



# *Chronic kidney disease associated with heat stress: a literature review*

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## **ABSTRACT**

The purpose of this scientific literature review document is to demonstrate the incidence of Chronic Kidney Disease in field workers caused by thermal stress. The Prisma methodology was applied to papers published in databases such as Google Academic, Scielo, Bireme, and Lilacs in which publications were found that address the topic of thermal stress in the labor sector. The publications consulted were from 2018 to 2023. It is necessary to emphasize that chronic kidney disease has increased in work sectors with exposure to high temperatures and mainly occurs in the countryside and production areas. (Ruiz Herrera, 2020). Global warming is causing an increase in exposure to high temperatures in confined environments, internal environments in production areas, and in open environments, which directly affects the health of workers. (ILO, 2023). As a result of the review, 15 articles on occupational safety and heat stress were included. Among the conclusions of this review, it was found that the workers studied are characterized by being exposed temperatures without wearing clothing appropriate to the work environment or protection from exposure to ultraviolet rays and therefore experience an increase in body heat, added to this means they

have long working hours, do not take breaks and do not ingest adequate fluids recommended by an occupational doctor or the person in charge of occupational hygiene and safety; The incidence of kidney disease associated with heat stress was 41.9% in males with an age of presentation of 46 years, in stage II, with work-related heat stress as the main risk factor.

## **INTRODUCTION**

In work environments, workers are exposed to a series of environmental factors that if not controlled, could become causal agents of damage to workers' health. Heat stress is the heat load that people experience and accumulates in the body and that results from working conditions, work environment, equipment, or work clothing and rehydration with adequate fluids that allow the losses of electrolytes in sweat generated by heat to be restored. Among the main work sectors that present the most heat stress and that in the long term manifests itself in kidney disease are the production sectors, confined sectors, and the outdoor work sector, but with social exposure, which is agriculture. There is evidence that long-term heat stress could lead to kidney damage because the dehydration generated by heat in the work environment makes the kidneys need to be more active to compensate for organic hydration processes. Chronic kidney disease (CKD) is defined as a progressive functional or structural change of the kidneys that persists for 3 months or longer.

Heat stress is the heat load that farmworkers receive and accumulate in their body and that results from the interaction between the environmental conditions of the place where they work, the physical activity they perform, the clothes they wear, and the medications and energizers they ingest. (Ruiz Herrera, 2020) Knowing that labor flexibility is characteristic of agro-industrial seasonal production (Campo), whose main problem is to take advantage of the periods in which production increases. (Krisher, 2020)

In Nicaragua, fieldwork and industrial production are the ones that make the greatest contribution to the country's economy; therefore, these workers work longer working hours because the more work they do, the more paid the work is. Currently there is an increase in the number of patients who are diagnosed with chronic kidney disease, and who are active workers in the field and production industries who are often unaware of the risk factors that trigger this pathology, such as: Not wearing personal protective equipment or exposing oneself to high temperatures, not drinking enough water, taking painkiller medications and drinks based on the information collected, this study should be the basis for translating this research to other work environments that are exposed to high temperatures or that are exposed to high environmental temperatures with the demonstrated deleterious effects and effects of the same on human beings and thus propose universal protection measures, in addition to their employers, so that they can carry out programs that benefit, with immediate attention to the symptoms or

promote improvements in the workplace, enforcing the rules imposed for the field worker, since they are often unaware of the main risk factors related to physical stress (Sellarés, 2018) who are one of the causes of this kidney pathology, knowing that this is one of the pathologies with a high morbidity and mortality in the country, being the fourth cause of death of Nicaraguans nationwide.. (MINSA, 2019)

Heat stress occurs when the body is unable to regulate its internal temperature properly in extreme heat. It can cause a variety of symptoms, from mild discomfort to serious illnesses such as heat stroke. It is important to stay hydrated, seek shade, and avoid prolonged exposure to the sun to prevent heat stress.

Heat stress can hurt the kidneys and contribute to the development of chronic kidney disease (CKD). Dehydration and excessive loss of mineral salts due to extreme heat can put an additional burden on the kidneys, which can lead to long-term kidney damage. Additionally, in extreme cases of heat stroke, kidney function can be quickly compromised, which can be potentially fatal if not treated properly. Therefore, it is crucial to take measures to prevent heat stress, especially when daily tasks demand to stay for prolonged periods in the sun; For example, agricultural workers, fishermen, masons, foundries, brick manufacturing, manufacture of ceramic objects, cement plants, ovens, bakeries, laundries, scalding processes, vulcanization, among other items that their job is to expose themselves to the sun, which can trigger so many skin diseases, and also to develop chronic kidney disease by not having protection measures against the sun.

