INDIVIDUAL PARAMETERS INFLUENCING TOLERANCE TIME OF MINE RESCUE TEAM MEMBERS IN THE HEAT

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INTRODUCTION

The maximum exposure time for mine rescue teams working in hot climatic conditions has been fixed in time tables [3] for the German mining industry. **As** a common finding in the rescue service physical fitness and heat tolerance are not strongly correlated. Several working groups have attempted to identify individual parameters (anthropometric data, physical fitness etc.) that influence a subject's reaction to heat stress (e.g. [4], [5]). The study presented here shows a practical approach to estimate the influence of anthropometric data, physical fitness and strain parameters at the end of a heat tolerance test (HTT) for all mine rescue team members of a mine in order to get criteria that allow a ranking with respect to heat tolerance and then eventually may be applied to new candidates of mine rescue teams.

MATERIALS and METHODS

Physical fitness was measured using a Dynavit(TM) test on a bicycle ergometer - corresponding to a $W_{180\text{-}age}$ ergometric test.
A heat tolerance test was performed according to [7]: (30 minutes walking on a treadmill [external load 70 W] at t_{db} = 39 °C; t_{wb} = 37 °C; clothing: shorts) that should be used to predict the strain during a climatic exposure. Only one subject had to quit the HTT before its nominal length of 30 minutes.
After a resting phase of 1.5 hours at the same day a climatic exposure was performed at t_{db} = 32 °C and t_{wb} = 27 °C with treadmill work on alternating levels of slope and velocity. During this test a self contained breathing apparatus **(SCBA;** 14.1 kg) and a flame proof garment (7.0 kg) were worn.
During the exposures an ECG was recorded to estimate heart rate and rectal temperature was monitored continuously. Body weight was measured before and after each exposure. The subjects were informed that they could request termination of the exposure at any time. Exposures were also discontinued in the event of either heart rate exceeding a value of "220-age" or rectal temperature exceeding 38.5 °C.
Valid data are available for a total of 52 members of a rescue team.

RESULTS

The anthropometric data of the subjects are given in Table 1. The fitness score has a mean value (± std. dev.) of 109 ± 21 (values above 100 are classified as "good", values above 125 as "very good"). At the end of the HTT heart rate was 143 ± *26* min^{-1}, rectal temperature ammounted to 38.1 ± 0.3 "C and mass loss during HTT was 0.85 ± 0.43 kg.

The mean time of the climatic exposure **was** 55 minutes. The data was analysed using a "survival analysis with covariates" (BMDP 2L [1]), as **used** previously for analysis of climatic exposure [2]. **Assuming** a Weibull distribution Table 2 gives the **results** of the analysis: neither age, nor Broca-Index (body mass (kg) devided by (body height (cm) - 100); assumed to show overweight) nor heart rate at the end of the HTT showed significant influence on the exposure time. Only fitness score and rectal temperature at the end of the HTT showed significant influences. The analysis of only these two variables revealed that the coefficients differed by a factor of 83: accordingly, **an** increase of the fitness score by 10 % corresponds to **a** decrease **of** rectal temperature at the end of HTT ≈ 0.13 "C within the model. As it is not easy for a **well** trained subject to increase his fitness by 10 %, with respect to the span of rectal temperatures at the end of HTT physical fitness only has little influence on the tolerance time under climatic strain in our study. Fig. 1 gives exposure times for the climatic exposure as a function of rectal temperature at the end of HTT, the data points being marked according to the fitness score of the subjects.

Table 1: Anthropometric data of 52 mine rescue team members.

	mean value	standard deviation	minimum	maximum
age / yrs	34.5	6.26	24.1	47.6
body height / m	1.79	0.06	1.65	1.93
body mass / kg	83.0	9.4	65.8	111.3
Broca-Index / %	105.7	10.3	86.4	138.4
BMI / kg/m²	26.0	2.46	21.5	34.0

variable	coefficient	std. error
CONSTANT	38.3705	11.3068
age / yr	0.0095	0.0110
Broca-Index / %	-0.6722	0.5482
heart rate at the end of HTT / min^{-1}	-0.0011	0.0032
rectal temperature at the end of HTT / °C	-0.9049	0.2991
fitness score / Dynavit	0.0096	0.0046
SCALE	0.0268	0.0483

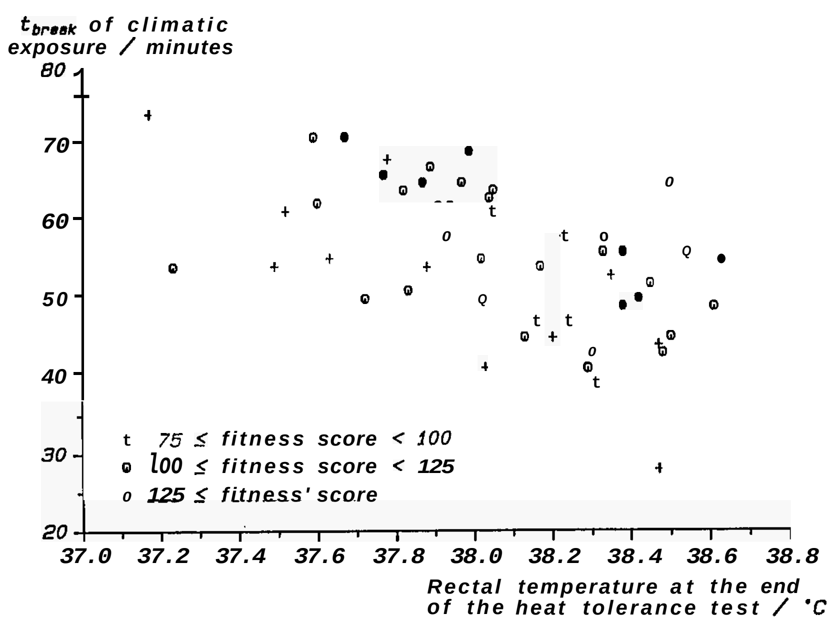

Fig. 1: Break off time of the climatic exposure as a function of rectal temperature at the end of the HTT, marked according to the individual fitness score.

CONCLUSIONS

Age and Broca-Index do not show any significant influence on the tolerance time in the heat and also physical fitness only shows little influence on the tolerance time in the heat in our study. Body temperature at the end of the HTT is not an adequate criterium to predict tolerance time during our climatic exposure: 50 % of the individuals classified as "non heat tolerant" on the basis of the HTT (rectal temperature above 38.0 °C at the end of HTT) are exceeding the target exposure time of 50 minutes (according to [3]) during the climatic exposure, i.e. they are predicted false negative.

Finally, the intraindividual variation of body temperature during HTT on different days was quite **high,** as validated on **4** subjects (also cf. [6]). So the heat tolerance test was decided not to be used during the recruitment of new members of the mine rescue teams in the Ruhr valley mining district.

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