

## Occupational heat stress leading to chronic kidney disease

Research published in the January edition of the Pan American Journal of Public Health, entitled Chronic Kidney Disease of non-traditional origin (CKDnt) in Mesoamerica: a disease primarily driven by occupational heat stress, highlights heat stress in occupational settings as the main driver of the epidemic of CKDnt in Mesoamerica. This publication was developed in collaboration with the Pan-American Health Organization and researchers from Karolinska Institutet in Stockholm, University of Birmingham, University of El Salvador, University of Gothenburg, University of Colorado at Denver, and University of Massachusetts Lowell, and La Isla Network. The results provide stakeholders with strong evidence of the need to implement strategies to prevent heat stress and associated kidney disease among workers.



### Introducing CKDnt

An epidemic of chronic kidney disease of non-traditional origin (CKDnt) occurs in regions along the Pacific coasts of Nicaragua, El Salvador, Costa Rica and Guatemala. The disease is not related to known causes of CKD, such as diabetes and hypertension, and is more common among young male agricultural workers, especially sugarcane cutters. Based on evidence from epidemiologic studies, CKDnt in Mesoamerica can be considered a work-related disease driven by heat exposure at work.

### Supporting evidence

This PAHO special report outlines the following as sufficient evidence to support heat stress at work as the main driver of the CKDnt epidemic in Mesoamerica:

## 1. Early Anecdotal Evidence

CKDnt was first noted in the 1990s, when sugarcane workers showed high mortality and morbidity in Nicaragua, El Salvador and Costa Rica.

- Results of serum creatinine from an unpublished study with about 900 sugarcane workers in Nicaragua, half with high values and half with normal values, showed that physically demanding work in high temperatures without proper hydration leads to “heat fatigue syndrome” and then to kidney disease.
- In El Salvador, young male agricultural workers without known risk factors presented end-stage kidney disease. In Costa Rica, a new clinical entity of ‘sugarcane worker nephropathy’ emerged.
- As a result, most clinicians viewed CKDnt as a work-related disease.

## 2. Descriptive Prevalence Studies Suggest Work-Related Cause

Population-based surveys supported an occupational origin of CKDnt in high-risk communities because:

- Kidney dysfunction was between 2 and 5 times more frequent in men than women in high-risk communities.
- In contrast, sex differences were small within occupational categories.
- Prevalence was low in non-working populations.

Occupations with reported CKDnt are:

- Sugarcane cutters and other cane field workers.
- Workers in other high-intensity agriculture.
- Workers in non-agricultural occupations

with demanding heavy manual labor in high temperatures, such as construction and mining.

## 3. Analytical Epidemiologic Studies Highlight Heat Stress as a Key Factor

Most analytical studies have been conducted among sugarcane field workers in Guatemala, Nicaragua, El Salvador, and Costa Rica focusing on physical and biological changes during the work shift and throughout the harvest season. Key takeaways from these studies include:

- Sugarcane cutting in industrial agriculture requires high levels of physical effort. This physical activity could be compared to the first 12 hours of adventure racing, but occurs 6 or even up to 7 days a week, and during 5 to 6 months harvest.
- Evaluations across the work shift conducted in sugarcane cutters concluded that physical body changes were compatible with recurrent dehydration from demanding work in hot environments.
- Across the harvest, decline in kidney function was more *severe* in workers with a combination of exposures to high metabolic heat and high environmental temperatures.
- The *proportion* of workers newly developing kidney injury increased according to increasing physical demand in jobs done in the same environmental heat (dose-response).
- A water-rest-shade program in El Salvador reduced the impact in kidney function across shifts and its implementation stopped kidney decline in cutters over the harvest. In Nicaragua, in cutters with the highest physical workload, the water-rest-shade measures were not enough to prevent kidney

function decline, suggesting the need for a more intense prevention for those groups.

- Higher heat exposure, low water intake and longer work weeks were associated with higher declines in kidney function over a 4-month period in brick making workers.

#### 4. Scarce evidence for other occupational or environmental risk factors

- Pesticides have been studied as risk factors for CKDnt. With the exception of some isolated findings, no studies observed associations with pesticide use.
- Exposure to metals and metalloids has been considered as a risk factor. Although further research is necessary, it is unlikely that metal exposures play an important role in this disease.
- Infectious agents, especially leptospira and hantavirus, have been evaluated in some studies, but no associations with kidney disfunction have been found that could explain the disease occurrence.

#### 5. Non-occupational risk factors

- Non-work-related risk factors do not explain the observed work-related epidemiological patterns of CKDnt. Urinary infections, consumption of pain-relief medicine, alcohol, and tobacco have not emerged as significant risk factors. Genetic susceptibility should be studied further.