Heat is one of the physical, and environmental pollutants that can most affect the world of work, especially at certain times of the year. Chronic kidney disease is a condition in which the kidneys cannot filter blood properly for a long time. This can lead to the accumulation of toxins in the body and serious health problems. Chronic kidney disease can be caused by various conditions, such as diabetes, high blood pressure, and autoimmune diseases, among others. It is important to detect it early to treat it and avoid complications. Treatment may include dietary changes, medications, and in advanced cases, dialysis or kidney transplantation.

The direct action of heat on the body triggers a defense within our body against this temperature rise. The environmental conditions that affect the human body are The temperature of the air, the relative humidity, the radiant temperature emitted, by the heat sources, and the speed of the air. The most common thing is that workers who are exposed to heat causes discomfort at work or discomfort, but sometimes if the conditions are extreme, the discomfort becomes dangerous or toxic to life and health.

Unlike others, heat is a pollutant that is generated by the individual himself, in two different ways: one is the metabolic reactions that occur mainly in the liver and the other is the muscular activity that the individual performs.

Heat stress is not the pathological effect that heat can cause in people, but the cause of the various pathological effects that occur when excess heat accumulates in the body. The heat load that workers receive and accumulate in their bodies is the result of the interaction between environmental conditions, physical and metabolic activity, and the clothing they wear.

Without taking breaks, there comes a time when it is so hot that workers feel uncomfortable, and apathetic, with decreased attention increasing the probability of work accidents occurring.

Other factors that intervene in the risk of heat stress are: Duration of the work, if it is long, even if the heat stress is not very high, the worker can accumulate a dangerous amount of heat.

There are personal factors such as:

1. Lack of acclimatization to heat.
2. Obesity.
3. Age.
4. Health status.
5. Taking medicines.
6. Poor physical shape.
7. Lack of rest.
8. Alcohol consumption
9. Drugs
10. Excess caffeine.
11. Having previously suffered from a heat-related disorder

Lack of heat acclimatization is one of the most important personal factors. Unacclimatized workers can be harmed in heat stress conditions that are not harmful to their colleagues who have been working in those conditions for some time.

Acclimatization to heat makes the body better able to tolerate the effects of heat, as it favors physiological thermoregulation mechanisms: it increases sweat production and decreases its salt content, increases peripheral vasodilation. This does not raise the core temperature of the body as much. Heat stress and its consequences can be especially dangerous in outdoor work, such as construction, agriculture, etc., so for workers, it is a dangerous situation that

mainly occurs on the hottest days of summer due to the direct action of the sun, prevention programs are aimed at regulating the time of exposure.

Prevention is everyone's task without exception, training and awareness tasks in occupational risk prevention. Chronic kidney disease associated with heat stress is a complex topic that requires too much research as it can be related to chronic exposure to heat stress, such as in workers exposed to high temperatures or due to excessive heat that can lead to dehydration, making it difficult to eliminate waste products through urine.

## **MATERIAL AND METHODS**

### **Within the investigation stage:**

First, a topic was proposed, based on the corresponding line of research, due to the author's experience with chronic kidney patients and the facilities to investigate and delve deeper into the topic of interest, since in the environment in which he works he has more access to a lot of information, permission was requested from the authorities of the CIES institution, in order to use the name of such a prestigious institution and use its name in this publication, we subsequently searched for related topics in national and international journals, we collected and discarded articles from journals that did not understand the dates corresponding to 5 years, we also discarded articles from journals that were not caused by heat stress, several reports and corresponding works were carried out to learn a little more about the topic to be studied.

A literature review was carried out and an exhaustive bibliographic search was carried out with information published between 2018 and 2023 where clinical studies and bibliographic reviews were identified such as review of scientific medical articles databases such as Google Scholar, Scielo, Bireme, and Lilacs in which publications that address the issue of heat stress in the labor sector were found.

The search strategy was through the filtering of articles found with the use of keywords, such as; chronic kidney disease, heat stress, hemodialysis, as well as for searches in the rest of the databases. In Google Scholar, the search was carried out in natural language using the words; chronic kidney disease, heat stress, hemodialysis, occupational diseases, non-communicable diseases, diseases in adults, occupational health, renal psychology, and renal nutrition, among other related words.

