



A Study on Analysis of Water Sample in Chronic Kidney Disease of Unknown Origin (CKDU) Patients in Western Region of India in a Tertiary Care Center

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KEYWORDS

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ABSTRACT:

Background: Chronic Kidney Disease of unknown origin (CKDu) is an emerging public health issue, especially in certain geographic areas without traditional risk factors like diabetes or hypertension. Environmental factors, particularly water quality, have been suspected contributors.

Objective: To analyze and compare water quality parameters from areas with and without CKDu cases to identify potential associations.

Methods: This study involved water samples from two populations: individuals diagnosed with CKDu (n = 118) and a control group (non-CKD, n = 1112). Parameters measured included pH, EC, TDS, alkalinity, chloride, fluoride, nitrate, sulphate, total hardness, iron, calcium, and magnesium.

Results: Significant differences were observed in water alkalinity (p = 0.001), sulphate levels (p = 0.01), calcium (p = 0.001), and magnesium (p = 0.001), which were higher in CKDu-affected areas.

Conclusion: Elevated levels of certain water constituents may be associated with the development of CKDu, suggesting a potential environmental contribution to the disease etiology. Findings are in line with previous studies from Sri Lanka, Andhra Pradesh, and El Salvador.

Introduction

Chronic kidney disease is a global public health problem associated with premature mortality, decreased quality of life. A trend towards an increase in its incidence and prevalence has been reported worldwide.

Chronic kidney disease (CKD) is an irreversible deterioration of renal function, which results from diminished effective functioning renal tissue. Resultant damage of metabolic, excretory, and endocrine

functions of the kidney indicates the progress of medical condition of uremia.

The first description resembling what would later become known as CKDu can be found in a 1993 report by Mani¹. He described chronic interstitial nephritis as the leading cause of chronic renal failure in patients presenting to a single hospital in Chennai. The overall prevalence of chronic interstitial nephritis in this report was 28%, increasing to 38% among lower income patients. Approximately 70% presented with advanced kidney failure.



Chronic Kidney Disease of unknown origin (CKDu) refers to kidney dysfunction not attributable to traditional causes such as diabetes or hypertension. It has been increasingly reported in agricultural communities and rural populations, often associated with environmental and occupational exposures.

Water contamination has emerged as a potential factor, particularly in endemic zones such as Sri Lanka (Jayasumana et al., 2014), El Salvador (Orantes et al., 2011), and India's Uddanam region in Andhra Pradesh (Reddy et al., 2019)^{2,3,4}.

This study aims to investigate the possible role of various water quality parameters in the etiology of CKDu in Marathwada region.

Materials and Methods

Study Design: Cross-sectional analytical study.

Setting: Tertiary care hospital Aurangabad and surrounding district and talukas of Marathwada region.

Clinical Data

In the present study data of CKDu patients will be collected from Nephrology OPD & Ward of MGM Medical College & Hospital, Aurangabad. Case record form will be prepared. The collected data will be entered in Microsoft-Excel in predefined format.

Inclusion Criteria-

- 1) All diagnosed chronic kidney disease patients.
- 2) Age 18 year and above.
- 3) Belonging to both genders.
- 4) Patient willing to participate in the study.

Exclusion Criteria:

- 1) Patient of acute kidney injury of any cause
- 2) Patient not willing for participation

The physio-chemical parameters in water samples—*pH*, *hardness*, *TDS*, *conductivity*, *alkalinity*, *calcium*, *magnesium*, *sulphate*, *chloride* and *fluoride*—were analyzed using standard methodology provided by International Standard.

For heavy metals in water samples—*lead*, *cadmium* and *chromium*, *Silica*—samples will be prepared by EPA

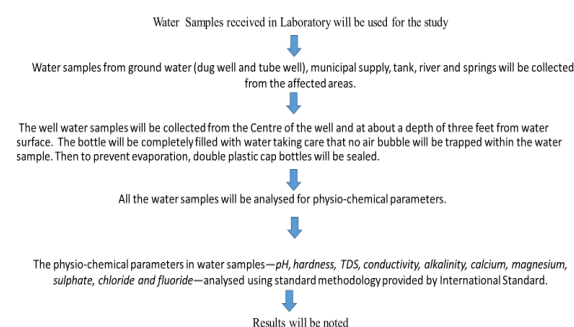
method (Environment Protection Agency) & IS (International Standard).

