ORIGINAL RESEARCH PAPER

THE INFLUENCE OF SERVICE CLOSING SETS ON THE WORKING CAPACITY

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Abstract

The aim of study was to determine the specific clothing sets impact on physical working capacity. Repeated working capacity tests were conducted on Latvian police officers` summer and winter wear clothing sets (uniforms), in order to assess the changes in physical working capacity under the influence of specially designed garment sets. Step-ergometry and physical fitness testing after EUROFIT test methodology was used to evaluate the working capacity under certain dynamic conditions. Physical working capacity in Harvard steptest by HSTI index averaged out to 78.6±1.3, which indicates mediocre work capacity of participants. The fitness of the experiment participants by EIROFIT test results was evaluated as average or below average, but by separate indicators (static muscle strength, abdominal muscle strength, cardiorespiratory system functional capability) as low. Under influence of the clothing sets, physical work ability decrement was determined in the winter uniform of an average of 29,8% (P<0,05) compared to the summer uniform. The set of winter clothing significantly (P<0.05) decreases body's strength indicators that are involving large amplitude motions, as body`s flexors dynamic strength (17,6%), leg muscle explosive power indicators (5,4%). The movement speed agility (3.5%) and body flexibility reduces significantly. Insignificant (P>0.05) changes appear in static muscle strength, arm movement speed, hand's dynanometry indicators, as well as a static body balance. Comparing the changes of body's physical fitness indicators under the influence of summer and winter wear uniforms, it can be concluded that significant performance decrease of policemen working capacity was detected while wearing winter uniforms. That was caused by too tightly designed clothing restricting body and arm movements, especially in wide range body and arm motion, but practically *does not affect the performance of small range motions of body and arms or static body muscle tension. Significant deterioration of physical working capacity and the result deterioration of cardiorespiratory or endurance running tests with gradually increasing speed, are caused by the movements limiting effects of winter clothing kit, total weight of winter uniform, as well as the loss of thermoregulatory efficiency shown by the gathering of excreted sweat in winter clothing.*

Key words: *Service clothing sets, physical working capacity, Harvard steptest, EIROFIT test*

Introduction

This research was carried out as a part of ESF financed RTU project aimed at development of new functional properties of smart textile and integration in innovative products. Depending on the job activity, service clothing can be very specific and different. The police uniforms' impact on police officers performance was investigated in this research.

Police uniforms have very high standards, due to difficult and various working environments, having to spend long hours both in offices, cars, and outdoors both in summer and winter. But the actually police officers uniforms was produced many years ago and have grown out-of-date and are not functional any more. RTU is implementing now a new project, to create new functional materials that can be used in police uniforms.

The aim of the research was to determine how do the new service clothing sets influence police officers performance ability.

Materials and methods

12 participants from the Riga region State Police Office took part in 30 experiments, testing 3 sets of 6 types of uniform developed during the customer's project.

The average age of the experiment participants was 25.7±1.6 years. During the experiment all participants were apparently healthy and expressed no complaints about the state of their health.

All participants' physical performance was evaluated according to standard Harvard Steptest procedure (5), and using the EUROFIT test battery which tests 9 various abilities such as muscular strength, endurance, balance, speed, agility, and cardio respiratory endurance by using 20 meter shuttle test (1,2,7).

Hand dynamometry was used to determine static force of the muscles. Maximal force of the hand flexors was determined during a test using hydraulic hand dynamometer Saehan Masan (Korea).

Heart rate (HR) was registered at rest, during physical exercise and recovery period and monitored using telemetric pulse system Polar Team System (Finland).

The tests were organised in LASE laboratory premises and in sport game hall in the morning and before noon. The temperature during laboratory tests was 15 – 16 C on average, the air humidity was 78 – 82%.

Results and discussion

The physical performance ability according to the Harvard Steptest Index (HSTI) was on average 78.6±1.3 which indicates a mediocre participant performance (6).

Body mass index (BMI) that describes body weight and height ratio was on average 28.3±1.1 kg/m2 in participants, which according to normative (4) corresponds to increased body mass. Increased BMI can be explained with increased muscle mass, as well as increased fat percentage in the upper arms, abdomen and back area.

