved that EMS training has significant effects on the body composition of trainees alreadyat a small volume of exercise (45 min/week), and rather short-term intervention (14 weeks). Total body fat in the above research training group was reduced by 1.35 kg ($p = 0.001$). Vatter [16] subjected to his research 134 trainees who completed 12 exercise units lasting 25 minutes each. Body weight and BMI within the group remained about the same, but the body fat percentage decreased by 1.4%. Another numerous studies from Canada, China, France and Germany [17] confirm the success of this method in terms of reducing subcutaneous and visceral fat and gaining muscle mass.

It is therefore confirmed that the most ideal way to deal with this problem is the middle of the way, which means that in prevention of weight gain most optimal is dietary restriction, i. e. reduction, resp. control of energy intake combined with physical activity [6, 7, 8, 18, 19, 20].

Based on the above, the aim of our research was to extend the knowledge about the influence of EMS (electrical muscle stimulation) training on changesin physical composition of trainees in combination with modification of eating habits and without.

Materials and Methods

The research group consisted of 86 trainees divided into two groups. Average age of trainees was 41, youngest 18 years old, oldest 62 years old. Theprobands were regular visitorsof XBody fitness center in Prešov. Every trainee agreed with publication of their results of body composition measurement. Group 1 comprised39 trainees participating in the program twice a week for 20 minutes of strictly EMS training applyingan XBody device, without dietary restriction. The second, experimental group consisted of 47trainees who, in addition to attending the same form of EMS training, underwent dietary adjustment.

It consisted of an individual diet plan created by their trainer, graduate of doctoral studies in the field of sports education with specialization nutritional expert, after initial diagnostic of body composition based on their basal and work metabolism. It consisted of an offer from approximately 20 menus for breakfast, lunch, snack and dinner. Calories in menus were balanced to match their daily individual calorie consumption.

The diet was balanced against the macro-nutrients recommended in the introduction,ratio: 55% carbohydrates, 25% protein and 20% fat.

In addition, they followed the general recommendations which we consulted with them before experiment. Most important recommendations for daily meals are:

- breakfast within an hour after waking up,
- eating maximum 4 times a day (breakfast, lunch, dinner and others according to individual custom),
- fruits (2 servings) to be eaten only in the morning, vegetables (3 servings) mostly in the afternoon,
- consume meat at most 2 times a week, fish at least 3 times a week,
- prefer whole grain products, natural rice, olive oil and omit animal fat (including butter etc.),
- using stevia instead of sugar to sweeten meals,
- drink at least 0.04 dcl of pure or low-sodium water per kilogram of weight.

Initial body composition diagnostics in both groups were performed using InBody 120 prior to attending the first EMS training unit. We were observing changes in body composition in the following parameters: body weight (BW), body fat mass (BFM), skeletal muscle mass (SMM), visceral fat (VF) a intracellular water (ICW).We assumed that all participants were primarily concerned with reduction of their subcutaneous fat and muscle toning. Neither group acted other than doing usual housework on top of the undertaken EMS training program, and all had a predominantly sedentary job. The research was conducted in November 2018, with output measurements of changes in body composition after 4 weeks.

To detect statistical significance in differences between groups and was used t-test for independent samples and the relationships between the observed parameters of the body composition were evaluated based on Pearson correlation coefficient.

We declare that the experiments reported in the manuscript were performed in accordance with the ethical standards of the Helsinki Declaration and that the participants signed an informed consent form.

Results

The probands who have only undergone EMS training without modification of their eating habits have reduced their overall body weight by 2.45 kg on average, at most 6.1 kg, but not less than 0.3 kg. We detected positive changes in this factors: total BW, BFM and VF. (table 1).

We founded very interesting detection in case with trainees with extreme values. The female trainee with the biggest loss in BW (6.1 kg), demonstrated a decrease in all items at a ratio of 73.8% BFM, 18.0% SMM

and 8.2% ICW. The female trainee with the smallest BW (0.3 kg) experienced the second biggest increaseSMM (1.3 kg) and ICW increase (0.3 l), while losing 1.9 kg of BFM.

Table no. 1 Changes in body composition of trainees

		BW (-kg)	BFM (-kg)	SMM (+kg)	VF (-cm^2)	ICW (-litre)
Without modification	diet x	2,5	2,75	0,51	3,6	0,34
	s	1,265	0,816	0,535	1,005	0,208
Including modification	diet x	4,32	4,24	0,82	11,03	1,07
	s	1,233	0,523	0,779	2,403	0,582

Legend:BW – body weight, **BFM**- body fat mass, **SMM**-skeletal muscle mass, **VF**- visceral fat, **ICW**-intracellular water, **x**- arithmetic mean, **s**-standard deviation,

Those probands who have modified their eating habits accordingly,reduced their body weightby an average of 4.30 kg, corresponding to a loss of 1kg per week. In this case again, as a result of gainingSMMof 0.86 kg on average, the actual weight loss was up to 5.32 kg, of which 79.88 % BFMand 20.11 % ICW. Taking into account intraindividual assessments of our research, we can highlight results of a trainee that achieved BW reduction by 6.8 kg, of which 6.1 kg was BFM, while the VF reduction represented 14.1 cm^2 and it was one of the best result achieved in this body composition parameter, but also with a minimal loss of SMM (0.1 kg).Another trainee achieved the largest SMM gain (2.3 kg), which at a total BW loss of 2.6 kg further accounted for a loss of 4.7 kg BFM, of which VF 12.1 cm^2.

