RESEARCH ARTICLE

GEOGRAPHICAL DISTRIBUTION OF THE CHRONIC KIDNEY DISEASE OF UNKNOWN ORIGIN IN SRI LANKA: IN THE REGION OF IRRIGATION RESERVOIRS

1Jayasekara JMKB, 2Dissanayake DM, 3Adhikari SB and 4Palitha Bandara

1Department of Pathology, Faculty of Medicine, University of Peradeniya, Sri Lanka
2Department of Pathology, Faculty of Medicine, University of Peradeniya, Sri Lanka
3GPS analyst, Mahaweli Development Authority, Kotmale, Sri Lanka
4Regional Director of Health services, Regional Director's Office, Anuradhapura

ARTICLE INFO

ABSTRACT

Objectives: In early nineties investigators noticed an alarmingly high incidence of an apparently new form of chronic kidney disease of unknown aetiology (CKD-U) in some parts of Sri Lanka. The aim of the studies was to investigate the geographical distribution of CKD-U using GIS and GPS mapping.

Methods: Community based information was collected from 11323 patients for GIS mapping using ARC 9.2 software. Based on GIS mapping, two locations were selected for GPS mapping to locate the households of 863 CKD-U patients with reference to reservoirs, irrigation canals and the topography of the areas.

Results: showed that the GIS mapping indicated five high prevalent areas. Communities who consumed water from natural springs showed a low prevalence of the disease. GPS mapping showed that most of the affected villages are located below the reservoirs and canals with stagnant irrigated water.

Conclusion: Epidemiological data on geographical distribution infers that while older foci of CKD-U are persisting, there is an emergence of new foci with time. The location of the affected villages below the level of the reservoirs/canals may indicate the possibility of draining of irrigated water to the shallow wells of the households, which is the source of drinking water.

INTRODUCTION

Chronic Kidney Disease (CKD) is defined as either kidney damage or decreased kidney function for a period of three months or more (Andrew et al., 2003). It is characterized by progressive destruction of renal mass with irreversible sclerosis and loss of nephrons over a long period of time depending on the underlying etiology. CKD is a slow progressive disease, which requires dialysis or transplantation at the end-stage. It is an emerging health problem all over the world (Eknoyan et al., 2004). The disease is often associated with poor prognosis and it incurs economic burden on the patient, family, community and the country as a whole. Common causes of CKD include diabetes mellitus, hypertension, urological diseases and glomerular nephritis. Toxins, collagen vascular disease and infections are the rare causes of CKD. Sri Lanka is an island in the Indian Ocean below the southern tip of India with a special topography. The island with a landmass of 65,525 km² has a central massif with its tallest peak rising 2500 meters above sea level. One hundred and three river basins spread radially from the central hills outward to the coastal plains. The island receives an average of 1800 mm rainfall from the two distinguished monsoons. The region in the south–west quadrant (wet zone) receives annual rainfall of 2200 mm covers only one third and the balance with a rainfall about 2000mm encompass 2/3 of the country (dry zone). The dry zone of the country is characterized by intricate network of man made reservoirs and canals that provide water for paddy cultivation and for human and livestock use from pre Christian era up to date. However, CKD is abundant only in one part of the dry zone namely North Central Region of the country.

In early nineties investigators in Sri Lanka have noticed an alarmingly high incidence of a new form of chronic kidney disease of unknown aetiology (CKD-U) in North Central Region of the Sri Lanka. This kidney disease was not related to any of the known causes such as diabetes mellitus, hypertension & infection (Wanigasuriya et al., 2007). However, histopathology of affected kidneys showed tubulo interstitial nephritis, which is suggestive of a toxic aetiology. Researchers who investigated the disease proposed number of risk factors including high level of fluoride in ground water (Herath et al.,2005) heavy metals such as cadmium (Bandara et al.,2008), exposure to inorganic pesticides (Peiris et al.,2006), usage of aluminium containers for cooking and ochratoxin (Wanigasuriya et al., 2008) etc.

Although many studies on the aetiology of the disease were carried out by different research groups, a comprehensive epidemiological study has yet been reported. As such,
Identification of the aetiology has become a difficult task. Geographic information systems (GIS) and geographic position system (GPS) are computer-aided database management and mapping technology that organizes and stores large amounts of multi-purpose information. Health mapping has evolved from Dr. John Snow’s cholera death mapping (Johnson Steven, 2006) in mid-nineteenth century to the latest Internet-based mapping and GIS is particularly useful to health professionals and administrators in planning and day-to-day management (Colledge et al, 1996). It offers powerful tools to determine geographical distribution and variation of diseases, and their prevalence and incidence. GIS has been successfully used in the management of many vector-borne diseases (Balaji, 2000; Srivastava and Nagpal, 2000). In this study, we attempted using GIS and GPS technologies to study the geographical distribution of CKD-U, which is an important non-communicable health problem in Sri Lanka. The present study was carried out to with the aim of studying demographic characteristics of the patients, geographical distribution of the disease, location of households of the CKD-U patients in relation to reservoirs, irrigation canals and the topography of the affected area that would help identifying potential aetiological factor/s, which could be associated with the disease.

