

# HEAT INTOLERANCE ASSESSMENT OF 367 POST HEAT STROKE CASES

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## INTRODUCTION

Under extreme conditions of exercise-heat stress, even healthy, well acclimated, and physically fit individuals will ultimately store heat at a rate that will cause body temperature to rise. However, those individuals who are not able to sustain heat and whose body temperature will start rising earlier and at a higher rate than that of others, under the same conditions, are defined as "heat intolerant" (1, 2). To identify an individual's susceptibility to exercise-heat stress a Heat Tolerance Test (HTT) was developed by Shapiro et al 3 decades ago (3). The HTT is performed in the Heller Institute of Medical Research according to the following protocol: 120 min exposure to 40°C and 40% relative humidity in a climatic chamber while walking on a treadmill, dressed in shorts and T-shirt, at a pace of 5 km/h and 2% elevation (1). During the exposure rectal temperature and heart rate are continuously monitored, and sweat rate is calculated from differences in body weight (10 g) and corrected for fluid intake.

Heat intolerance is ascertained when following the 120 min exposure to heat: rectal temperature exceeds 38.5°C or heart rate exceeds 150 bpm (1). Understandably, the larger the deviation from the expected values in a healthy individual, the more pronounced is the state of heat intolerance. Moran et al showed that not only rectal temperature and heart rate will not deviate from the limits mentioned, but the dynamics of changes in these parameters will tend to plateau towards the end of the 120 min test, while in the intolerant subjects a continuous rise will be evident (4, 5).

Exertional heat stroke (EHS) is a state of extreme hyperthermia that occurs when excess heat, generated by muscular exercise, exceeds the body's ability to dissipate it at the same rate (6). The occurrence of EHS is sporadic and thus it resembles a state of heat intolerance. The present study evaluates the differences in the tolerant to heat of former EHS individuals.

## METHODS

Analyses of 367 diagnosed cases of EHS were executed. An electronic database is available on all cases suspected as heat stroke. This database includes personal, environmental, activity, and treatment information on each individual. Classifications for heat tolerance or heat intolerance were done only after each individual was tested in the climatic chamber and in reference to his core temperature and heart rate values and dynamic.

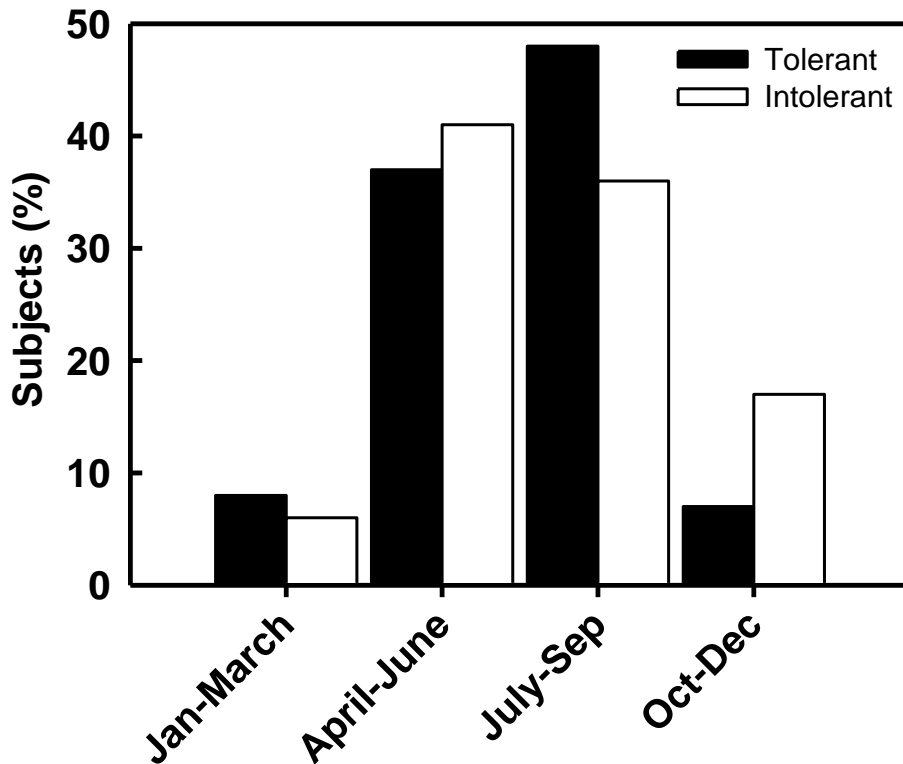
The heat tolerance test (HTT) was performed as previously described by Moran et al. (4). The test was performed in a climatic chamber under 40°C and 40% rh climatic conditions. The

