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Maternal Urinary Iodine Concentration and Usage of Iodized Salt

This study was carried out to find the maternal urinary iodine concentration (UIC) and the knowledge and practice of mothers on iodized salt at third trimester in Jaffna district of Sri Lanka. Four hundred and seventy seven pregnant mothers were randomly selected from six Medical Officers of Health (MOH) divisions among the twelve in Jaffna District, Sri Lanka. Maternal urinary iodide level and the knowledge and practice of iodized salt were assessed. Among the 477 pregnant mothers mean age, weight, height and gestational period were 28(±5) years, 63 (±11) kg, 154 (±6) cm and 39(±1) weeks respectively. Mothers those who had no formal education, grade 1-5, grades 6-11,Grade 1213 and degree & above were 0.2 (*n*=1), 9.6 (*n*=46), 58.9 (*n*=281), 23.9 (*n*=114) and 7.3% (*n*=35) respectively. Maternal median UIC was 140.0 µg/L and ranged from 36.0 to 644.0 µg/L with the inter quartile range (IQR) was 126.0 to 268.0 µg/L. Of the total mothers, 65.1% (*n*=311) had UIC less than 150.0 µg/L which indicates prevalence of iodine deficiency among the study subjects in Jaffna District was 65.1 % according to the World Health Organization recommendation. Also, 22.7% (*n*=109) and 11.7% (*n*=57) had adequate (150 – 250 µg/L) and excess (greater than 250.0 µg/L) level of iodine excretion in their urine respectively. Among the 477 mothers, 82.5 (*n*=393), 2.5 (*n*=12) and 15.0 % (*n*=72) used iodized salt, iodized and normal salt and the unaware of iodized salt respectively. Further, 15.5 (*n*=74), 0.8 (*n*=4), 30.2(*n*=144) and 53.5% (*n*=255) of the mothers, do not know about iodized salt & iodine deficiency disorders (IDD), know about IDD, know about iodized salt and know about the IDD & iodized salt respectively. Of the total mothers 55.9 (*n*=267), 15.1 (*n*=72) and 14.1 % (*n*=67) had the knowledge on goiter, mental and growth retardation respectively. Among the iodine deficient mothers (UIC <150.0 µg/L), 74.0 % (*n*=231) had educational level below GCE (O/L) and 64.0 % (*n*=199) of iodine deficient mothers added iodized salt before cooking and rest of them added it after cooking by all different methods. Further, 66.0 (*n* =205), 21 (*n*=65) and 13 % (*n*=41) of iodine deficient pregnant mothers added iodized salt directly, mixed with

water and washed with water for cooking respectively. Based on these findings, this study indicates that 65.1 % of pregnant mothers in Jaffna district had iodine excretion in their urine below the accepted level and maternal iodine deficiency is mainly associated with their educational level and way of iodized salt adding practice.

Keywords: iodine deficiency, iodized salt, pregnant mothers, urinary iodine concentration

The influence of drinking water quality on chronic kidney disease of unknown aetiology in *Ulagalla* Cascade in dry zone, Sri Lanka

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Abstract

Chronic Kidney Disease of unknown aetiology (CKDu) is one of the major health issues in Northern part of Sri Lanka which recorded highest mortality and morbidity rates. Literature has revealed an increase of 227% in live discharge patients with end-stage CKDu, whereas the death rate increased by 354% during 2011-2016. The main responsible reason for the CKDu has not yet been identified and hence many scientists have suggested number of certain risk factors where the CKDu-mfo (CKDu multifactorial origin) term derived. However it relates with certain drinking water quality parameters strongly. This study was focused on evaluating the drinking water quality of *Ulagalla* cascade in Anuradhapura district with admiration to CKDu. Thirty wells and twenty tanks were selected as sampling locations for groundwater and surface water respectively from the cascade. Water quality parameters such as pH, electrical conductivity, total dissolved solids, turbidity, Sodium, Magnesium, Calcium, Potassium, Arsenic, Lead, Cadmium, Ammonium Nitrogen, Nitrate Nitrogen, alkalinity, Sulphate, Chloride and Phosphate were analysed and observed parameters were compared with drinking water quality standards (WHO, 2011 and SLS 614:2013).In groundwater turbidity, Magnesium, Chloride and Cadmium were not significantly different from the maximum permissible level ($p>0.05$) while surface water has shown significant difference only for the turbidity ($p>0.05$).Both well and tank water samples from *Thodamaduwa* were polluted by Cadmium which exceeded the maximum permissible level standards. It was recorded as averages of 0.15, 0.13 and 0.019 ppb in groundwater and 0.01ppb in tank water. Accordingly the study it can be suggested that cumulative levels of heavy metals (such as Cd) may be aggravating the CKDu in the Northern Central Parts in Sri Lanka.