METHODS

In first part of the study Geographical Information System (GIS) mapping was used (ARC 9.2 software) to study the geographical distribution of the disease. Information was collected with reference to basic demographic data (age & sex) and respective addresses of 11323 chronic kidney disease patients who attended community renal clinics (Fig 2) that were especially established to follow up CKD-U patients and hospital nephrology clinics and in high prevalence areas. Community based data collection was carried out with precautions to prevent counting the same patient twice or more. The patient density per each Gramaniladhari division (GN-smallest administration unit of the country) was calculated using the ARC 9.2 software. Subsequently the patient density was expressed in relation to the 1000 population in each Gramaniladhari division (Census & Statistics report, 2009). Based on the findings of the GIS mapping, two locations, one area with a large reservoir (Padaviya) and another area with multiple small reservoirs (Nikawewa) were selected for further studies. Geographical Position System (GPS) mapping was specially used to study the location of households of the CKD-U patients in relation to reservoirs, irrigation canals and the topography of the two selected areas. There were 1100 and 97 reported patients from Padaviya and Nikawewa respectively. Homes of these registered patients were visited to record the GPS coordinates, collect demographic data and to reconfirm the diagnosis using documentary evidence. Due to unavailability of patients, migrations, lack of information or subjects, which do not fulfill the diagnostic criteria, the sample was restricted to 863 during home visits. (796 and 67 patients from Padaviya and Nikawewa respectively). The diagnostic criteria used for CKD-U includes absence of Diabetes Mellitus, hypertension, urinary tract infections or other renal diseases in the history, presence of urinary protein and presence of radiological / pathological evidence of chronic kidney disease.

RESULTS

The demographic information showed that the male: female ratio of the disease is 2.4: 1. CKD-U is more prevalent in the age group over 40 years with a mean age of 54.7 ± 8 yrs (fig 1). Out of the total, 90% of the patients were farmers. The source of drinking water was shallow wells (92%), tube wells (7%) and water reservoirs (1%). CKD-U was present even among patients who consumed boiled water exclusively for lifelong. Clustering of the disease was observed in 30% of the patients.

![Figure 1 Age & Sex distribution of CKD-U patients in Medawachchiya, Padaviya & Kebithigollewa area.](image-url)

![Figure 2 Geographical distribution of CKD-U patients in Sri Lanka with hospitals/renal clinics.](image-url)
that there is an emergence of new foci with the time while older foci are persisting. Low prevalence of the disease was noted in communities who consume water from natural springs for drinking (some villages of Kebithigollewa (figure 3)). Figure 4 shows the distribution of patients in Girandurukotte mainly a paddy farming area that is supplied by the two reservoirs namely Ratkinda and Ulhitiya.

The disease is reported only in the villagers who live in the Eastern bank of the Mahaweli river supplied by the two reservoirs while those who live in the Western bank supplied by the natural springs are not affected. Figure 3 shows distribution of patients in Padaviya-another affected paddy farming area supplied by the Padaviya reservoir and the patient distribution in Medawachchiya area where high density of smaller reservoirs is seen. GPS mapping shows that most of the affected villages are below the reservoir or canals (Figure 5). Area with the lowest altitude is affected by the disease.

**DISCUSSION**

The geographical distribution of the CKD-U shows that the disease is confined to some areas of the dry zone predominantly in the North Central Region (NCR), which includes villages of North Central, North Western and Uva provinces. Though the population at risk is scattered in the North Central Region, large number of patients have been detected in Medawachchiya, Padaviya and Girandurukotte with two smaller foci in Medirigiriya and Nikawewa. It has been observed that all five regions affected with the CKD-U encompass a well developed irrigation system comprising of either one or two large reservoirs (Padaviya & Ratkinda /Ulhitiya) or cluster of small reservoirs (Medawachchiya & Nikawewa). Water from these reservoirs is mainly used for agricultural purposes. However, the people who live in these areas consume water from shallow wells for their all other daily needs except bathing. These shallow wells are purposely positioned close to the irrigation canals and most are downstream of the canal so that the dwellers can gain water without digging too deep. Water levels of these shallow wells are proportionate to the water levels of the canals indicating that the ground water table is recharged from irrigation canals & reservoirs. Therefore, the ground water level is fluctuated proportionately with the water levels of the reservoirs and canals. This shows that there is a definite seepage of water from these canals to the shallow wells. As such, it is clear that almost all these shallow wells are fed by irrigation canals and not by natural springs. It has been observed that the prevalence of the disease is comparatively low in the villages where natural spring water is available for drinking & cooking.
Observations of the study reveals that the exposure to the aetiological agent remains unchanged and new disease foci are reported to be emerging. Therefore, prospective surveillance studies and regular screening programmes are essential to combat this devastating disease. The reported Familial occurrence of the disease with no evidence of clear Mendelian inheritance could be due to exposure of the siblings to the aetiological agent rather than direct genetic/inherited background for the disease. Similarly, familial occurrence & location of the affected house holds in the lowest lying area has been observed in Balken nephropathy [Tatu et al.,1998; Craciun and Rosulescu,1970; Mandal et al.,1987] too, where the causative agent is supposed to be toxic in nature. Disease preponderance in males may be due to their frequent exposure to the aetiological agent than females. This could also be due to another unknown contributory factor that operates in males which increases the risk of the disease.

**CONCLUSION**

The characteristic geographical distribution of the disease related to stagnant irrigated water indicate the possibility of an environmental factor related to water in the pathogenesis of the disease. The use of water from the shallow wells for drinking by the affected population indicates the possibility that the aetiological agent is water soluble.

**Acknowledgement**

The authors wish to acknowledge the South Asian Clinical Toxicology Research Collaboration for bearing the travelling expenses and partial funding for this study.

**References**