Discussion

The group of trainees participating in EMS training program without any particular diet restrictions experienced an average weight reduction by 2.5 kg, a result which does not prove substantial changes in body composition, as the group gained an average weight of 0.51 kg and achieved an average reduction of 3, 09 kg was 88,9 % of BFM and 11,1 % of IBW.In the comparison of the monitored components, this group of trainees indicate a very strong relationship between the changes in BW and BFM (r = 0.89), BW and SMM (r = 0.85) and also strong between changes in BFM and SMM (r = -0.59).

In line with the foregoing knowledge, SMMgain could be perceived as a positive fact, which latently prevents further growth of the BFM. This would clearly indicate the protein-anabolic effect of physical activity when loss of body fat is accompanied by loss of muscle mass. Nevertheless, we may also admit that the participants, regardless of the nature of the training, had their mealsalso immediately after accomplishing the physical activity units, which could have helped to increase muscle mass as they did not have corresponding knowledge of adequate diet in relation to training. When comparing our results with the results of the authors quoted in the introduction, such as (15), our traineeshave reduced their body fat by 1,4 kg more than in their study. Similarly, the results by (16) show that his probands reduced BFM by 1.4% during EMS training accompanied by only minor changes in body weight, while our probands by up to 5.57%. Even more interesting is the comparison of our results with the results of (21) who implemented EMS training with his probands three times a week for a period of 8 months. Following the intervention in his research, not only did the participants not reduce their body weight, but what is more, they gained 0.2 kg of fat. This result could be explained by the fact that the study participants, in line with our experience, may have believed that they couldafforda higher calories intakethanks to higher metabolic expenditure.This suggests that the heterogeneity of the results achieved only through doing exercise could be greatly influenced by the different eating habits of the trainees.

The second group of our study participants who, in addition to applying the EMS training method, have also modified their eating habits, achieved a three-times higher VF reduction (11.03 cm^2),considered the scientifically most valuable result which confirmed the hypothesis of significant effect of diet on visceral fat level. Considerable still ismore than three-times higher loss of ICW (1.07 l), which we also see as a consequence of changes in eating habits, this time by adjusting the drinking regime. The body retaining water has gradually learned better water management. By monitoring the female trainees we found cases of "lean" obesity, when the traineesdid not seem obese at all, but their body composition showed a low level of SMM and high levels of both BFMand VF. In evaluating the relationship between the observed components, we observed a very strong relation between changes in BW and SMM (r = -0.76) and stronger between BW and ICW (r = 0.61) and between fat parameters (r = 0.68).

We compared our results with the research by (22), according which a group of 98 women who performed strength training 15 minutes a day and twice a week underwent further aerobic training at a duration of one hour, reduced their weight by 3.6 kg/month. The trainees, similarly to ours, had their diet individually adjusted in order to achieve body fat reductionof 1 kg per week. After having compared the results, the EMS-based training programwe conductedproved more effective in terms of weight reduction, as our participants have reduced their weight during the same period by an average of 4.30 kg.

The significance of diet in weight adjustment was also confirmed in the study by (23), who carried out a randomized two-year research in 6 academic centers around the USA, studying two groups of probands aged 18

to 65 years, what is comparable with our sample. One group attended two 20-minute seminars by a nutritionist, and the second, a commercial group, attended such one-hour sessionsweekly in the long term with a focus on a diet plan, activity plan and weight control. After the first year, the first group reduced its BW by an average of 1.3 kg and by further 0.2 kg after two years, whereas in the second group with regular dietary control, following the first year BW loss of 4.3 kg was observed on average followed by another 2.9 kg reduction after the second year.Based on our results and citeted authors we can summarize that in case of the more complex intervention combining diet modification and sufficient PA is possible to achieve this result even after one month.
Statistical significance was confirmed in favor of the diet change sample in all observed parameters ($p < 0.01$).

Conclusion

The results of a 4-week EMS training performed in 2 independent groups twice a week for 20 minutes at a time, in one group including eating habit modifications, confirmed the generally anticipated assumption that suchphysical activity performed would be beneficial in reducing the overall body weight as well as eliciting favorable changes in body composition of the trainees.
In case of the more complex intervention (combining diet modification and exercise), the results are up to three times more substantial, indicating the undisputable importance of considering both the factors, and thus proving greater, not only, weight reduction effectiveness, but also in case of body composition.It has further been confirmed that the level of VF, which plays an important role in the overall health of the individual, is significantly affected by dietary habits.