Key words: Chronic Kidney Disease of unknown aetiology, Drinking water quality, Drinking water quality guidelines, North central province

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Introduction

The tank cascade system (TCS) in dry zone is one of the most advanced water conveyance mechanisms developed to overcome water scarcity problems from the ancient irrigation history (Mahatantila et al., 2008). Water in tanks was not only used for agricultural purposes but also for domestic purposes include drinking (Jayawardena, 2015). Tail end tank of TCS may significantly polluted as a result of intensive application of agrochemicals in paddy fields which were not evident in ancient time (Kumari et al., 2013).As a result of polluted water intake there are some health concerns reported from the people inhabited in the dry zone. CKDu is very aggressive disease with absent of certain responsible causes. Dialysis or kidney transplant are the only medical solutions for this disease. The cost of dialysis of CKDu patients has become a severe problem on the government health authorities (Chandrajith et al., 2011). Consequently, nearly 80% of these patients ultimately die from kidney failure within the first two years (Misra and Saxena, 2012).*Ulagalla* cascade is one of the prominent cascades in Anuradhapura district with twenty small tanks highly utilizing for agricultural purposes and still no any study has conducted to evaluate water quality in the cascade with relevance to CKDu. Therefore, the present study has been conducted to characterize the surface and groundwater quality with relevance to CKDu in *Ulagalla* cascade. The aim of the study was to evaluate the ground water and surface water quality parameters and subsequent comparison with WHO (World Health Organization) and Sri Lankan Standards for potable water (SLS 614, 1983) related to CKDu in "*Ulagalla* Cascade" in Anuradhapura district, North Central Province, Sri Lanka.

Methodology

Water quality parameters such as pH, electrical conductivity, total dissolved solids, turbidity, sodium, magnesium, calcium, potassium, arsenic, lead, cadmium, ammonium nitrogen, nitrate nitrogen, alkalinity and phosphate were analysed in groundwater and surface water

Table 3: Selected water quality parameters and methods of analysis

Parameter	Method of analysis
pH	Multi parameter analyzer (HACH-HQ40d)
Electrical conductivity	Multi parameter analyzer (HACH-HQ40d)
Total dissolved solids	Multi parameter analyzer (EUTECH PCD650)

Turbidity	Turbidimeter(EUTECH TN-100)
Sodium	ICP-OES(Thermo ICAP 7400)
Magnesium	ICP-OES(Thermo ICAP 7400)
Potassium	ICP-OES(Thermo ICAP 7400)
Calcium	ICP-OES(Thermo ICAP 7400)
Arsenic	ICP-OES(Thermo ICAP 7400)
Lead	ICP-OES(Thermo ICAP 7400)
Cadmium	ICP-OES(Thermo ICAP 7400)
Phosphorous	Ascorbic acid method (APHA 1998)
Alkalinity	Acid base titration(APHA 1998)
Nitrate nitrogen	Salicylic acid method(APHA 1998)
Ammonium nitrogen	4500NH F phenate method(APHA 1998)

separately in the laboratory (Table 1).Both sulphate and chloride anions analysis were done by National water supply and drainage board, Anuradhapura. The observed water quality parameters were compared with drinking water quality standard (WHO, 2004 and SLS 614:2013) values. To evaluate measured drinking water quality parameters of groundwater and surface water a T test (one sample t test and two sample t test) was performed by using Minitab statistical software package. Once the input data was imported as a point layer into ArcGIS 10.1, geodatabase was created to generate the maps of spatial distribution of selected ground water quality parameters.

