Occupational herbicide exposure may induce Kidney injury molecule I (KIM I) and Neutrophil Gelatinase-Associated Lipocalin (NGAL) levels in sugarcane farmers in rural Sri Lanka

Occupational herbicide exposure may induce Kidney injury molecule I (KIM I) and Neutrophil Gelatinase-Associated Lipocalin (NGAL) levels in sugarcane farmers in rural Sri Lanka

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Abstract

Extensive use of herbicides is common among agriculture workers in Sri Lanka (SL). Recent studies hypothesized the role of agrochemicals in the development of mysterious chronic kidney disease termed as CKDu. Paraquat and Glyphosate were leading herbicides among sugarcane farmers (SF) hence occupational exposure is inevitable. This study reports detection of urinary Paraquat and Glyphosate residues among SF residing in CKDu emerging regions (Uva province; Warunagama and Rahathangama) of SL along with tubular injury biomarkers KIM I and NGAL. Collected urine samples were compared with non-endemic controls (CN) (Southern province; Matara). Paraquat, Glyphosate, KIM I and NGAL levels (Warunagama, n = 66; Rahathangama, n = 69; Matara, n = 66) were estimated using Enzyme Linked Immunosorbent Assays. Urinary creatinine, microalbumin and albumin creatinine ratio (ACR) were also assessed for kidney function. Generally herbicide residues and injury biomarkers were higher in SF with compared to CN. Creatinine adjusted urinary glyphosate and paraquat levels were significantly higher in Warunagama (271.3 ± 23.7 µg/g Cr, 2.08 ± 0.33 µg/g Cr; $p < 0.001$) but not in Rahathangama (250.4 ± 18.8 µg/g Cr, 0.79 ± 0.12 µg/g Cr; $p > 0.05$) when compared with CN (191.2 ± 14.2 µg/g Cr, 0.67 ± 0.05 µg/g Cr). Urinary NGAL levels were significantly higher (12.4 ± 4.7 ng/mg Cr $p < 0.0001$, 12.0 ± 2.8 ng/mg Cr; $p < 0.0001$) in both Warunagama and Rahathangama. However, urinary KIM I levels were not significant (101.6 ± 25.0 ng/g Cr, 114.6 ± 25.5 ng/g Cr; $P>0.05$) with compared to CN (34.9 ± 20.1 ng/g Cr, 1.8 ± 0.4 ng/mg Cr). In conclusion, current study confirms higher urinary herbicides levels in SF, potentially due to occupational exposure. Similarly, higher urinary KIM I and NGAL levels were also reported in both CKDu emerging locations and could be link with elevated herbicide residue levels. However, low but detectable levels of urinary herbicide, KIM I and NGAL in non-endemic controls may support dietary exposure and warrants further studies.

Keyword: chronic kidney disease, Glyphosate, herbicide exposure, kidney injury, KIM I, Paraquat, NGAL

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Introduction:

Extensive use of herbicides is common among agriculture workers in Sri Lanka (SL). Recent studies hypothesized the role of agrochemicals in the development of mysterious chronic kidney disease termed as CKDu. Paraquat and Glyphosate were leading herbicides among sugarcane farmers (SF) hence occupational exposure is inevitable. This study reports detection of urinary Paraquat and Glyphosate residues among SF residing in CKDu emerging regions (Uva province; Warunagama and Rahathangama) of SL along with tubular injury biomarkers Kidney Injury Molecule I (KIM I) and Neutrophil Gelatinase Associated Lipocalin (NGAL).

Materials and methods:
Male sugarcane farmers who are cultivating more than ten tears ($n = 135$) were recruited from two sugarcane farming regions (Rahathangama and Warunagama) in Uva Province, Sri Lanka. Collected urine samples were compared with non-endemic controls (CN) (Southern province; Matara). Paraquat, Glyphosate, KIM I and NGAL levels (Warunagama, $n = 66$; Rahathangama, $n = 69$; Matara, $n = 66$) were estimated using Enzyme Linked Immunosorbent Assays. Urinary creatinine, microalbumin and albumin creatinine ratio (ACR) were also assessed for kidney function. Statistical analysis was performed using IBM statistics (v23). In all analysis, $p<0.05$ was considered as significant.

Results & Discussion:

Creatinine adjusted urinary glyphosate and paraquat levels were significantly higher in Warunagama (271.3 ± 23.7 µg/g Cr, 2.08 ± 0.33 µg/g Cr; $p < 0.001$) but not in Rahathangama (250.4 ± 18.8 µg/g Cr, 0.79 ± 0.12 µg/g Cr; $p > 0.05$) when compared with CN (191.2 ± 14.2 µg/g Cr, 0.67 ± 0.05 µg/g Cr). Urinary NGAL levels were significantly higher (12.4 ± 4.7 pg/g Cr $p < 0.0001$, 12.0 ± 2.8 pg/g Cr; $p < 0.0001$) in both Warunagama and Rahathangama than the control group (1.8 ± 0.4 pg/g Cr). However, urinary KIM I levels were not significant in both locations (101.6 ± 25.0 ng/g Cr, 114.6 ± 25.5 ng/g Cr; $P>0.05$) with compared to CN (34.9 ± 20.1 ng/g Cr,). According to the findings the potential capabilities of occupational exposure may induce urinary KIM-1 and NGAL levels in sugarcane farmers.

Conclusion:

In conclusion, current study confirms higher urinary herbicides levels in SF, potentially due to occupational exposure. Similarly, higher urinary KIM I and NGAL levels were also reported in both CKDu emerging locations and could be link with elevated herbicide residue levels. However, low but detectable levels of urinary herbicide, KIM I and NGAL in non-endemic controls may support dietary exposure and warrants further studies.

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