

## **A Research Program on Health, Performance and Cold Protection of Soldiers in Long-Term Combat during Winter**

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### **ABSTRACT**

*The information of the effects of cold environment on health and performance of soldiers comes mainly from short-term measurements, which have lasted only for a few hours or maximally a few days. However, it could be expected, that during long-term strenuous combat exercise in winter conditions several factors e.g., physical and mental fatigue, decrease of thermal insulation of clothing due to moisture and dirt, and dehydration may decrease performance.*

*The aim of this research program is to improve military performance in extended military operations in cold conditions. The research is performed in co-operation with Finnish Defence Forces and the Oulu Regional Institute of Occupational Health during years 2003 – 2007 in Northern Finland.*

*The measurements are carried out in ca. two weeks winter combat exercise and in additional laboratory and field measurements. In a two weeks winter manoeuvre in December 2004 the study was carried out in four levels: 1) Soldiers from two companies (n = 319) answered to detailed questionnaires before the exercise, in the middle of the exercise before starting the shooting training, and at the end of the entire exercise. In the first questionnaire the background and expectations were asked. In the later questionnaires the experiences were recorded by the same structure as in the first questionnaire. 2) One platoon (28 subjects) from these companies was selected for detailed physical and health examinations, which were carried out before, in the middle and after training. Moreover, their experiences, physical and mental strain, nutrition and evaluations of clothing were recorded every day by several questionnaires. 3) The thermal balance of 10 subjects was measured continuously during the exercise by recording skin and clothing temperatures, heat flow from the skin and moisture inside the clothing. Also heart rate was measured and the movements of four subjects were recorded by satellite navigation system (GPS). 4) The activities of the studied groups were recorded by military personnel, and they also evaluated the military performance of the companies.*

*The data was recorded successfully and in spite of many studied parameters, the collaboration between researchers, military personnel, and studied units and individuals worked well. Before starting the study, only a few subjects refused to participate in the measurements, which were based on voluntary participation. The troops and individuals were usually able to perform their tasks. Preliminary results suggest e.g., that there was no marked decrease in physical performance during the field exercise and the expectations and experiences were strongly associated with each other.*

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Available from: <http://www.rto.nato.int/abstracts.asp>.

## **1.0 INTRODUCTION**

With few exceptions, the information on the effects of cold environment on health and performance of soldiers comes from short-term measurements, lasting only for a few hours or maximally a few days. To our knowledge, the existing information on extended winter time military field training describe the effects of 4.5 days training on physical performance (Hackney et al. 1991), 9 - 10 days field training on cognitive and physical performance (Hodgdon et al. 1991), hormones and metabolism (Hackney and Hodgdon 1991, 1992), 10 - 12 days training on accidents, illnesses or frostbite (e.g., King et al. 1993, Burstein et al. 1996) and a 12 weeks training on haematological parameters (D'Alesandro et al. 1992). The results have shown that thyroid function was altered already after 72 h training (Hackney et al. 1995), but if the amount of clothing, nutrition and sleep was adequate, no marked decline in physical performance was seen (Hodgdon et al. 1991). During a 12 weeks military field training haemoglobin and red blood cell count decreased and plasma volume increased (D'Alesandro et al. 1992). It has been also shown that expectations before the training are strongly associated with the later experiences in cold (Johnson et al. 1989).

It could be expected, that during long-term strenuous combat exercise in winter conditions several factors e.g., physical and mental fatigue, sleep loss, decrease of thermal insulation of clothing due to moisture and dirt, dehydration and negative energy balance may decrease the performance of soldiers and military units.

The aim of this research program is to improve military performance in extended military operations in cold conditions. Another aim is to improve the methods of monitoring and evaluating soldiers' physical and mental performance in the field in winter time. Part of the study is also to compare the newly developed model M2005 of combat clothing and personal equipment of Finnish soldier with the combat clothing model M91.

Specific aims of the research program are to evaluate soldiers' thermal balance, energy expenditure, performance, physical loading, fatigue and recovery from physical strain, to compare soldiers' own estimation of their performance to the measurements and to compare the performance of those soldiers, who have asthma diagnosis, to those who have not. The measurements are carried out in ca. two weeks winter combat exercise and in additional experiments in the climatic chambers and in the field during combat training.