We included 15 review studies and 2 original studies, we took into account studies in which patients were working ages between 18 and 50 years old and who worked in the field who were exposed to the sun and we excluded patients who had associated chronic diseases who were

also exposed to the sun as this could accelerate kidney deterioration and would not be clearly the cause of thermal exposure. Patients who routinely take medications and drink energy drinks were also excluded.

The studies reviewed presented their findings through the sociodemographic characterization of farm workers, in which the average age of chronic kidney disease was an average of 46 years, from an age range of 18 to over 50 years, and a greater number of males.

Summary Table of Bibliographic Findings

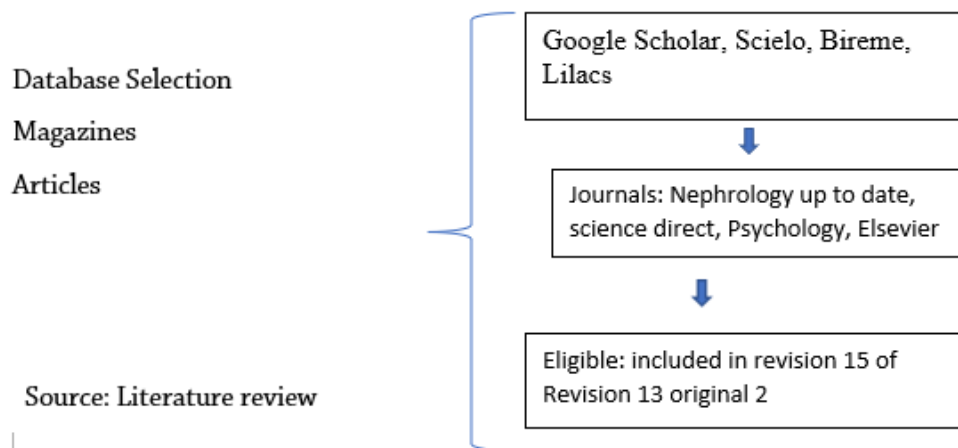
No	Article	Year	Country	Language	Title	Magazines
1	Original	2023	Spain	Spanish	Pilot follow-up study in patients with diabetic kidney disease using NORA application	Spanish Society of Nephrology
2	Revision	2023	Mexico	Spanish	Psychiatric Symptoms in Patients with Chronic Kidney Disease	Psychology and Health
3	Original	2023	Cuba	Spanish	Human health in the face of heat stress due to climate change	Archio Médico de Camaguey Magazine
4	Revision	2023	Mexico	Spanish	Psychiatric Symptoms in Patients with Chronic Kidney Disease	Psychology and Health
5	Revision	2023	Ecuador	Spanish	Chronic kidney disease of non-traditional causes	
6	Revision	2022	Costa Rica	Spanish	Mortality and hospital discharges due to chronic kidney disease of non-traditional causes	Costa Rican Medical Act

7	Original	2022	Brazil	Spanish	Occupational repercussions in people with terminal CKD who attend Hemodialysis with an occupational justice hand	Brazilian Journal of Occupational Therapy Notebooks
8	2022	Venezuela	Spanish	Nursing diagnosis of emotional state in patients with chronic renal failure during their treatment.	More Vita Health Science Journals	Original
9	Revision	2021	United States	English	Chronic Kidney Disease	Elsevier
10	Revision	2020	Guatemala	Spanish	Social and Occupational Determination of Patients with Chronic Kidney Disease	Science, technology and health
11	Revision	2020	Spain	Spanish	Chronic kidney disease	Spanish General Society
12	Revision	2020	Cuba	Spanish	Three-dimensional risk matrix applied to a biosafety assessment in a Hemodialysis practice	Cuban Journal Health and Work.

13	Revision	2020	Colombia	Spanish	Chronic kidney disease of farming communities, a review of the literature	IATREIA Magazine
14	Revision	2020	United States	English	Occupational heat stress leads to chronic kidney disease.	PAHO Report
15	Original	2018	Guatemala	Spanish	Working conditions of patients with CKD who attend the National Unit for the Care of Chronic Kidney Patients (Unaerc)	Science, Technology and Health Journal

Literature review

**Literature Review Flowchart**





## RESULTS AND DISCUSSION

The line of research related to non-communicable diseases such as chronic kidney disease associated with physical stress has been studied from different angles and perspectives, for example: From the number of articles reviewed, we find that according to (Rivera Medina, 2021) 33.3% of the patients included in her study had chronic kidney disease and that most of them were in stage G3 predominantly in the male gender, while she showed that the patients she had studied was 13.3% also corresponding to the male gender. In turn, it reports that the male gender predominated in 55.7%. In another study carried out Significant differences ( $p = 0.006$ ) were observed in the percentage of employed people between men (40.1%) and women (22.9%). These results are very similar in most studies since 80% of the rural working population is male. Knowing in advance that the largest population that works in the field sector and all field jobs are mostly male, it is not uncommon to find these figures in almost all the reviews found. (Jiménez Arana, 2018)(Calix, 2020)(Molinuevo, 2018)(Ruiz Herrera, 2020)

