Effect of sportswear with compression technology EXO SENSIFIT on running performance according to mid-term endurance and selected physiological parameters

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Abstract
Within the framework of pilot study, we tested effect of running outfit with compressive technology EXO SENSIFIT on running performance according to mid-term endurance and selected physiological parameters through quasi-experiment. Four probands completed within one week two identical exercise tests, one in standard running clothes, second one in sportswear EXO Sensifit (Calf, pants and shirt). Test vita maxima was conducted on treadmill, the initial speed was set at 11.5 km / h-1, with increasing speed of 0.5 km / h-1 every 200 meters and inclination 1°. Cardiorespiratory parameters and duration of the test were assessed. We did not notice significant distinction in any physiological parameter. There was an obvious distinction in the duration of the test. Nevertheless, this could be also added to incorporation or placebo-effect.

Key words:
endurance, compressive dress, testing, heart rate

Souhrn
V rámci pilotní studie, jsme prostřednictvím kvaziexperimentu ověřovali vliv kompresní technologie běžeckého oblečení Salomon EXO SENSIFIT na běžecký výkon charakteru střednědobé vytrvalosti a vybrané fyziologické parametry. Čtyři probandé absolvovali v průběhu jednoho týdne dvakrát totožné zátěžové vyšetření, jednou ve standartním běžeckém oblečení, podruhé v oděvu EXO SENSIFIT (calfy, kalhoty a triko). Test vita maxima proběhl na běhacím páse, iniciální rychlost byla 11,5 km.h-1 s navýšením rychlosti o 0,5 km.h-1 každých 200 metrů, sklon 1°. Hodnoceny byly kardiorespirační parametry a délka trvání testu. Nezaznamenali jsme výrazné rozdíly v žádném fyziologickém parametru. Rozdíl však byl patrný v délce trvání testu. Toto však můžeme spekulativně přičíst i zapracování popř. placebo efektu.

Klíčová slova:
vytrvalost, kompresní oděv, testování, srdeční frekvence

Introduction

As a predecessor of compression technologies, which are now implemented in various parts of the clothing can be considered women's tights, which appeared on the market during 20 years of the last century. Among empirically and subjectively per-

ceived benefits of these tights were, besides higher heat comfort and less skin dryness also reduction of pain associated with varicose veins and promoting blood circulation in the lower body (Liu, Lao, Kwok, Li, & Tokura, 2010).

Current compression garments, especially trousers or compression socks (CALF) providing compression from the ankle to calf, support venous blood flow by reducing venous distension in healthy subjects as well as in patients with venous insufficiency. This could be a precondition to increase cardiac output during relaxing and during exercising. Agu, et al. (2004) proved the effect of compression stockings that reduce swelling of the lower limbs caused by venous congestion and also the effect on deep tissue oxygenation of lower limbs (Agu, Baker, & Seifalian, 2004). These findings were confirmed by Bringardem et al (2006). They showed higher oxygenation in healthy people who wore compression stockings (Bringard, Denis, Belluye, et al. 2006). Currently, the compression technique is used in the treatment of patients with venous insufficiency. The compression rate in patients is determined by objective findings: light compression is intended for patients with varicose veins, higher one is applied in patients with post-thrombotic syndrome. Static pressure around 20 mmHg is indicated for thromboprophylactic bedridden patients. It is shown that use of lightly compression stockings increases the flow rate in femoral veins as well as in the inferior vena cava. Better results show calf stockings than the femoral ones. The femoral stockings are indicated in patients with proximal swelling, e.g. after pelvic venous thrombosis, in pregnancy after sclerotherapy or after surgery. Compression stockings are used for prevention of venous thrombosis in long, for example aerospace travel (Herman, Janik, Musil, et al., 2003).

It is obvious that the successful clinical use of compression technology in health care will be followed by efforts to transfer this knowledge to performance and professional sport. The origins of these experiments can be found in 1970 in cycling, in the 80s was examined the effect of compression clothing on performance and in particular the regeneration of athletes. In the 90s of the last century, DuPont has developed a product Power Lycra, which within the framework of a marketing campaign associated with its introduction to the market has attributes such as „support muscles" and „prevention of muscle pain".

Despite the lack of scientific research that would deal with the benefits of compression dress for endurance sport, increase of these products is obvious. This is partly caused by companies marketing that supply their products on the market. Sport pioneer and holder of trends has become triathlon. The current trend of the compression technology spreading in this sport is the subject of Kappler's analytical studies (2009).