Forced vital capacity of the lungs (FVC), was determined by using flow spirometer (One Flow Spirometer, UK) and was on average 5.09±0.40 liters in group, which exceeds the normative but only for untrained men (5).

If the FVC indicators that describe the functional state of the respiratory system can be considered good, then Life index (LI), which describes the vital capacity of the lungs and body mass ratio in a group was on average 55.9±5.1 ml/kg which is lower than the average normative for untrained men (5). The differences in respiratory system functional indicators can depend on increased body mass, indicated by body mass index (BMI) scores.

The EUROFIT test results (Tab.1) – body static balance in Flamingo test on average 10.0±0,9 times per minute; plate tapping – 12.0±0,1 seconds, Sit-and-reach flexibility test – 8.0±1.0cm, speed and agility by 10x5m shuttle – 20.0±0.22 seconds, showed an average balance, flexibility, speed and agility performance.

Table 1

EUROFIT test indicators in summer and winter clothing sets

Indicators	Flamingo Balance (1min)	Sit-Ups (1min)	Sit-and-Reach (cm)	Plate tapping(sek)	Bent arm Hang (sek.)	Standing broad jump (m)	Shuttle run (10x5m) sek	Endurance shuttle run (20 m) min.	Body weight (kg)	Right hand grip (kg)	Left hand grip (kg)
Summer clothing sets	10.0 ±0.9	34.0 ±2.0	8.0 ±1.0	12.0 ±0.1	12.4 ±1.7	2.22 ±0.07	20.0 ±0.2	4.23 ±0.29	93.4 ±2.8	56.0 ±2.0	57,. ±1.8
Winter clothing sets	7.5 ±0.4	28.4 ±2.2	0.75 ±1.8	10.7 ±0.1	13.0 ±1.9	2.10 ±0.05	20.7 ±0.3	3.77± 0.19	92.9 ±2.6	55.5 ±1.8	56,. ±2.2
Difference	-2.5	-6.0	-7.25	-1.3	0.6	-0.12	-0.7	-0.46	-0.45	-0.5	-1.0
Confidence	>0.05	<0.05	<0.05	<0.05	>0.05	<0.05	<0.05	<0.05	<0.05	>0.05	>0.05

The strength indicators, such as arm strength on average was 56.0±2.0kg, sit-ups – 34.0±2.0 times in a minute, bent arm hang – 12.4±1.7 seconds, standing board jump – 2.22±0.07 meters, indicate mediocre or low core, leg, arm, and shoulder muscle group strength performance.

The performance of cardio respiratory. system indicated 20 meters endurance in the shuttle – run by 4.23±0.29min which indicates that participants have a generally low endurance and the body`s aerobic abilities pointing out a lack of cardio respiratory training.

In general the EUROFIT test results of the participants are average or below average, but separate results such as static muscle strength, abdominal muscle strength, cardio respiratory system functional capability are low.

To evaluate how the changes in performance can be influenced by the clothing sets, repeated tests were carried out, both in summer and winter clothing sets (Tab.1).

Physical performance according to the Harvard Steptest Index in winter clothing sets were evaluated as 55.2±6.8 or low. Physical performance according to HSTI was by 29.8% lower in comparison to the police officers who performed in summer clothing, which is significant and statistically feasible (pp<0.05). Such a significant reduction can depend on several factors. It is important to verify the movement restriction of the winter clothing sets, since the movement is particularly problematic when stepping on the 50cm high Harvard Steptest bench. When the resistance created by the clothing is solved, the muscle load and performance increases, which in its turn increases the heart rate during the test and recovery period thus decreasing the Steptest index evaluation (Fig.1).