On the other hand, it refers that 83% of the patients studied generated the loss of years of productive life and had to be disabled from work at the age of 46, in turn, it refers to that of the 32 patients included in its study, the ages of 46 years had to be disabled. It determined that environmental and occupational exposure in working conditions, heat stress associated with dehydration in intense physical activity, limited access to health services, poor diet, and poor quality of life, were risk factors for the patients studied to have a high glomerular filtration rate as in the study carried out where the patients studied had risk factors such as; be from a rural area where day laborers are employed due to exposure to heat stress. Whereas (MartinezMarín, 2018) (José, 2019)(Ruiz Herrera, 2020)(Calix, 2020)(Rivera Medina, 2021) determine the risk factors associated with chronic kidney disease (CKD) in adults at the Santa Teresa health center, in the period November 2017 to November 2019 they were family history of CKD, comorbidity, smoking and use of NSAIDs. It is worth mentioning that the age that will predominate will be 46 years in these studies since most of the patients who work in the field as day laborers are male, in addition to the fact that as the disease is progressive, the damage is gradual as they are exposed more and more to heat stress. Without taking any of the measures of breaks during work, ingesting liquids, oral serum among other measures already mentioned throughout this document, and no check-ups are carried out, it is not until they have all the florid symptoms that they go to a hospital the causes that led them to chronically get sick kidneys are not known until then.

On the other hand, in his study of Risk factors associated with chronic kidney disease, he determined (Rivera Medina, 2021)the use of drugs such as NSAIDs (OR 2.87) and PPIs (OR 4.17) was associated with the development of CKD, confirming this same hypothesis to a percentage of the triggers of this chronic pathology and to the inappropriate use or abuse

of these medications by the majority of all field workers who are ingested in an absurd way to perform better in their work.

(Ruiz Herrera, 2020) Throughout his research under the title *The Economic, social and Labor Determination of Chronic Kidney Disease of non-traditional Causes*, he talks about how for agro-exporting countries and global markets to resort to deregulation and labor flexibilization they sent a large volume of the peasant population massively mobilized to the plantations since the twentieth century just in the intense harvest periods. This led to little training in the diseases that could be caused by being intensely under the sun for hours, not to mention the little vigilance of the supervisors to observe if they complied with the protection measures or that they were having periods of breaks and intake of liquids and oral serum and the little awareness that the peasant had of stopping during the days because the more work they got, the better the pay. Due to this context, in the last 20 years, cases of chronic kidney disease began to be reported, which were not associated with traditional factors, since according to the international standards of the time they established as a population suitable to exercise productive functions, among them were young people and children between the ages of 15 and older, according to the National Institute of Statistics (NIS).

In turn, given joining the labor market and facing the intensity of work, they reported a series of strategies, including the consumption of powerful analgesics which they call: vitamins, and in very extreme cases amphetamines and psychotropics used to work without pain, all this used as a work strategy and perform better in their jobs without counting that in prolonged tasks they ingest energizers to reduce physical fatigue whose side effects are raising blood pressure and heart rate which leads to kidney damage, the free sale of many substances by street vendors in the agricultural fields has not been able to stop them because if the peasants did not buy these suppliers they would not arrive. (Ruiz Herrera, 2020)

(Guzman, 2023) In this research, a higher prevalence of CKD was found in women but more deaths were registered among men whose factors related to aging and complications generated by other diseases not precisely due to heat stroke, however the occupations of the reported dead patients were agricultural activities, therefore it did not consider that the causes were only due to chronic pathologies, It is worth mentioning that this study was carried out in the facilities of a nursing home where psychiatric diseases predominated, so it did not consider these results conclusive.

(Molinuevo, 2018) Regarding the age of the patients included in the study, significant differences ( $p < 0.001$ ) were observed between the average age of the employed (43.5 years) and the unemployed (49.6 years). It is evident that occupational occupation is a variable strongly dependent on the age and sex of the individual, so it was decided to control the effect of these

two variables to avoid biases in the formation of the samples to be compared and to estimate the independent effect of the renal replacement therapy modality on occupational occupation.

