A Pilot Project: Physiological Programs for the Reduction of Occupational Injury and Illness, and Productivity Enhancement in Tree-planters.

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Summary:

Tree planting demands sustained high work output and is associated with high injury rates. However, the physiology of this occupational group has not previously been characterized. Therefore, the objective of this study was to begin to evaluate physiological and biochemical responses to the work of tree-planting. Data were collected from 10 healthy male tree-planters following 3 weeks (season midpoint, 19±5 days = Time 1) and 6 weeks (end of spring contract, 37±5 days = Time 2) of planting.

Calculated plasma volume levels indicated that planters were adequately hydrated, and 3-day diet history analysis revealed that energy and nutrient supplies exceeded the dietary reference intake for extremely active males. However, body mass values decreased by 1.7±1.5 % body mass, (or 1.3±1.2 kg), with approximately 1±1 kg of this due to fat loss. Further conformation of caloric deficit (caloric intake less than energy output) was demonstrated by low blood glucose levels throughout the day. The implications of this finding are evident in previous work which has shown that even mild hypoglycemia (low blood glucose), at levels very similar to those found in the current study, can result in impaired cognitive and motor function.

No changes were noted at any time for indicators of systemic (whole body) inflammation. However, resting levels of Creatine Kinase (a marker of muscular overuse) were significantly increased later in the season compared with the first sampling time, and increased above resting levels following planting at both sampling times. These data indicate that some muscle damage was occurring on a daily basis, and although there was less recovery at time 2, the damage was not severe enough to evoke a general inflammatory response.

All cortisol levels were within the normal range at the first sampling session, however, 7/9 early morning samples were greater than clinically normal at the second testing session. In addition, late season resting norepinephrine values were significantly increased with 30% of planters exceeding the normal range at time 1, increasing to 67% at time 2. These changes in resting levels of the stress hormones cortisol and norepinephrine, are also indicative of increasing stress levels later in the season.

Hemoglobin is the compound that transports oxygen to the body tissues. Its relevance to endurance performance is demonstrated by a host of studies which have indicated a direct improvement in VO_2max, velocity, and/or time to exhaustion with increased hemoglobin levels, as well as the prevalence of illegal blood doping (addition of hemoglobin by artificial means) in events such as the Tour de France. No changes were observed in hemoglobin levels over the duration of the current study. However, when the individual results were examined, 26% of the values for hemoglobin were found to be at 142±3 g/L. Although clinical anemia is not considered in males until hemoglobin values fall to less than 140 g\L, values in the range of 16-17 g/L are commonly reported for athletic populations. The planter’s hemoglobin levels then, could be considered to be sub-optimal for an endurance athletic population, especially if there is some altitude exposure.

Previous research has shown that the response of the immune system to exercise is generally favorable until either the intensity or the duration of the exercise load becomes “severe”, at which point the immune response becomes impaired. Planters demonstrated a positive immunological response with a mobilization of neutrophils and lymphocytes following planting at time 1. This increase in white blood cell number was blunted at time 2.

Physiological measures used were not sensitive enough to detect the effects of hypoglycemia or fatigue, possibly due to the delay between the time of finishing planting and the testing sessions (up to 2 hrs). No significant differences were detected between hand-grip strength (dominant and non-dominant hands, before and after exercise, early and late season). Similarly a hand agility test did not reveal any significant differences other than higher agility scores for the dominant over the non-dominant hand.

The overall aerobic fitness level of the group (predicted VO_2max 47.3±6.0 ml/kg/min) was greater than that reported for sedentary subjects (43±7 ml/kg/min), but was considerably lower than that reported for trained non-athletes (58.7±5.0 ml/kg/min) or endurance athletic populations (77.1±3.5) ml/kg/min. The relative work-load during planting was assessed by recording heart rates every 5 min on one day for each subject. The vast majority of the work was performed at less than 75% of maximal heart rate or 64% of maximal oxygen consumption (VO_2max). Interestingly, the 2 planters with the highest planting rate also had the highest aerobic fitness levels and were the only 2 planters who spent time in the higher intensity zone. Combined with the moderate VO_2max of the planters, these data suggest that improved aerobic fitness could lead to enhanced planting rates. It is also interesting to note that some of the epidemiological research on repetitive strain injuries has indicated that overall fitness levels are a strong predictor of incidence of injury, with increased fitness providing a protective influence regardless of the site of injury. This effect is not difficult to reconcile when one considers that if the maximal capacity is increased any given work-load becomes a lower relative proportion of the maximum and hence a less disruptive process.

In conclusion, the pilot project has provided a good introduction to the physiology and biochemistry of tree-planting. This information can be used to generate some recommendations regarding the quality of data collection in any subsequent investigations. In addition, some preliminary guidelines for areas that may lead to enhanced production and reduced incidence of injury during planting can be made.