Results and discussion

This study was focused on the evaluation of drinking water quality parameters in both groundwater and surface water separately with relevant to CKDu. Based on the WHO, (2004) and SLS (614: 2013) guideline values, average pH, turbidity, sodium, calcium, sulphate, phosphorous, nitrate nitrogen, ammonium nitrogen and alkalinity values in the groundwater were below the maximum permissible level. Average value of all the other parameters were exceeded the WHO, (2004) and SLS (614: 2013) guideline values (Table 2).Only three wells showed cadmium concentrations (U18, U19 and U20). Recorded average cadmium concentrations were 0.15 µg/L, 0.13 µg/L and 0.01 µg/L in U18, U19 and U20 respectively.

Table 4: Water quality parameters and average values in groundwater

200

Alkalinity (mg/L)	33.33 - 162.5	200	500
Nitrate nitrogen (mg/L)	0.07 - 8.35	50	50
Ammonium nitrogen (mg/L)	0.07 - 0.13	0.2	0.5
Sulphate (mg/L)	1.33 - 70	250	250

Parameter	Recorded average range in *Ulagalla* cascade	Maximum permissible level SLS (614: 2013)	Maximum permissibl (WHO
pH	6.7 - 8.7	6.5-8.5	6.5-8.5
Electrical conductivity(µS/cm)	427.10 - 2590.67	500	250
Total dissolved solids (mg/L)	111.43 -1718.33	500	500
Turbidity (NTU)	0.92 - 20.85	2	5
Sodium(mg/L)	7.51 - 81.54	200	200
Magnesium (mg/L)	2.9 - 110.05	30	30
Potassium (mg/L)	0.81 -12.9	10	10
Calcium (mg/L)	12.27 - 120.76	100	75
Arsenic (µg/L)	0.03 - 0.44	0.01	0.01
Lead(µg/L)	1.76 - 8.85	0.01	0.01
Cadmium(µg/L)	0.01-0.15	0.003	0.003
Phosphorous (mg/L)	0.18 - 1.05	2	-
Chloride (mg/L)	50 - 1176.67	250	250

Table 3 shows the water quality parameters and recorded average ranges in surface water of *Ulagalla* cascade. All the water quality parameters in the surface water except turbidity were below the maximum permissible guideline values based on the WHO, (2004) and SLS (614: 2013) and they are suitable for drinking purpose. The Thondamaduwa tank showed an average cadmium concentration of 0.01 µg/L. There were no significant differences in the turbidity, nitrate nitrogen, arsenic and cadmium between groundwater and surface water ($p>0.05$).

Table 5: Water quality parameters and average values in surface water

Parameter	Recorded range in average *Ulagalla* cascade
pH	5.8-8.2
Electrical conductivity(µS/cm)	94.25 - 806.33
Total dissolved solids (mg/L)	70.11 - 538.87
Turbidity (NTU)	1.62 - 313.19
Sodium(mg/L)	7.51 - 81.54
Magnesium (mg/L)	1.39 - 23.55
Potassium (mg/L)	2.61 - 10.13
Calcium (mg/L)	8.86 - 41.25
Arsenic (µg/L)	0.02 - 0.19
Lead(µg/L)	0.59 - 2.80

Cadmium(µg/L)	0-0.01
Phosphorous (mg/L)	0.08-0.18
Alkalinity (mg/L)	10.42 - 70.83
Nitrate nitrogen (mg/L)	0.12 - 1.97
Ammonium nitrogen (mg/L)	0.07 - 0.24
Sulphate (mg/L)	1-16
Chloride (mg/L)	20 - 280

Conclusions

Majority of the water quality parameters were not exceeded the SLS and WHO drinking water quality standards. In groundwater turbidity, Mg+2, Cl-, Cd+2 were significantly higher than the maximum permissible levels of SLS and WHO ($p>0.05$). But except turbidity all the other parameters of surface water were significantly lower than the maximum permissible drinking water quality parameters ($p<0.05$). A significant difference was not observed between groundwater samples and surface water samples ($p< 0.05$) only for turbidity, NO3-N, As and Cd. All the other water quality parameters (pH, EC, TDS, Na+, Mg+2, Ca+2, K+, NH4+N, alkalinity, Pb, SO4-2, Cl-, PO4-3) were significantly different from groundwater and surface water samples. The major cause for CKDu hypothesized in the study is chronic exposure to cadmium and arsenic through the food chain and also from pesticides. Cd and As did not detect in the surface water and Ground water wells except T1 tank (Thodamaduwa) (Surface water) and U18, U19,U20 well (in ground water) which were marked as Cd polluted water wells.

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