Chronic kidney disease and patients on renal replacement therapy are important factors in incapacity for work, as only 33.3% of working-age patients with this pathology are still active. However, there are important differences that moderate this result and that need to be analyzed.

Active patients mostly opt for outpatient peritoneal dialysis treatment, so almost half of the patients in this modality are working, while this figure is reduced to one in five in the case of patients who follow hemodialysis in a center. Some studies have also analyzed the positive effects of maintaining a job for dialysis patients.

Especially in the initiation of renal replacement therapy with dialysis, the option of ambulatory peritoneal dialysis shows clear advantages over the other options, in such a way that such prestigious entities declare that patients of working age should be specifically advised about the options of home dialysis, however in our country Nicaragua there have been more deaths in terms of the use of home peritoneal dialysis since there are many patients who refuse to the treatment for the care that must be taken with these, for example, the use of sterile gloves, the change between each dialysis, the misuse or little expertise for self-care, the risk of infections and the poor hygiene they have, the indiscriminate use of periodic medical material in common waste, which contributes or leads to more infections has been reported in the mayor's offices, which contributes or leads to more infections, the patient therefore prefers to go to hemodialysis centers if they have the means to afford them and those who can do so often do not go, the population is not apt by culture to have the discipline to take charge of their health whether they have it from the government or apply in their social security program.

Also, the variables that significantly affect the patient's work situation, such as the male gender, work more in areas of heat exposure men 40.1%, which agrees with most of the studies presented in this document.

Kidney transplantation also stands out in that same study, however in our country according to the laws, the compatible kidney must be donated by a family member and most of the relatives have comorbidities so there are few statistics of transplant patients, so the return to work of these patients is little, Another factor that Nicaraguans have is for all the ailments we make use of injections many times so much that we are channeled for whatever reason there is vascular exhaustion and the vascular accesses that we have in the country are few, so if all the accesses run out, they must return to peritoneal dialysis and it becomes a vicious circle of poor hygiene and therefore death.

## CONCLUSIONS

As a result of the above, this literature review identified that not all possible causes of chronic kidney disease are caused by chronic diseases and that despite the talks and multiple information, the worker does what he is used to doing because of his culture or his way of doing things, because that is how he was taught from the beginning, to do them.

Chronic kidney disease can significantly affect a person's ability to work, especially in advanced cases of the disease. Symptoms of chronic kidney disease, such as fatigue, weakness, nausea, difficulty concentrating, and sleep problems, can interfere with work performance and the ability to perform physical and mental tasks. In addition, treatments such as dialysis can take time and energy, which can make it even more difficult to maintain a full-time job.

It is important for people with chronic kidney disease to work closely with their doctors and employers to find solutions that allow them to maintain a healthy balance between work and managing their kidney health.

This may include adjustments to work hours, modifying work tasks to accommodate physical limitations, or considering work-from-home options. In some cases, it may be necessary to seek less physically demanding employment or consider applying for disability if chronic kidney disease significantly affects the ability to work.

However, highlighting that, in our country, the largest working population is that of the countryside, working day by day to get ahead and within the limitations we have, we seek to take advantage of them to get ahead, also highlighting that we have areas with thermal rises and the agricultural activities carried out by our field workers predispose them to diseases of renal origin.

This could be improved from the beginning of work, that both employers and the employee are committed to carrying out safe work and this could improve both the health and the economy of the country.

Heat stress can increase blood pressure, which in the long term can evolve into chronic kidney disease, and can be influenced by multiple factors; such as genetics, high blood pressure, and diabetes mellitus among others, so heat stress is only one possible risk factor.

We recommend with everything that has been studied on this subject that people exposed to high temperatures such as field workers should be committed to their health, should take measures to stay hydrated, reduce self-medication, notify their supervisors if they do not feel acclimatized so that they can give them breaks, wear cotton clothes, avoid drinking alcoholic and energy drinks and protect yourself from the heat to reduce the risk of kidney complications.

Since it is an issue with too much impact on the health of field workers, urge other possible researchers to carry out collaborations and more studies, since due to the limitations that were obtained in this review, they were interviews in the field, since it was a descriptive study from the beginning and much more could be done for these workers, such as giving them more follow-up with talks, more frequent supervision in their work area, force the employee to make use of their protective equipment and all preventive measures and to stop activities if they refuse to do the right thing, to avoid these diseases and both them and their supervisors to comply with the requirements stipulated for the benefit of the worker as stipulated by the Ministry of Labor.

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