Physico-chemical analysis of textile & sugar industries effluent in water samples for- *pH*, Hardness, TDS & Heavy metals.

Water samples were collected from areas with a high prevalence of CKDu (n = 188) and compared with control regions (n = 1112) reporting as non-CKDu. Statistical Analysis:

Data were analyzed using mean \pm SD, and independent t-tests were applied. A p-value <0.05 was considered statistically significant.

STUDY FLOW



The collected data will be compiled in MS excel sheet 2007 for analysis of this data SPSS version 26.0 will be applied.

The qualitative data will be represented in form of frequency and percentage.

It will also be represented in the form of usual impression like bar diagram, pie diagram, etc.

Results :

Total 188 (14.5%) of CKDu diagnosed out of 1300 patients whose samples of water analysis has been done.

Table 1: Incidence of CKDu amongst CKD

Subjects	Frequency	Percent
ckd	1112	85.5
ckd u	188	14.5
Total	1300	100.0



Table 2: Demographic characteristics of study groups:

The mean age of CKDu patient was 37.77 years while Non-CKDu was 42.8 years.

Demographic Parameters	CKD (1112 Cases)	CKDu (188 Cases)
FARMING	639 (57.5%)	68 (36%)
SUGARCANE WORK	78 (7%)	48 (25.6%)
AGRICULTURAL WORK	614 (55.2%)	72 (38.5%)
EXPOSURE TO FERTILIZER	60 (5.4%)	24 (12.8%)
EXPOSURE TO PESTICIDES	22 (1.91%)	48 (25.6%)
EXPOSURE TO INDUSTRIES	28 (2.49%)	130 (69.23%)
EXPOSURE TO HEAT	43 (3.83%)	113 (60.25%)
PESTICIDE/INSECTICIDE EXPOSURE	24 (2.10%)	48 (25.6%)
ALLIED MEDICATIONS (Ayurvedic/Herbal)	43 (3.83%)	109 (57.69%)

EDUCATION	107 (9.6%)	32 (16.7%)
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Fig 1: Risk factors in CKDu:

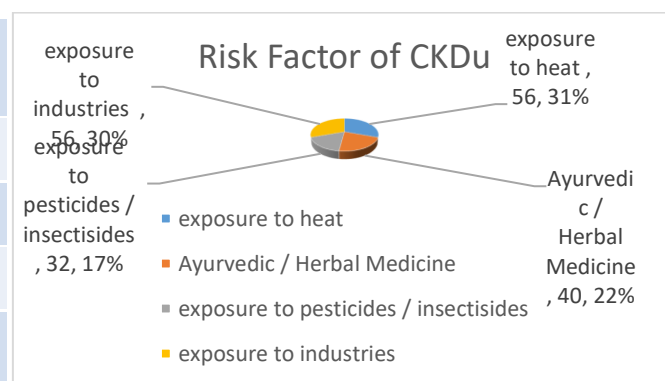


Fig 2: Distribution of source of water in CKDu:

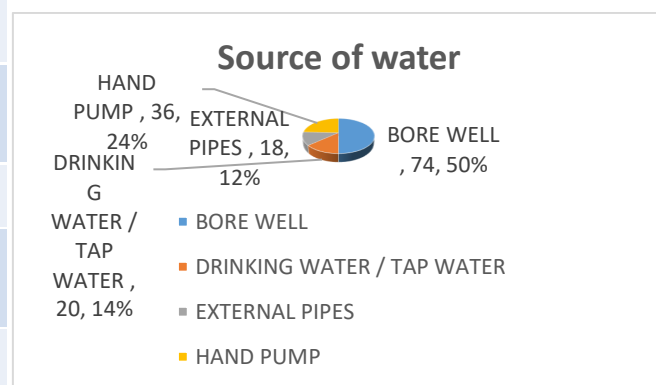


Table-3: Water analysis in CKD and CKD u patients

Variables	Subjects	Mean	Std. Deviation	P value
Ph	CKD	7.807	.7537	0.34
	CKD u	7.868	1.0709	
EC	CKD	1053.213	460.3902	0.24
	CKD u	1096.101	509.6611	
TDS	CKD	668.012	306.7634	0.07
	CKD u	712.426	331.1902	
Alkaline	CKD	250.270	137.1186	0.001 (S)
	CKD u	311.851	169.6102	
Chloride	CKD	112.029	59.4994	0.604