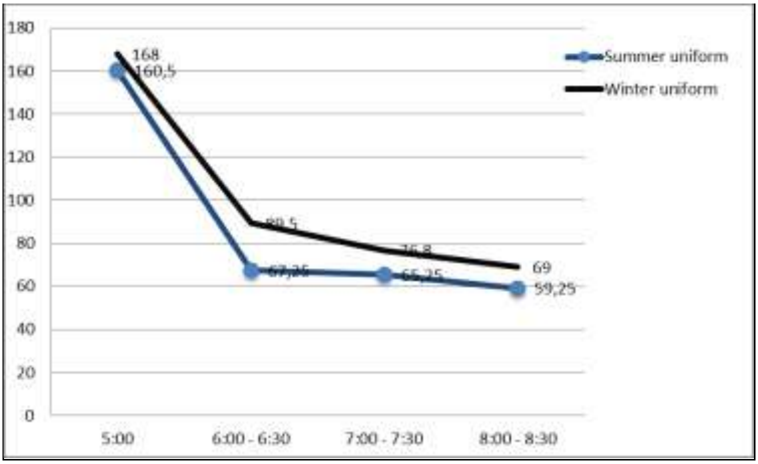

Figure 1. Heart rate frequency during Harvard steptest and recovery period in experiment participants wearing various clothing sets

The overall body load including heart rate is increased in the steptest by the weight of winter clothing set, which is 4.6kg in comparison to summer clothing set that is 2.9kg.

The heart rate during performance is affected by the endogenous heat discharge efficiency. The changes in the body and clothing mass due to sweat after the performance tests indicate efficient endogenous heat discharge (8). The amount of water lost by sweating during the experiments was determined by the changes of body mass by weighing before and after an entire day of tests. Throughout the tests, the participants were not allowed to consume water or any other liquids.

Among various clothing sets, the greatest body mass loss was determined to participants wearing summer clothing sets, where as participants with the winter clothing sets, that is, with the greatest overall load – the average loss of water in the group was 36.8% ($p<0.05$). Such a reduction in sweat release suggests that the sweat is stored by the winter clothing and it remains there (3.8). Thus it can be concluded that the winter uniform decreases water vapor penetrability, which results in decreased water loss through sweat in comparison to the summer uniform. Therefore the results indicate that the winter clothing has insufficient thermoregulation efficiency.

When evaluating the clothing set influence on performance, it was vital to analyze the test results changed performed in various clothing sets (Tab.1). A significant ($p<0.05$) decrease by 17.6% of body flexor dynamic force was observed, as well as decrease in muscle explosive force in the jump test by 12.0 cm or 5.4% on average, also decrease of 0.7sec or 3.5% in running speed and agility when performing 5x10m shuttle-run, which were mainly because of the winter uniform restrictions to the amplitude of body movement. The decrease in flexibility and static balance was insignificant ($p>0.05$).

There was a significant decrease ($p<0.05$) in cardio vascular endurance when performing 20m shuttle-run with gradually increasing speed – 0.46sec or 10.9% on average in the group. The decrease in cardio respiratory performance in winter clothing sets is caused by fatigue, which occurs when overcoming the clothing restrictions, as well as overcoming the additional body load with the total winter clothing set weight.

Regardless of the clothing sets, the hand dinamometry indicators remained almost unaffected ($p>0.05$) because the execution of the test is basically not affected by the police winter uniform.

A positive dynamics in the winter clothing sets was determined in two tests. The plate taping test result, when tapping 25 times on the plate, increased by 1.3sec or 10.8% on average ($p<0.05$). Since one has to move the hand on the board back and forth in a short distance, it can be concluded that the winter uniform does not affect arm movements within small amplitudes.

Regardless of the increased total weight of the winter uniform set, the bent arm hang test results increased by 0.6sec or 4.8%. During the test, the arms are fixed in a particular position and no movements are made which could explain the insignificant ($p>0.05$) increase in static muscle endurance.

Thus, in general, one can conclude that under the influence of winter clothing sets significantly ($p<0.05$) body strength indicators connected with wide amplitude movements are decreased, such as body muscle dynamic strength and leg muscle explosive force. Significant decrease ($p<0.05$) is observed in the movement speed and agility, as well as flexibility, causing reduced performance in winter clothing sets.

At the same time muscle static strength, hand movement speed, hand dynamometry, as well as the static balance of the body are not affected because the winter clothing sets do not affect the body and arm movement performance with small amplitude or static muscle exertion with no movements.

