

OBSERVATIONS ON WOMEN WORKING UNDER THERMAL STRESS

by

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INTRODUCTION

Numerous workers are exposed at work to hot conditions either from the work process, the climate, or from internally generated metabolic heat. A complicated relationship exists between proposed heat exposure limits and parameters such as dry bulb temperature, the velocity and humidity of surrounding air, radiant heat loads, metabolic heat generation, clothing, acclimatization state, age, sex, nutritional habits, and physical condition.

In addition to new job opportunities promulgated by equal employment opportunity legislation, greater longevity of women and a trend toward smaller families all point to continuing increases in the labor force participation of women and especially into those areas where the money is--many traditionally male jobs where women are being provided the opportunity to demonstrate their competency.

Many women are exposed on the job to increased thermal stress while performing numerous industrial tasks such as shoveling, machine loading, materials handling, laundry work, etc. which require significant exertion of physical strength for which it is desirable to determine a quantitative basis of the levels of physical effort required. The age and physical condition of the female worker, the work environment, and the type of work performed determine levels of physiological stress which must be quantified for the female in order to reduce or negate undo strain through proper job design and/or employee selection.

Exposure Constraints

The National Institute for Occupational Safety and Health has developed criteria for recommended standards with respect to occupational exposure to a hot environment, (NIOSH, 1972). The recommended work practices require special procedures if the work environment exceeds 79°F. wet bulb globe temperature (WBGT) for males and 76°F. for females. Differences in physiological responses by males and females are well established although it is unclear if they represent true sexual differences. NIOSH recommendations for the employment of special work practices to reduce the risk associated with physical work in hot environments are predicated on studies of males and generalized to encompass established female variances. With respect to acclimatization work practices, permissible exposure

limits for women are purely estimates according to the author of these recommended practices (Jensen and Dukes-Dubos, 1976). Dukes-Dubos further states that there is a need for more evidence with regard to the accuracy of these estimates for women. Indeed several investigators have commented in their findings that research is needed in the area of female responses to long-term and intermittent work in hot environments. This lowered adjustment for the female tends to support the traditional opinion that females are not as tolerant to thermally stressful work as are males, tending to support employer efforts to utilize only males for these types of jobs.

It must be noted that these generalizations and the reduction in allowable temperature to define a heat stress environment which evokes special work practices is based upon observations to include 95% of the female working population. While protective legislation need cover such a broad spectrum of individual variability practicality constraints dictate at the industrial setting that the majority of women who seek employment performing physiologically demanding tasks in a thermally stressful environment possess certain physiological characteristics found at the upper percentiles for their population distribution.

Female Factors of Interest

Women possess roughly two-thirds of men's total body strength with significant variations of 35 to 86% between different muscle groups (Laubach, 1976). These variances allow for many upper quartile women on strength distributions to be as strong as or stronger than their male counterparts who rank within the lower half of male strength distributions. Similar distributional differences can be made for degrees of physical condition when examining aerobic powers with appropriate divisions by individuals body weight. Yet many employers continue to avoid hiring women for work in thermally stressful environments in that they believe through classical sex stereotyping, that females do not possess the physical work capacity requisite to perform the tasks. This same discriminatory action has been generalized to the aging worker resulting in conclusions that the older worker is not capable of performing similar work tasks. Few jobs exist in industry which require more than 50% of the young man's physical work capacity over the course of the work day. Indeed most industrial

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task designs require significantly less than 50% of the young man's physical capacity (AIHA, 1971). Therefore many tasks exist which can be performed by either the older male or the female with respect to the quantity of energy expended necessary to do the task. Those individuals while having less maximal capacity than the average young male still possess the capability to perform given work tasks by employing a greater percent of their physical work capacity than that required by the young male, yet they may still operate within the limits of half their maximal work capacity.

The majority of studies to determine the individual physical work capacities, physiological cost for various work tasks, and the effects of various environmental parameters have been performed on males. Recently much emphasis has been placed on the study of women and older individuals in an attempt to better define the levels of stress that these individuals can endure without compromising their health or safety manifested by the task/environment constraint.