	CKD u	114.628	83.2773	
Fluride	CKD	.521	1.4307	0.29
	CKD u	.645	1.9457	
Nitrate	CKD	38.321	19.9055	0.002 (S)
	CKD u	43.628	28.7774	
Sulphate	CKD	50.079	23.0387	0.96
	CKD u	50.160	27.4251	
Total Hardness	CKD	359.103	143.5179	0.001 (S)
	CKD u	416.420	186.3835	
Iron	CKD	.250	1.6719	0.23
	CKD u	.107	.0482	
Calcium	CKD	64.509	33.5811	0.001 (S)
	CKD u	80.498	37.1199	
Magnesium	CKD	39.759	30.3334	0.001 (S)
	CKD u	48.176	22.5352	

The water analysis showed significant differences observed in water alkalinity ($p = 0.001$), hardness, nitrates ($p = 0.01$), calcium ($p = 0.001$), and magnesium ($p = 0.001$), which were higher in CKDu-affected areas.

Discussion:

The findings suggest significant alterations in water composition in areas where CKDu is prevalent. High alkalinity, calcium, magnesium, and hardness may play a role in nephrotoxicity, possibly through chronic exposure. These findings are consistent with studies from Sri Lanka, where high water hardness and metal contamination, including cadmium and arsenic, were implicated (Wanigasuriya et al., 2011; Jayasumana et al., 2014)^{2,3}.

In Andhra Pradesh, India, the Uddanam region has seen similar patterns with elevated calcium, fluoride, and hardness in groundwater (Muthulakshmi et al., 2020; Reddy et al., 2019)^{4,5}. Moreover, El Salvador and Central America have linked CKDu to a combination of heat stress, dehydration, and poor-quality drinking water (Orantes et al., 2011; Wesseling et al., 2013)^{6,7}.

Although this study does not find statistically significant differences in fluoride or iron, it raises concerns about cumulative exposure to multiple moderately elevated parameters contributing to renal injury over time.

Our study investigated the relationship between water quality and the prevalence of Chronic Kidney Disease of Unknown Origin (CKDu) in a rural population. The water analysis data from our region revealed significant concerns in terms of water safety, with multiple samples showing elevated levels of total dissolved solids (TDS), hardness and trace heavy metals like calcium and magnesium. These findings suggest a potential environmental etiology contributing to the burden of kidney disease in this population.

The average TDS levels across the sampled areas exceeded 600 mg/L in more than half the cases, indicating mineral-heavy water. According to the WHO, water with TDS levels above 600 mg/L may be considered poor quality, and chronic consumption could potentially strain renal function over time⁸.



The detection of significant amounts of calcium and magnesium is particularly concerning. These environmental contaminants, when considered in the context of repeated exposure and cumulative toxicity, may provide a mechanistic basis for CKDu in this region. A pivotal study by Jayasumana et al. (2015)² from Sri Lanka linked CKDu with consumption of hard water contaminated with pesticides, fluoride, and heavy metals such as cadmium and arsenic. The researchers found that well water with high conductivity and TDS levels—exceeding 500 $\mu\text{S}/\text{cm}$ —was commonly used by affected populations. Notably, the synergistic effect of multiple nephrotoxicants was emphasized as a plausible etiology.

Our findings are similar in several respects, especially regarding TDS, alkalinity, calcium and magnesium. Although pesticide levels were not assessed in our current study, anecdotal evidence suggests widespread agrochemical use in adjacent farming communities.

Reddy et al. (2019)⁴ studied the Uddanam region in Andhra Pradesh, reporting a high CKDu prevalence and implicating water sources with elevated silica, fluoride, and TDS as likely contributors. Similar to our findings, the Uddanam study showed that residents used untreated groundwater, often exceeding acceptable quality parameters.