Due to marketing policy of individual producers, compression dress is associated with a positive effect on performance increase, respectively speeding up of the recovery time. Conclusions of current scientific studies are not so unambiguous. There are examined many attributes of compression dress use, while the fundamental issue can be included relationship between compression technology and:

- muscle physiology (exercise and fatigue)
- circulatory parameters
- thermoregulation
- recovery
- Injury Prevention
- placebo effect

The influence of compression technology on the size of aerobic energy output while running a continuous pace was examined, where significantly lower values were detected using compression garments (Bringard, Denis, Belluye, et al. 2006). Effect of complete compression dress on running economy was studied by Bakken, et al. (2009). Conclusions of this study are not entirely clear, but partly confirm the conclusions Bringarda et al. (2006) that deals with effect of the compression technology on decrease of running difficulty.

In our study, we focused on comparing mid-term endurance with and without the use of compression garments, namely Salomon product, under the trade name EXO Sensifit. Producer states the following benefits of the use of compression technology:

„A) Better oxygenation: Strengthens upper body, allows a simpler and bigger blood supply.

b) Maximum energy: Reduces muscle deformity and loss of energy by 20%, increases muscle performance by 5%

c) Faster Recovery: Accelerates blood circulation thereby prolongs time to exhaustion by 15% and improves the reduction of lactate „(Salomon, 2011, p. 2)

Within the framework of our pilot, case study, we made an attempt to verify postulates regarding performance improvements.

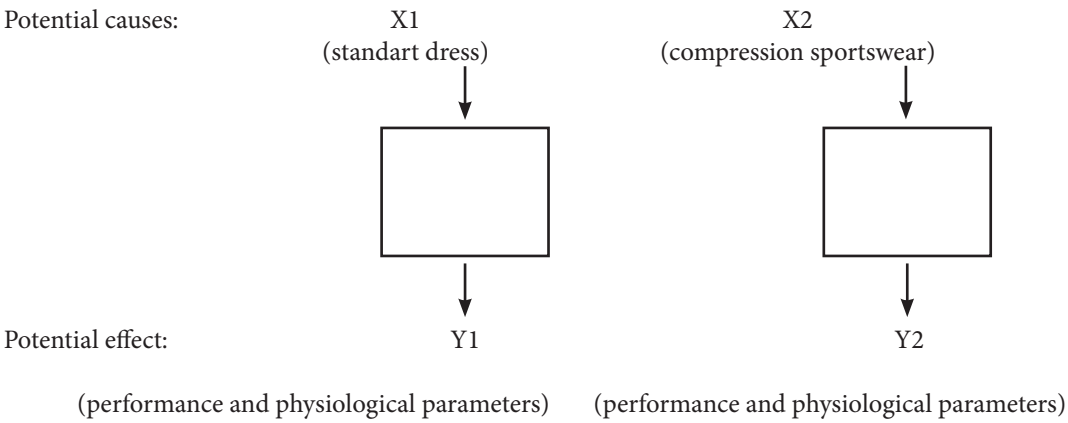
Methods

The essence of our quasi-experimental pilot study is a verification of the influence of clothing with compression technology on manifest variables (performance, heart rate, ventilation parameters) and latent (anaerobic threshold) variables. . The task is detection of an associational relationship, where the input variable is formed by compression and standard clothing output variable is formed by manifest and latent variables. It is also necessary to capture and minimize factors that can affect course and result of the experiment, i.e.:

- characteristics of the probands (age, sex, subjective status, nutrition, fluids, medication, fitness, influence of biorhythms, psycho-emotional load);
- test conditions (climatic conditions, biological stress factor, etc.);
- the issue of the assessment ANP (expert assessment);

Diagnosing quality is generically given value of manifest and latent variables expressed in metric and physiological parameters.

Our intention is is to expose causal relationship by using quasi-experiment. To confirm our hypothesis is in a controlled experiment used a potentially causal variable, in the form of deliberate manipulation, with an expectations for change in the output, thus the category of potential effects (see diagram below).



