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Identification of People at Risk of Developing Chronic Kidney Disease among Rural Disadvantageous Population in Bangladesh

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Authors' contributions

This work was carried out in collaboration among all authors. Authors TR and HUR designed the study, performed the statistical analysis, wrote the protocol and wrote the first draft of the manuscript. Authors TR and AIC managed the analyses of the study. All authors managed the literature searches. All authors read and approved the final manuscript.

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ABSTRACT

Background: Chronic kidney disease (CKD) is a global disease and the prevalence of CKD is increasing in both developed and developing countries. The current study aimed to assess subjects in the rural areas of Sylhet district in Bangladesh to identify individuals who may be predisposed to at risk for developing CKD.
Methods: A cross-sectional study was carried out among 996 subjects from Sylhet district of Bangladesh. Data were collected by using a standard questionnaire from 82 villages. Data about socio-demographic, medical history and anthropometric and biochemical parameters were collected. Urine dipstick test was done for both albumin and glucose. Descriptive statistics and ANOVA-test were performed for statistical analysis.

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Results: The study revealed that people living in rural areas of Sylhet in Bangladesh are at risk of developing CKD and the hidden cause behind it includes not only diabetes and hypertension, but also other lifestyle related factors. Younger participants were found to be at less risk compared to older participants for developing CKD. From urinary dipstick test, 2% and 3.3% subjects had severe traces of albumin and glucose in their urine. Approximately 16% of subjects had hypertension. From the data of 99 out of 996 subjects for urine albumin dipstick test, 98 respondents were identified as stage I CKD patients and only one was identified as stage II CKD patients.

Conclusion: As dialysis and transplants are unsustainable in the long term, it is important to seek preventive strategies when patients are in pre-dialysis state and identify and manage those at high risk. Nutrition and life-style choices can play key roles to achieve this. So, urgent low-cost programs are needed to identify people who are at risk of CKD as well as address their current medical condition to initiate early management of CKD patients.

Keywords: Chronic kidney disease (CKD); BMI, BP (systolic and diastolic); serum creatinine; Bangladesh.

1. INTRODUCTION

Chronic kidney disease (CKD) is a major public health concern affecting the people of developed countries as well as developing countries [1]. CKD is defined by hematuria, proteinuria or decreased estimated glomerular filtration rate (eGFR) [2]. According to the National Kidney Foundation (NKF) Kidney Disease Outcome Quality Initiative (K/DOQI) guidelines, CKD is defined as, " *a chronic disease state in that irreversible, structural, or functional abnormalities of the kidney, with or without a decreased glomerular filtration rate (GFR), are present for at least three consecutive months*" [3]. Based on CKD-EPI (chronic kidney disease epidemiology collaboration) equation, which is better than MDRD (modification of diet in renal disease study) equation for a clinical setting, estimated GFR (eGFR) is used to classify different stages of CKD [4]. Many researchers proposed silent CKD as a pandemic and kidney patients suffers from other non-communicable diseases like cardiovascular disease, diabetes, glomerulonephritis and hypertension [1]. USRDS report revealed that, in 2016, the incidence rate of ESRD in the United States was 373.4 per million population (pmp) per year and the prevalence rate of ESRD was 2160.7 pmp, based on December 31, 2016 data in the US. Overall, CKD stages 1 to 5 increase from 13.6% in 2012 to 16.1% and CKD stages 3 to 5 rises from 6.2 to 7.5% in 2016 [5]. One study (2014) reported that the prevalence of CKD in Bangladesh was 26% [6]. In 2015, Das et al. showed that, prevalence of stage 2 CKD was 24% and mostly in female [7]. A study published in 2015 reported that, in low and middle income countries, the number of patients suffering from different stages of CKD was more than 3 times higher while compared to high-income countries worldwide [8]. CKD patients required either dialysis or kidney transplantation to maintain the health and increase the survival condition due to high risk for the progression to the end stage renal disease (ESRD) [9]. Hypertension, diabetes and age are considered as a major predictor of CKD [10].

