

PHYSIOLOGICAL RESPONSES DURING  
ASBESTOS REMOVAL WORK - A FIELD STUDY

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#### INTRODUCTION

The removal of asbestos-containing building materials requires the use of dust-repelling protective clothing and a respirator. Lightweight disposable suits are the most common types of protective clothing in use.

The removal of asbestos is physical work, which may sometimes be carried out in warm environments (e.g. boiler rooms). Very few studies have been performed to quantify the physiological responses to actual asbestos removal work (1).

The purpose of this study was to evaluate the metabolic and thermal strain during asbestos removal work in real work situations while wearing protective clothing and a respirator.

#### METHODS

Eight asbestos workers served as subjects. The field measurements were done in the morning between 7 and 12 at randomly chosen days. The asbestos removal work was always carried out in an area which was isolated with plastic sheeting. Air temperature and relative humidity were recorded. The main work postures and the work tasks were also observed minute by minute throughout the whole work period.

During the work the men wore either permeable or impermeable protective whole-body suits with a full-face or half face respirator mask. In addition, they wore gloves and shoes and, under the protective suit, short underpants and socks.

During the work the heart rate (HR) was continuously measured and recorded every minute by a telemetric system. Oxygen consumption ( $\dot{V}O_2$ ) at work was estimated from the individual  $\dot{V}O_2$  and HR relationships determined on the bicycle ergometer in the laboratory. Rectal temperature and skin temperatures measured on the chest and upper back were recorded every minute with portable Vitalog-system. The sweat rate was determined by weighing the subjects nude before and after the work period. Perceived exertion, thermal sensation, thermal comfort and skin wettedness were rated by the subjects with standardized scales.

#### RESULTS

The work time observed averaged (f SD)  $173 \pm 51$  min at the asbestos removal sites. The work included approximately a 15-min rest pause during every hour. The tasks were mainly stripping the asbestos insulation off from the pipes and boilers in underground corridors, in boiler rooms or in office rooms. The air temperature varied from 19 to 37 °C and relative humidity from 21 to 50%. The asbestos removal work was done for 73% of the observed work time in a standing position. The arms were elevated over shoulder level for 35% of the work time.

The mean HR was  $113 \pm 20$  beats  $\text{min}^{-1}$ . The estimated  $\dot{V}O_2$  values ranged from 0.9 to 1.9  $\text{l min}^{-1}$  and the peak rectal

temperatures averaged  $37.7 \pm 0.3$  °C. During the work the mean of two skin temperatures increased 2.2 and 2.0 °C for the impermeable and permeable clothing, respectively. The sweat rate varied from 162 to 583 g h<sup>-1</sup>,

The overall ratings of perceived exertion ranged from 'light' to 'fairly heavy', the thermal sensation from 'neutral' to 'warm' and thermal comfort from 'neutral' to 'unpleasant'. The skin wettedness varied from 'almost dry' to 'very wet'.

## CONCLUSIONS

The asbestos-containing materials were removed from building structures mainly with handtools ie. knives, saws, steelbrushes and less commonly with motorized machines. With the exception of one work place the environmental conditions were thermoneutral ie. between 23 - 25 °C. Although the work places were randomly selected, very few warm or hot work situations were found. Possibly hot working places do not represent a high proportion of the asbestos work, because often the heating units are shut off during the work.

Poor work postures were common during the removal work of asbestos. The high location of the pipes often required working on the scaffolding or ladder. Arms were frequently elevated over the shoulder level.

The mean estimated  $\dot{V}O_2$ , associated with the relative aerobic strain of 27 - 60% of the  $\dot{V}O_{2max}$ . On average, the asbestos removal work could be classified as moderately heavy dynamic work, including some heavy work phases. According to the analysis of work postures and environmental conditions the increases in HR and thermal responses seemed to be primarily due to the poor static work postures and the muscle work of upper body (2,3). In this study HR and skin temperatures were lower than those reported for steam tunnel asbestos workers (1). Under the examined environmental conditions the used protective clothing did not seem to add the heat strain. The subjective ratings were quite similar in both types of the suits, considering the different work loads and air temperatures. It can be stated that the heat strain was not excessive, because most of the work situations occurred in thermoneutral conditions and the rest pause for 10 - 15 min every hour decreased the physiological strain during work. Improvements in work methods and tools are needed to reduce metabolic and postural strain during the asbestos removal work.

## REFERENCES

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