The results of cardio respiratory or endurance running test with gradually increasing speed suggest that winter clothing sets significantly ($p<0.05$) affect the performance – cardio respiratory system abilities decrease because of the movements restrictive winter clothing sets, in the addition to the extra winter clothing weight, as well as decrease in thermoregulation, which is connected to the accumulation of sweat in the winter uniforms. General tiredness and lack of motivation to achieve the best result possible during the last load test cannot be excluded in this test.

Conclucions

1. In order to assess the changes in working performance under the influence of clothing set developed by the customer, repeated performance tests were carried out using summer and winter police uniform sets. Physical working capacity in Harvard steptest as per HSTI index decrease by 29.8%, as compared with the participants' performance when wearing summer police uniform. Such significant ($p<0.05$) decrease of working capacities is caused by several factors, such as movement restriction by winter clothing set, general body load caused by the weight of winter clothing set which is 1.7kg heavier, and lower endogenic thermal conduction effectiveness which is proven by body mass and clothes weight change as a result of sweating after performance and physical training tests. The sweat excreted by the body in winter clothing set accumulates and remain on the clothing set which is determined by reduced water steam conductivity that leads to reduced water loss while sweating, as compared with summer uniform. Thus, the results obtained show a lack of winter clothing uniforms thermoregulatory effectiveness.

2. Having assessed the impact of the developed clothing sets on the body performance in general, we can conclude that winter uniform sets cause significant decrease of the performance of force indicators ($p<0.05$) which is related to large amplitude motions, such as dynamic force of body flexors, speed indicators of leg muscles. The speed of movement and agility, body flexibility significantly decrease which leads to decreased performance of the police in winter uniform. Static endurance of the muscles, speed of arm movements, dynamometric indicators for the arms and body static balance function change insignificantly ($p>0.05$), as winter uniform does not affect the movements with small range of body and arm movements or static body muscle tension without motion performance.

The results of cardiorespiratory or 20m endurance shuttle running test with gradually increased speed show that winter clothing sets cause significant decrease in cardiorespiratory system performance ($p<0.05$) which is related to motion restricting impact of winter clothing sets, additional body load with the total weight of winter uniform and decrease in thermoregulation effectiveness related to accumulation of excreted sweat in winter uniform.

References

1. *Eurofit Fitness Testing Battery*. The Sport Science Resource. Retrieved 22.09. 2013. from http://www.topendsports.com/testing/eurofit.htm.
2. *EUROFIT metode*. Medicīniskās tehnoloģijas metodes izvērsts apraksts. Nacionālais veselības dienests. Retrieved 22.09.2013. from http://www.vmnvd.gov.lv/lv/datu-bazes/arstnieciba-izmantojamo-medicinisko-tehnologiju-datu-baze/32-sporta-medicinas-mediciniskie-pakalpojumi/eirofit-metode
3. *Heat transfer and evaluation of clothing. ACCP-1* (1992). Allied Combat Clothing publication. NATO International Staff – Defence Support Division. Military agency for standardization.
4. Kent, M. (2007). The Oxford Dictionary of Sports Science and Medicine.-3rd ed. – Oxford, NY: Oxford University Press, 624 p.
5. Lāriņš, V. (2004). Sporta medicīna. LSPA, Rīga,100 lpp.
6. *The Harvard Steptest.* The Sport Science Resource. Retrieved September 22.09.2013. from http://www.topendsports.com/testing/tests/step-harvard.htm.
7. Sauka, M., Priedite, I.S., Artjuhova, L., Larins, V., Selga, G., Dahlstrom, O. Et al. (2011). Physical Fitness in Northern European Youth: Reference values from the Latvian Physical Health in Youth Study. *Scandinavian Journal of Public Health*, 39, 35-43.
8. Šitvjenkins, I., Viļumsone, A., Lāriņš, V., Ābele, I., Torbicka, H., & Pavāre, Z. (2012). Quality Evaluation of the Combat Individual Protection System by EUROFIT Physical Fitness Testing. *LASE Journal of Sport Science.* Riga, Vol.3, Nr.1, p.31-46.

Submitted: April 19, 2013
Accepted: November 27, 2013