tested individual was dressed in shorts and tennis shoes while performing 120 min light exercise consisted of walking on a treadmill at a pace of 5 km/h and 2% grade. During the exercise body core temperature (Trec) and heart rate were continuously monitored.

## RESULTS

375 cases of EHS were reported to our Institute (8 cases (2%) were fatal). All patients belonged to the general population of young ( $20\pm 1$  yr.) active, healthy, male soldiers in the Israeli Defence Forces (IDF). The 367 patients were tested for their tolerance to heat: 53 soldiers (14.4%) were diagnosed as heat intolerant (HI) and 314 soldiers as heat tolerant (HT).

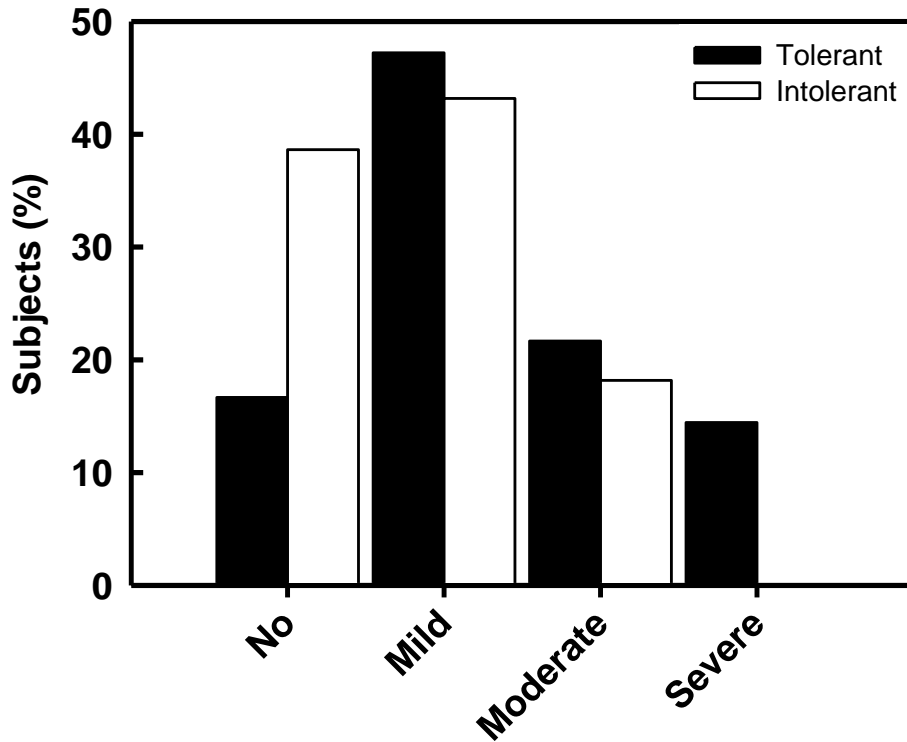
In Fig. 1 the distribution over the year of incidence of EHS is depicted. It is evident that more HI individuals collapsed during the autumn- winter season (October-March) than HT individuals (17% and 7%, respectively). To note, during the summer (July-September) heat stroke was more widespread in HT than in the HI group (48% and 36%, respectively).