The research is performed in co-operation with Finnish Defence Forces (FDF) and the Oulu Regional Institute of Occupational Health (ORIOH) during years 2003 – 2007 in Northern Finland. The project is a continuation of long-time research and development cooperation between the FDF and the ORIOH.

## **2.0 GENERAL DESCRIPTION OF MATERIALS AND METHODS**

Human factors and variables, as well as the effects of different combat clothing materials are studied in this project. Questionnaires, physiological measurements, performance measurements, health examinations and clothing tests are applied. The questionnaires record the background information of the soldiers, their expectations and experiences, physical and mental strain, nutrition and evaluations of combat clothing. Physiological measurements include maximal oxygen consumption test on a bicycle ergometer, continuous heart rate measurements, spirometry, peak-flow measurements and muscle performance tests. The thermal balance is measured by recording skin and clothing temperature, heat flow from the skin and moisture inside the clothing.

Until now, the main part of the study has been carried out during a 12 days field exercise in December 2004 in Northern Finland. The exercise started as a 5 days combat training and continued by a 7 days combat shooting

training. The research team took part in the planning sessions of the manoeuvre to ensure that the measurements could be carried out without problems either to the study or to the manoeuvre.

The subjects were voluntary male conscripts, aged 18 – 23 years, from an infantry battalion of Kainuu Brigade, Kajaani. The study was carried out in four levels.

## **2.1 Questionnaires on Expectations and Experiences**

Soldiers from two companies (n = 319) answered to detailed questionnaires before the exercise, in the middle of the exercise before starting the shooting training, and at the end of the entire exercise. In the first questionnaire the background and expectations were asked. In the later questionnaires the experiences were recorded by the same structure as in the first questionnaire.

## **2.2 Physical Fitness, Physical Strain and Health**

One platoon (28 subjects) from these companies was selected for detailed physical and health examinations, which were carried out before, in the middle and after training. Moreover, their experiences, physical and mental strain, nutrition and evaluations of clothing were recorded every day by several questionnaires.

## **2.3 Heat Balance, Heart Rate and Locomotion**

The thermal balance of 10 subjects was measured continuously during the exercise by recording skin and clothing temperatures, heat flow from the skin and moisture inside the clothing. Also heart rate was measured and the movements (route, speed, distance and altitude) of four subjects were recorded by a satellite navigation system (GPS).

## **2.4 Military Performance**

The activities of the studied groups were recorded by military personnel, and they also evaluated the military performance of the companies. Moreover, some individual evaluations of military performance were also carried out.

## **3.0 EXPERIENCES FROM MEASUREMENTS DURING THE MANOEUVRE**

The data was recorded successfully in spite of many studied parameters. The collaboration between researchers, military personnel, and studied units and individuals worked well. This success is partly due to that the research team took part in the planning sessions of the manoeuvre and thoroughly designed the timing and places of the measurements with the military planners.

The whole study was based on voluntary participation. The test subjects were conscripts, and after information about the study their consent was asked. Only a few subjects refused to participate in the measurements. During the 12 days measurements no one refused to continue the measurements.

The soldiers were usually able to perform their tasks in spite of the continuous or repeated measurements during the entire exercise. It seems to be important that the daily measurements do not require long transportation. Especially, the measurements should not shorten the resting time of the test subjects or impair the nutrition. Getting new garments to wear during the test period seemed to increase the motivation markedly.

Preliminary results from the measurements in the 12 days winter manoeuvre suggest e.g., that there was no marked decrease in physical performance during the exercise and the expectations and experiences were strongly associated with each other. The manoeuvre performed did not seem to be so strenuous that it would have produced long term fatigue. Furthermore, the soldiers were not engaged in sustained overexertion during the manoeuvre. The subjective estimation of personal performance, as well as mood, was better after the manoeuvre than before it. The modern technology with satellite surveillance (GPS) seems to be a promising tool to evaluate soldiers' activities and performance in field conditions.

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