Within the framework of our pilot study four able-bodied probands (Avg. Age = 39.2, s = 4.7), focusing on an endurance sport disciplines, completed functional stress testing vita maxima on a treadmill repeatedly within one week (HP Cosmos, Germany). The initial speed was set at 11.5 km / h-1, with increasing speed of 0.5 km / h-1 every 200 meters. Inclination of the treadmill was 1° throughout the test. The cardiorespiratory parameters were monitored during the test. Heart rate was scanned and recorded within an independent technology by cardio-indicator Polar RCX5 and ventilation parameters were recorded by methods called "breath by breath" through spiro-ergometer Oxycon Delta (Viasys, Hamburg, Germany).

Probands completed the first testing dressed in standard (free) sportswear that covered whole body except the upper limbs. The second test was completed one week after under similar conditions in the same shoes, with the compression outfit Salomon EXO SENSIFIT. It consisted of a three-quarter pants (covering the knees), calfs and T-shirt. All three parts contain elements of compression technology.

Results

Final values of the stress testing are summarized in Tables 1 and 2. According to casuistic and pilot nature of our study, we did not calculate any average and resulting values fall under each proband separately.

Table 1 Selected values of the stress test vita maxima completed in the ordinary running outfit (test 1) and in sportswear EXO SENSIFIT (test 2)

	1	2	3	4	5	6	7	8	9
Proband A	H R 10kmh^{-1}	% maxi-ma	H R 12kmh^{-1}	% maxi-ma	HR min	HR max	HR avg	HR AT	at AT
test 1	128	69	148	80	72	185	155	171	14,5
test 2	132	71	149	80	85	186	157	169	14,5
Proband B									
test 1	148	73	172	85	110	202	176	184	13,5
test 2	147	72	173	84	113	205	179	185	13,5
Proband C									
test 1	141	75	153	81	100	188	167	172	13
test 2	133	71	152	81	98	188	161	167	13
Proband D									
test 1	123	68	147	81	99	182	154	161	13,5
test 2	124	68	144	79	82	183	152	162	14

Legend:

1 – heart rate while running speed 10 km h^{-1}

2 –. HR percentage value while running speed 10 km h^{-1} (HR max = 100%)

3 – heart rate while running speed 12 kmh^{-1}

4 – HR percentage value while running speed 12 km h^{-1} (HR max = 100%)

5 – minimal HR

6 – maximum HR

7 – average HR

8 – HR at anaerobic threshold

9 – speed at the anaerobic threshold (km h^{-1})

Table 2 Selected maximum values of the stress test vita maxima completed in the ordinary running outfit (test 1) and in sportswear EXO SENSIFIT (test 2)

	1	2	3	4	5
Proband A	v max	VE	BF	RQ	VO_2max
test 1	17,5	127	47	1,18	53,5
test 2	18	138	48	1,18	57,9
Proband B					
test 1	17	131	50	1,12	63,6
test 2	17,5	146	57	1,20	68,0
Proband C					
test 1	16	140	45	1,11	62,3
test 2	16,5	138	46	1,08	60,9
Proband D					
test 1	17	150	52	1,07	71,22
test 2	17,5	155	48	1,02	78,3

Legend:

1 – maximum reached speed (km h^{-1})

2 – ventilation (L • min^{-1})

3 – respiratory rate

4 – respiratory quotient

5 – maximum oxygen consumption (L • min-1 kg^{-1})

For a small number of probands is not possible to determine the value of statistical or substantive relevancy of distinction in diameter. Partly we can evaluate practical relevancy. The results do not reveal significant differences in any of the observed physiological and parametric values. Nevertheless the only value that increased at each proband in the second part of the test is the maximum achieved speed. This difference made 0,5 km h^{-1} for each individual, which corresponds to 150 meters.

Discussion

We see limits of this study not only in the number of probands (it is necessary to increase the amount of tested individuals) but also in the design of the study. We assume that if compression technology brings any benefits, so these benefits are not detectable during running performance according to mid-term endurance specifically in graduating test vita maxima lasting up to 10 minutes.

Similar findings were published in Faulkner's study et al. (2012), which dealt with the influence of compression apparel on performance and selected physiological parameters in short and speed endurance capabilities (Faulkner, Gleadon, McLaren, et al. 2012).

Kleingartner et al. (2012) dealt with mid-term endurance and influence of the compression apparel on physiological parameters (HR, VO2max and RPE). Unlike our research was the initial locomotion walk rate of 4,0; 4,8 and 5, 6 km h^{-1}. There was no significant effect of the compression technology on observed parameters. Minimum differences on the border of substantive relevancy were noted in RPE (4,8 km.h^{-1}) and VO2max (4 km.h^{-1}) (Kleingartner, Porcari, Doberstein, et al., 2012).

