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Occupational heat stress is a concern for outdoor workers exposed to high temperatures and humidity. Effects of heat stress include heat stroke (overheating of the body at or above 40°C potentially leading to organ damage), reduced ability to think and process information clearly (which can be dangerous using machinery or in high-risk settings), and in extreme cases, death. In Central America, where **chronic kidney disease (CKD) of unknown etiology disproportionately affects younger men**, research is focused on how heat stress influences the onset of CKD and how to best protect outdoor workers from the harmful effects of heat.

In the United States, the U.S. National Institute for Occupational Safety and Health has established a Recommended Exposure Limit (REL) to protect workers from the effects of extreme heat. Based on outdoor temperature and humidity, a worker's individual body weight and the intensity of work being performed, the REL represents the maximum temperature workers should be exposed to in order to keep body temperature at a safe level. The REL is meant to protect the worker from having their internal body temperature exceed 38°C; a level considered dangerous.

The **MANOS study**, carried out by the **Boston University Research Group for the study of CKD in Central America** in **El Salvador** and **Nicaragua**, included 569 outdoor workers during a three-day period in early 2018. Worksites spanned across five industries: corn, plantain, brickmaking, construction, and sugarcane. Participants completed questionnaires to characterize their workday and job tasks. We used wet bulb globe thermometers to measure the working environment wet bulb globe temperature (WBGT), and for each worker we continuously measured internal, also called core, body temperature (T_c), heart rate (HR), and physical activity. For each worker we calculated their REL. Blood samples were collected pre- and post-shift on the third day of observation to analyze serum creatinine used to estimate glomerular filtration rate (eGFR), our primary measure of kidney function.

High ambient temperatures (based on WBGT) were recorded at most worksites, particularly in construction and plantain where participants were active during warmer afternoon hours. These industries had the longest average work shift duration (of 9.3 and 7.2 hours), compared to sugarcane and corn. However, outdoor temperatures were also high at two sugarcane sites, where median temperatures hovered around 29°C and maximums exceeded 32°C. Workers in sugarcane across both countries had the highest physical activity rates, heart rates and core body temperatures.

Nicaraguan sugarcane workers most often exceeded their REL and had body temperatures higher than 38°C for the longest duration of time during their shift. All industries except for corn had at least one worker whose body temperature exceeded 39°C. Higher body temperatures and heart rates were associated with lower kidney function (eGFR values <60 and 60-90 mL/min/1.73m²). More time resting was associated with a lower average heart rate.

The results point to a particularly elevated level of heat strain among sugarcane workers in El Salvador and Nicaragua, often in conditions well above the REL. Sugarcane workers, especially agrochemical workers, were more likely to record higher work rates and to work in warmer ambient conditions, even when compared to other industries where workers spend more time outdoors during afternoon hours.