References

[1] Booth FW, Gordon SE, Carlson CHJ, Hamilton MT. Waging war on modern chronic diseases: primary prevention through exercise biology. In.: J. Appl. Physiol. 2000; 88:774–87. doi:10.1152/jappl.2000.88.2.774
[2] Neel JV. Diabetes mellitus: a 'thrifty' genotype rendered detrimental by "progress." In: Journal Human genetic. 1962;14:353–62.
[3] Neel JV. The "thrifty genotype" in 1998. In: Nutr Rev. 1999; 57:2–9. https://doi.org/10.1111/j.1753-4887.1999.tb01782.x
[4] Flegal KM, et al.Prevalence and trends in obesity among US adults, 1999–2000. In: JAMA. 2002; 288, 14:1723–27. doi:10.1001/jama.288.14.1723
[5] Flegal KM. Excess Deaths Associated With Underweight, Overweight, and Obesity. In: JAMA. 2005;293, 15:1861–67. doi:10.1001/jama.293.15.1861
[6] Krahulec B. Odporúčania pre liečbu obezity u dospelých. Európsky projekt primárnej starostlivosti a odporúčania Obezitologickej sekcie Slovenskej diabetologickej spoločnosti. In: Diabetes Obez. 2004; 8, 4:91–97.
[7] Meško D**.** Obezita a športová aktivita. In: Via Practica. 2007;11,4:536 – 39. ISSN 1336-4790
[8] Stejskal P. Teoretické poznatky o vlivu sportu pro všechny na zdraví. In: Zborník z 1. konferencie športu pre všetkých „Šport pre všetkých a zdravie", 2002, Bratislava, Asociácia športu pre všetkých SR, s. 18 – 28
[9] Križanovič F. [online]. Redukcia hmotnosti a pohybová aktivita. 2014. [cit.2018-05-03]. Available at: https://mdiet.blog.sme.sk/c/367422/redukcia-hmotnosti-a-pohybova-aktivita.html
[10] Lawrence AD,et al. Diet rapidly and reproducibly alters the human gut microbiome, In: Nature, 2013; 23:559–63. doi: 10.1038/nature12820
[11] Tillisch K,et al. **Consumption of Fermented Milk Product with Probiotic Modulates Brain Activity.** In: *Gastroenterology*. 2013; 7:1394-401. doi: 10.1053/j.gastro.2013.02.043
[12] Hall KD,et al. Calorie for Calorie, Dietary Fat Restriction Results in More Body Fat Loss than Carbohydrate Restriction in People with Obesity. In: Cell Metab. 2015; 22, 3:427-36. doi: 10.1016/j.cmet.2015.07.021
[13] Bukovský I. Plán B- 30 dňový manuál zdravého chudnutia. Bratislava: AKV. 2015, ISBN 9788089719013.
[14] Zatsiorsky K. Science and Practice of Strength Training. Human Kinetic. 2006. ISBN 978-0736-281
[15] Kemmler W, Birlauf A, Von Stengel S. [online]. Norimberg: Univerzita Elangen. 2009. [cit.2018-05-03]. Available at: https://www.miha-bodytec.com/sk/studie-k-nizkofrekvencnej-elektrostimulacii-celeho-tela/
[16] VatterJ. [online]. Univerzita Bayreuth: Publikácia vydavateľstva AVM-Verlag München. 2003. [cit.2018-05-03]. Available at: https://www.miha-bodytec.com/sk/studie-k-nizkofrekvencnej-elektrostimulacii-celeho-tela/
[17] FDA. Electrical Muscle Stimulators and Iontophoresis Devices. [online]. 2015. [cit.2018-05-03]. Available at: https://www.accessdata.fda.gov/cms_ia/importalert_240.html
[18] Weinsier RL. The Role of Physical Inactivity in Obesity. In: Obesity Research. 2003; 11:1246–62. doi: 10.1038/ncpendmet0554
[19] Yumuk V. et al. European guidelines for obesity management in adults. In: Obesity facts. 2015; 8:402–24. doi: 10.1159/000442721

[20] Uher I, Buková A, Švedová M, Kűchelová Z. Lifestyle and environment influences on body fat in adolescent population. In: Sport Science. 2016; 9, 1:24-27. ISSN 1840-3662.
[21] Porcari JP. Effects of Electrical Muscle Stimulation on Body Composition, Muscle Strength, and Physical Appearance. In: Journal of Strength and Conditioning Research, 2002; 16, 2:165–72.
[22] Christensen JR, et al. Diet, physical exercise and cognitive behavioral training as a combined workplace based intervention to reduce body weight and increase physical capacity in health care workers - a randomized controlled trial. In: BMC Public Health, 2011; 11:671. https://doi.org/10.1186/1471-2458-11-671
[23] HeshaS, AndersonJW, AtkinsonRL, et al. Weight Loss With Self-help Compared With a Structured Commercial Program A Randomized Trial. JAMA.2003; 289, 14:1792-1798. doi:10.1001/jama.289.14.1792