

PHYSIOLOGICAL EFFECTS OF WEARING LIGHT WEIGHT NBC BATTLE DRESSES IN HOT ENVIRONMENT

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INTRODUCTION

A solution to reduce heat strain is to replace the NBC over garment plus standard battle dress by an NBC combat clothing design. A challenge for industrialists is to conceptualize it without a significant heat stress increase by conserving the NBC protective qualities. Four NBC suits are compared to the standard battle dress. Chemical filters inserted are the only differences between the suits (CICC = charcoal impregnated compressed cells, experimental CICC, sphericals and activated charcoal cloth). We investigate physiological and psychological load due to wearing such equipment in hot and humid environment.

METHOD

Six modalities were investigated for all experiments (reference nude, standard battle dress, TcNBC O = light weight NBC battle dress with CICC, TcNBC A = light weight NBC battle dress with experimental CICC, TcNBCB = light weight NBC battle dress sphericals, TcNBCC = light weight NBC battle dress with activated charcoal cloth). In a climatic chamber the CLO index was measured on a mannikin. Each ensemble was tested six times with hood in place. Four male soldiers walked at 4km/h for 45 minutes in a climate chamber (Td. = 35 °C, Hr = 40%). Each walk was preceded by 10 minutes seated rest and followed by 30 minutes seated rest. Subjects did not drink during testing. All suits were in full protection mode (gas mask, gloves, hood in place). Measurements were : rectal and skin temperature, heart rate, sweating, sweating weight included in each part of the suit, and psychological questionnaire after each test.

The same protocol was performed in a tropical country with six soldiers from an operational group. WBGT vary from 29°C to 31°C during the morning under an open tent (30°C to 34 °C under sun). Subjects were tested at the same hour. Walking was limited to 30 minutes under the sun. Before and after, they sat down under the shade of an open tent. Drinking was then possible. Measurements were : climatic parameters, rectal and skin temperature, heart rate, sweating, sweating weight included in each part of the suit, psychological questionnaire after each test, hematocrit, urine volume, osmolality and density.

RESULTS

We obtained a CLO index of : standard battle dress = 0.6, TcNBCO = 0.7, TcNBCA = 0.8, TcNBCB = 0.9, TcNBCC = 0.7. In the climatic chamber, the difference between rectal and skin temperatures was equivalent for all suits, even for the standard battle dress. During walking period, this difference was higher than 1°C with standard battle dress and TcNBCC. Heat stress and strain perception (questionnaire) are higher with TcNBCB.

Table 1 reports total dehydration (difference between body weight before and after the tests minus water consumed) for field trials. Just after walking, a decreased plasmatic volume was present when NBC suits were worn. Rehydration was not sufficient to replace water losses.

	Reference nude	Standard battle dress	TcNBCO	TcNBCA	TcNBCB	TcNBCC
Total dehydration bilan (ml)	48 ± 88	429 ± 96	567 ± 81	646 ± 85	611 ± 98	519 ± 94
% of body weight loss	0.06 %	0.61 %	0.81 %	0.92 %	0.87 %	0.74 %

Figure 1 presents the mean difference between rectal and skin temperature during the field experiment. It is never smaller than 1°C. TcNBCO and TcNBCC are the ensembles with the best results.

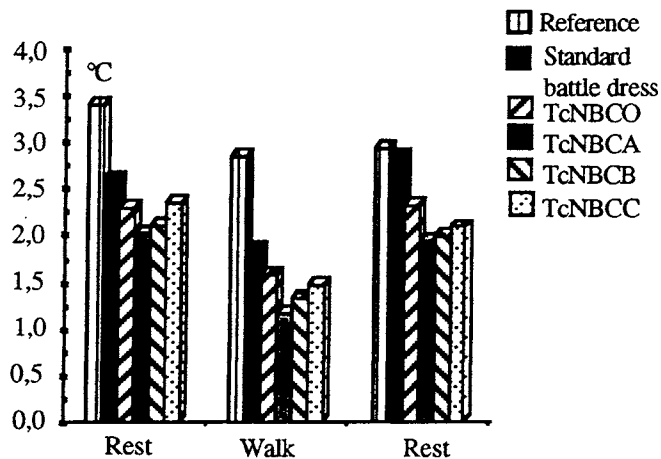


Figure 1 : Δ Tre-Tsk of the field experiment

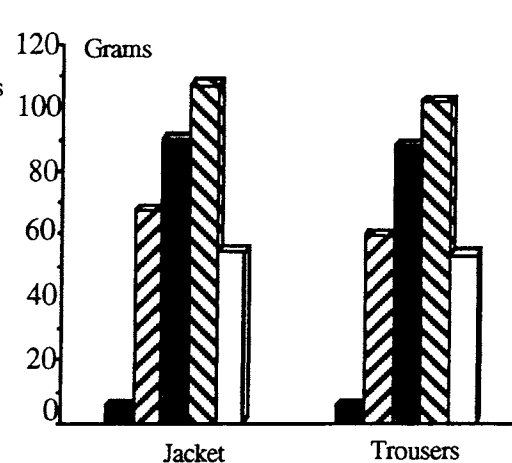


Figure 2 : Mean sweating fixed on each suit

In Figure 2, we find mean sweating weight fixed on each part of the suits. There was a large difference between standard battle dress and NBC suits. Jacket and trousers were impregnated by equivalent sweating weight for all modalities. TcNBCB fixed more sweating than others NBC suits.

TcNBCB also has the better protection level. Chemical tests before and after real sweating impregnation, show the importance of human sweating upon the decreasing of protection level with all NBC suits. The most permeable permit sweating evacuation out of the clothing itself and conserve a good protection level in comparison with the same dry suit.

CONCLUSIONS

All the physiological results show excellent consistency between laboratory and field tests. A good correlation was found between CLO index, total dehydration, Tre-Tsk difference (on the field) and sweat fixed inside the NBC suits. All light weight NBC battle dresses were wearable in full protection level. Heat strain differences were noticed between the chemical filter types due especially to their wind and water vapour permeability. Sweat was more fixed inside the less permeable suit and then decreased chemical protection. Wearing full protection is better accepted on the field.

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