**Figure 1: Season incidence of EHS divided by heat tolerant and intolerant cases**

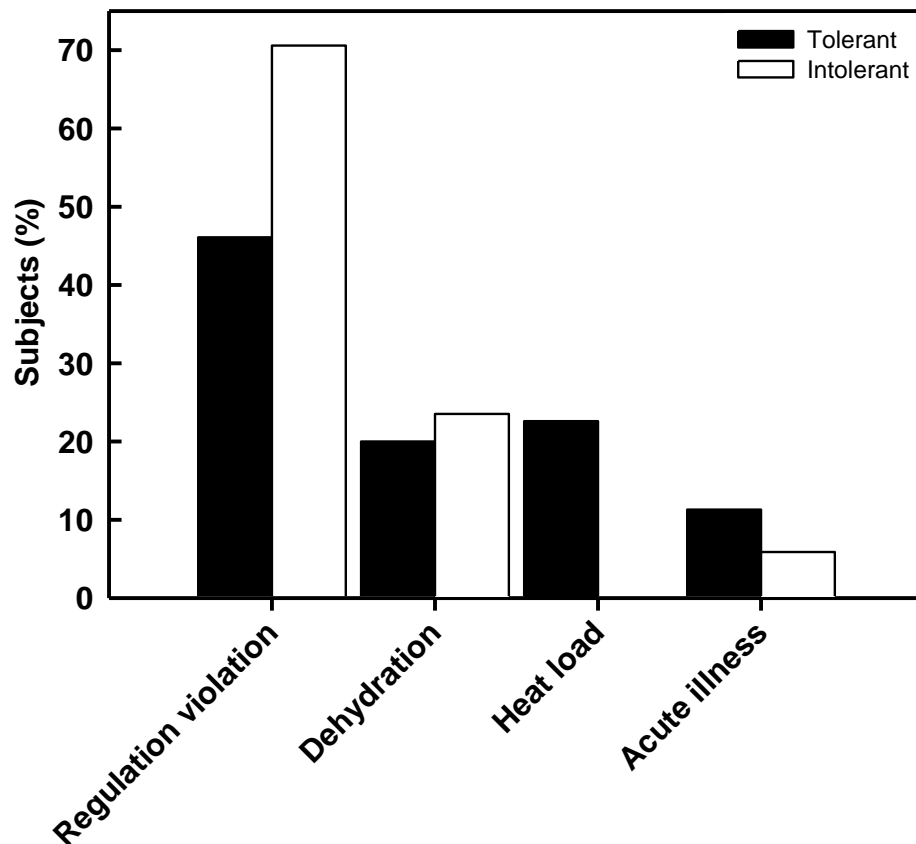
Analysis for the heat load during the collapse of the EHS patients revealed that under no heat load EHS occurred among 39% of the HI individuals and only in 16% of the HT

individuals. However, during mild and moderate heat load more cases of EHS were found in the HT group. During severe heat load there were only EHS cases among the HT group (15%) as depicted in Figure 2.



**Figure 2: Heat load during the incidences of EHS divided by heat tolerant and intolerant cases**

Analysis for predisposing factors for EHS (Figure 3) demonstrated that HI individuals were more sensitive for violation of regulations than the HT individuals. Accordingly, 70% of the HI cases in comparison to 46% of the HT cases were associated with violation of military orders, regulations, and/or guidelines.



**Figure 3: Pre-disposing factors related to the incidence of EHS divided by heat tolerant and intolerant cases**

## CONCLUSIONS

The fact that significantly more HI than HT individuals collapsed from EHS when there was no heat load and at the less warm months of the year, points to a possible explanation according to which the metabolic heat production in those HI individuals was higher than in their associates, while the environmental stress is less influential on heat storage.

It is also noted that violation of regulation was found to be the main risk factor for all EHS cases. However, it is emphasized in this study that HI individuals were more sensitive for heat injuries and this factor was 24% more meaningful for development of EHS among this young active population.

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