## Towards understanding CKDnt

Acute kidney injury episodes have been documented more commonly among male workers, cutters and other fieldworkers and is now being intensely studied as part of the physiopathology of CKDnt. Acute kidney injury is also seen in athletes with high physical demand in hot environments. Workers' hydration status is considered essential but preventing dehydration might not be enough to protect workers from rising body temperatures resulting from demanding work in hot environments, which could lead to kidney disease. There is a need for further occupational research that helps to understand long-term effects of increased core temperature, dehydration and impact of preventive measures.

## Conclusions

CKDnt in Mesoamerica is a work-related disease associated with heavy manual work in hot, mainly agricultural regions along the Pacific coast. Currently, no studies have provided evidence against the occupational nature of this disease. Occupational heat stress appears to be the strongest risk factor and the single unifying factor shown to lead to kidney dysfunction in CKDnt affected populations. Environmental exposures to pesticides, metals or infectious agents and other factors not related to work are not suspected as a main cause.

Current evidence for work-related heat stress is sufficient to require preventive programs where effectiveness can be evaluated. Sugarcane cutters have provided most of the evidence. However, with increasing environmental temperatures, risk may also extend to other occupations with

lesser physical demands, and to other regions as they warm. Action must be taken now, while we continue to improve our understanding of CKDnt.

## Relevance to stakeholders

**Producers and Employers:** These results provide the rationale for producers and employers to introduce and maintain water-rest-shade strategies to protect workers from developing CKDnt.

**Brands:** Brands promoting sustainability should ensure that workers in their supply chains are not facing demanding working conditions in high temperatures without proper water, rest, and shade programs in place. They should also work with their suppliers to guarantee measures are well-implemented.

**Governments:** Health and Labor ministries in countries likely affected by CKDnt should work with industry to protect the worker population from heat stress and its consequences. As with most chronic diseases, the cost of treating kidney disease is much higher than implementing measures to prevent it.

**ILO:** The evidence to date provides the basis for International Labor Organization to create guidelines and standards to ensure the protection of workers.

**Certifications:** Sustainability certifications should make worker-health a priority.

**Insurers:** Those offering insurance to industries with CKDnt in their workforce should include

conditions insisting on at least basic protections for workers against heat stress.

**Workers:** These results provide workers with evidence to obtain a deeper understanding of their risks at work and acknowledge the types of preventive programs employers can implement to protect their worker's health.

## References

1. Wesseling C, Glaser J, Rodríguez-Guzmán J, Weiss I, Lucas R, Peraza S et al. Chronic kidney disease of non-traditional origin in Mesoamerica: a disease primarily driven by occupational heat stress. *Rev Panam Salud Publica.* 2020;44:e15. <https://doi.org/10.26633/RPSP.2020.15>

Special report

**Chronic kidney disease of non-traditional origin in Mesoamerica: a disease primarily driven by occupational heat stress**

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**ABSTRACT** The death toll of the epidemic of chronic kidney disease of non-traditional origin (CKDnt) in Mesoamerica runs into the tens of thousands, affecting mostly young men. There is no consensus on the etiology. Anecdotal evidence from the 1990s pointed to work in sugarcane, pesticides and heat stress were suspected. Subsequent population-based surveys supported an occupational origin with overall high male-female ratios in high-risk lowlands, but small sex differences within occupational categories, and low prevalence in non-workers. CKDnt was reported in sugarcane and other high-intensity agriculture, and in non-agricultural occupations with heavy manual labor in hot environments, but not among subsistence farmers. Recent studies with stronger designs have shown cross-shift changes in kidney function and hydration biomarkers and cross-harvest kidney function declines related to heat and workload. The implementation of a water-rest-shade intervention in harvest in El Salvador appeared to halt declining kidney function among cane cutters. In Nicaragua a water-rest-shade program appeared sufficient to prevent kidney damage among cane workers with low-moderate workload but not among cutters with heaviest workload. Studies on pesticides and infectious risk factors have been largely negative. Non-occupational risk factors do not explain the observed epidemiologic patterns. In conclusion, work is the main driver of the CKDnt epidemic in Mesoamerica, with occupational heat stress being the single unifying factor shown to lead to kidney dysfunction in affected populations. Sugarcane cutters with extreme heat stress could be viewed as a sentinel occupational population. Occupational heat stress prevention is critical, even more so in view of climate change.

**Keywords** Renal insufficiency, chronic, occupational health; disorder, heat stress, pesticides; metals; infections; Central America

**CKDnt IN MESOAMERICA: A DEVASTATING EPIDEMIC** An epidemic of chronic kidney disease (CKD) unrelated to diabetes, hypertension and other known causes devastates the Pacific coasts of Nicaragua, El Salvador, Costa Rica and Guatemala (1). The epidemic emerged, initially unnoticed, in the 1970s (2,3). Tens of thousands of deaths have occurred among young male agricultural workers (3,4), particularly sugarcane cutters (3). The Pan-American Health Organization

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