Several studies have shown that women sweat less than men under identical task/environment conditions (Hardy et. al. 1941, Kawahata 1960, Hertig and Sargent 1963, Wyndham et. al. 1965, Bartnicki 1969, Fox et. al. 1967). Yet it has been shown that women have a higher density of sweat glands than do men (Kawahata 1960, Morimoto 1967, Bar-Or et. al. 1968, Knip 1969). Women have higher skin temperatures than men at the onset of sweating (Kawahata 1960, Fox et. al. 1967, Bittel and Henane 1975). Most hypothesize that these male-female differences in sweating capacities are a function of differing physical work capacities, physical condition, and degree of acclimatization but no concrete evidence has yet emerged to support these hypotheses.

With respect to core temperature differences, females have been reported to have higher values than males for work in heat (Wyndham et. al. 1965, Weinman 1967). Others have found that there are no differences at rest or during light work in heat (Haslag and Hertzman 1965, Morimoto et.al. 1967). Schwartz and Meyerstein (1970) found no differences in core temperature between sexes to work in heat.

Wells (1977) concludes that menstruation does not appear to make women more vulnerable to heat stress and that women may be more efficient regulators of body temperature than males.

Hertig and Sargent (1963) demonstrated that women can be acclimatized to heat, manifesting the same physiological adjustments associated with acclimatization in males: reduced heart rate; reduction in body core and skin temperature rise; onset of sweating at a lower skin temperature; and lessened discomfort. Two factors were stated which appear to put the

female at a disadvantage in the heat; a lower thermal gradient for removal of metabolic heat and less reserve capacity of the cardiovascular system to move blood to the skin.

After acclimatization, core temperatures and heart rates have been found to be about the same for both sexes for moderate work in heat but female sweat production is still half that of males (Wyndham 1965). Weinman (1967) concluded that there is no real difference in the acclimatization that can be reached in men and women but that they may achieve equal acclimatization in different ways using different configurations of components of the regulating process.

Parameters of Interest for Selection of Females

Evidence demonstrates that there exist significant male/female differences in response to heat stress; yet, one must not generalize that all males perform better under conditions of heat stress than any female. Many females do possess the work capacity and physical condition necessary to perform tasks previously termed acceptable only for certain males. Ideally, the ergonomically oriented industrialist tasked with placement of women on such jobs should evaluate both the metabolic cost of available tasks and the levels of environmental stressors associated with such tasks. He may then select the workers to fit the task/environment or modify the task/environment to fit the capacities of the available workers.

Some measure of physical work capacity is requisite for successful placement of females in hot jobs. An index of the individual's motivation is also valuable but often difficult to discern. The general health of the potential employee should be determined from a physical examination, a review of a medical history, age constraints, histories of absenteeism, etc. which provide the first mechanism for qualitative evaluation of employee potential. If this is termed satisfactory, quantitative evaluation of physical work capacity through the utilization of treadmill or step tests for values of heart rate, blood pressure, and aerobic power are most beneficial. Body weights may be ascertained and subcutaneous body fat percentages can be deduced from immersion techniques or simple skin fold measurements. Finally, strength evaluations may be made for both maximum voluntary contractions and continuous hold endurance employing large muscle groups. Examination and evaluation of women in this manner who seek hot jobs may be performed in a matter of hours and use of these observations provides a greater probability for worker success at the industrial setting than have the more traditional approaches.

CONCLUSION

Comparative data and distributions for women in higher quartile physical condition is presently being developed at several laboratories. Data with respect to strength parameters for females

working in hot environments is forthcoming as well as the effects of various decay periods on acclimatized states. These investigations should provide supporting evidence for pilot studies which tend to support the hypothesis that a large percentage of motivated women exist today who can perform moderate work loads (~300 kcal/hr.) in thermally stressful environments as well as most males. This data will also benefit the ergonomist in the selection of women to perform specific tasks or provide guidelines for the design of task regimens within given environments.

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