A similar experiment design as in our study chose Kemmler et al. (2009) although he tested long endurance. Duration of the graduated stress test vita maxima was 35.03 in average or 36.44 min. (1st and 2nd test). Probands used only compression knee-length socks. This research confirmed significantly higher performance at maximum stress test once the compression knee-length socks were used (ES = 0,40). Insignificant difference was observed only for values of VO2max (52,2 vs. 53,3 ml.kg.min^{-1}, ES: 0,18). Running performance on the level of anaerobic (14.11 vs. 13.90 km h^{-1}, ES: 0.22) and aerobic threshold (13,02 vs. 12,74 km h^{-1}, ES = 0,28) was significantly higher when compression knee-length socks were used (Kemmler, von Stengel, Köckritz, et al., 2009). Kemmler et al. (2009) deduced that the use of compression technology improves running performance, but explanatory mechanisms can be partly attributed to slightly higher aerobic capacity. In our study we recorded higher duration of maximum stress test at all four probands same like Kemmler et al. (2009) did. Likewise appear insignificant changes in ventilation parameters. From our point of view, these effects could significantly impact performance in the second test. It is also difficult to solve the issue of placebo, because in this type of research design we cannot satisfactorily treat control group and implement placebo.

This study served as a pilot study and in subsequent work we want

a) increase the number of tested individuals to be able treat the data statistically

b) modify the protocol in order to observe performance in long endurance thereby we will contribute to addressing the issue impact of compression technologies to delay onset of fatigue and exhaustion

c) monitor dynamics of stress lactate and post-exercise lactate, what might contribute to addressing the issue effect of compression technology on speed and quality of recovery

Resume

Pilot, casuistic study, whose limits of notice values are determined, showed minimal effect on physiological determinants during mid-term endurance exercise. It confirmed the conclusions of similar studies that compression technologies can lead to a later onset of fatigue and prolong the period of endurance performance. Next research following this study will be implemented in the long-term endurance and it will mainly focus on the role of compression technology in the post-exercise recovery.

References

1. Agu, O., Baker, D., & Seifalian, A.M. (2004). *Effect of graduated compression stockings on limb oxygenation and venous function during exercise in patients with venous insufficiency. Vascular. 12*(1), 69-76.
2. Bakken, B., Heil, D.P., Borgen, K., & Willis, S. (2009). *Influence of lower-body compression tights on markers of economy during steady-state running.* Unpublished manuscript, Montana State University, Bozeman.
3. Bringard, A., Denis, R., Belluye, N., & Perrey, S. (2006). *Effects of compression tights on calf muscle oxygenation and venous pooling during quiet resting in supine and standing positions. Journal of Sports Medicine and Physical Fitness.* 46(4), 548-554.
4. Faulkner, J.A., Gleadon, D, McLaren, J., Jakeman, L., & John, R. (2012). *Effect of lower limb compression clothing on 400 m sprint performance.* Journal of Strength & Conditioning Research: [Epub ahead of print]http://www.ncbi.nlm.nih.gov/pubmed/22592172
5. Herman, J., Janík, I., Musil, D., Staffa, R., & Zbořil, P. (2003) *Chirurgie varixů dolních končetin.* Praha: Grada, 200 s. ISBN 80-247-0252-5
6. Kappeler, N. (2009). What's up with those socks? *Triathlete. 3*, 108-115.
7. Kemmler, W., von Stengel, S., Köckritz,. C, Mayhew, J., Wassermann, A., & Zapf J. (2009) *Effect of compression stockings on running performance in men runners.* J Strength Cond Res. 2009 Jan;23(1):101-5. doi: 10.1519/JSC.0b013e31818eaef3.
8. Kleingartner, A., Porcari, J., Doberstein, S., Hendrix, Ch., & Foster, C. (2012) *Do toning pants help to give you a better workout?* Journal of Sports Science and Medicine 11, 567-568
9. Liu, R., Lao, T.T., Kwok, Y.L., Li, Y., & Tokura, H. (2010). *Effects of compression legwear on body temperature, heart rate, and blood pressure following prolonged standing and sitting in women. Fibers and Polymers. 11*(1), 128-135.
10. Salomon (2011) korporátní reklamní materiál, nedatováno.

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