The overlap in the water quality profile between our study and the Uddanam region supports the idea that chronic consumption of chemically imbalanced water plays a central role in CKDu pathogenesis.

In El Salvador, Orantes et al. (2011)⁶ described a high incidence of CKDu among agricultural workers, where water analysis from endemic areas showed low mineral content but high salinity and contamination with agrochemicals. Although the water chemistry differs somewhat from our region, the commonality lies in the occupational and environmental exposure to potentially nephrotoxic agents.

Interestingly, our study region also has a predominantly farming workforce, suggesting that in addition to water quality, occupational heat stress and dehydration may synergize to cause renal injury.

A key strength of our study is the integration of clinical findings with concurrent environmental data, particularly water analysis. However, limitations include the absence of pesticide and herbicide assays, which may contribute to the nephrotoxic profile. Furthermore, we did not measure individual exposure levels or biomonitoring heavy metal concentrations in blood or urine, which could strengthen causal inference.

The findings underscore the urgent need for public health interventions focusing on: provision of safe, treated drinking water in vulnerable communities; regular monitoring of groundwater sources for heavy metals and fluoride; community education about the risks of consuming untreated well water; and longitudinal epidemiologic studies to monitor kidney function in at-risk populations.

Future research should also explore gene-environment interactions, as certain populations may have genetic susceptibility to toxin-induced nephropathy.

Our water analysis supports the hypothesis that environmental factors, particularly water quality, play a significant role in the pathogenesis of CKDu in our region. This is in concordance with findings from Sri Lanka, Andhra Pradesh, and Central America. These insights demand urgent public health action to mitigate further kidney damage in susceptible populations and highlight the need for an integrated approach involving nephrologists, public health authorities, and environmental scientists.

This table compares water quality parameters and CKDu-related findings from our study region with previously reported data from Sri Lanka, Andhra Pradesh (India), and El Salvador⁸⁻²¹.

Parameter / Factor	Our Study Region	Sri Lanka (NCP)	Andhra Pradesh (Uddanam)	El Salvador
CKDu Prevalence	Emerging clusters in rural areas	High (>15% in some villages)	High (up to 27% in endemic villages)	High among young male agricultural



				workers
Water Source	Groundwater from wells, Bore wells	Shallow wells, tube wells	Groundwater (wells, borewells)	Wells, surface water
TDS (mg/L)	Often >600 mg/L	>500–1000 mg/L	>1000 mg/L	High salinity reported
Fluoride (mg/L)	<1.5 mg/L in multiple samples	>2.0 mg/L in affected areas	>1.5–3.5 mg/L	Not a major factor reported
Silica (mg/L)	Not reported	Not assessed	Elevated (>40 mg/L in some samples)	Not reported
Hardness (mg/L as CaCO ₃)	Moderately to very hard (>300 mg/L)	Hard to very hard	Very hard	Hard water reported in some regions
Cadmium / Arsenic	Trace amounts detected	Detected in some samples	Not consistently reported	Detected in some wells
Agrochemical Contamination	Not assessed	Yes (glyphosate, pesticides suspected)	Yes (possible role of herbicide residues)	Yes (heavy agrochemical exposure)
Occupational Risk	Agricultural labor, heat exposure	Farming + manual labor	Agricultural work, sun exposure	Sugarcane workers under high heat stress
Water Treatment/Filtration	Minimal to none	Limited	Minimal	Limited
Key Suspected Factors	Hardness, TDS, Calcium, Magnesium	Fluoride, cadmium, arsenic, pesticides	Silica, fluoride, TDS, heat	Heat stress, dehydration, agrochemicals

Conclusion

This study establishes a significant association between specific water quality parameters (alkalinity, calcium, magnesium, hardness) and CKDu. These findings underline the need for stricter monitoring of groundwater quality and public health interventions in high-risk areas.

Recommendations

- Implementation of safe drinking water practices.
- Longitudinal cohort studies to confirm causality.

- Community awareness and preventive screening in endemic zones.

- Policy development for water quality control in rural areas.

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Conflict of Interest

None declared.

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