Although the precise prevalence of ESRD in Bangladesh is unknown, it could be 200 to 250 per million population per year and the incidence rate will be higher than the prevalence rate [11]. The prevalence of CKD among urban Bangladeshi population has been estimated at 16% to 18% [6], and of them 11% were in stage III to V [12]. According to Bangladesh Renal Registry report, almost twenty millions people are suffering from CKD of various stages [13] and 100-120 people per million reached to ESRD every year [14]. In a study conducted in Dhaka, capital city of Bangladesh found that, 17.4% rural people suffered from CKD and among them, 1.7% was in Stage I, 2.1% in stage II, 13.1% in stage III, 0.3% in stage VI and 0.2% in stage V [15]. Changing life style is another factor of CKD and urban people might be at great risk of developing CKD due to adopting a sedentary life-style [16]. Based on a recent systematic review and meta-analysis, the overall prevalence of CKD was reported as approximately 23% in Bangladesh, where nine studies that were previously conducted in Bangladesh regarding the prevalence of CKD were included [17]. Among those nine studies, no study was done in Sylhet district, one of the biggest districts in the country. An earlier study showed that, approximately 66% patients with ESRD have no

access to any kind of treatment facilities in a resource-poor country like Bangladesh [11]. If at risk people, could be identified earlier, then it would be possible to take preventive measures and slow down or prevent CKD progression to ESRD. The current study therefore assessed subjects in the rural areas of Sylhet district in Bangladesh to identify individuals who may be predisposed to at risk for developing CKD.

2. METHODS

2.1 Study Design and Settings

A cross sectional study was carried out from March 2019 to May 2019. A simplified CRF was used for data collection to identify patients who are at risk of developing CKD from 82 villages of Sylhet district in Bangladesh, namely- Aktapara, Alfirnogor, Apraja, Bahadurpur, Barogor, Berajali, Birgaw, Bisna, Bosontopur, Buristal, Cukraposi, Dawaya, Donpur, Dungira, Durogor, Enayetnogor, Fatepur, Firuzpur, Foinda, Fokirnogor, Fusanogor, Gowrarong, Gobindopur, Haluargaon, Hasanabad, Hasunagar, Hobutpur, Honipur, Husenpur, Islampur, Jamalgonj, Janigaon, Jail Road, Jogairgaon, Jognatpur, Jolilpur,Junigaon, Kandigaon, Kutubpur, Kalijuri, Magura, Mamutpur, Mirjapur, Momotesor, Moulinogor, Muktitola, Mollikpur, Nahiargaon, Nasanabad, Nilpur, Nilampur, Nojetpur, Norulla, Noyagaon, Nurpur, Oyeshkhali, Pachisha, Paisha, Pirijpur, Polakpur, Rabarbari, Radhanogor, Rajargaon, Ramnogor, Sachna, Shanbari, Safela, Sreepur, Semostopur, Shakhati, Shashna, Shujatpur, Shukhdebpur, Sunamgonj, Sylhet, Tokipur, Thaakurbazar, Thakurghat, Thakurgaon, Voishverr, and Vorotpur.

2.2 Study Sample

996 subjects were enrolled in the present study randomly from the selected areas. Data from the participants were collected by the health care professional/community data collectors from patients who visited the local branch of Kidney Foundation Hospital and Research Institute (KFHRI) during the study period.

2.3 Data Collection Tools

A simplified CRF (Case Report Form) was used to identify participants at risk of having CKD in the study area. Some basic information, such as- demographic characteristics of the respondents, their current health condition and use of medication if any, available medical history (serum creatinine and random blood sugar level, skin infection, hypertension, diabetes), family history of having diabetes, hypertension, or nephritis, were recorded from both available medical records and from face to face interview of the participants. Anthropometric measurement and blood pressure both systolic and diastolic of the patients were also taken. Urine Dipstick test was done using Uripath-5 reagent stripes (Plasmatec Laboratory Product, UK) for the spot of both albumin (protein) and glucose.

2.4 Statistical Analysis

Data were analyzed using SPSS version 26.0. Sub-group analyses were carried out based on respondent classification for hypertension with three cut-offs [18]. Descriptive statistics were performed, and continuous variables were presented as mean and standard deviation. One-way ANOVA test followed by Post Hock Tukey's test was performed to see the mean differences between and within groups.

3. RESULTS

Table 1 represents the demographic characteristics of the respondents. Here we found that, there were 996 respondents, with 189 males (19%) and 807 females (81%). Approximately 82% of the respondents were married and 18% were unmarried. Among the respondents, 63% were housewife, 15% were students, 5% were in service and 5% were doing small business. The remaining were involved in other occupation (11%). Around 35% respondents were illiterate, 31% reported as having primary level education, 17% reported having secondary level education, and 14% reported as having higher level (graduate and above) education among the respondents. Additionally, 43% of respondents denied being a smoker or tobacco users, and 56% reported to use nothing.

Table 2 represents the clinical findings of the respondents. Among all respondents, 91% had no elevated random blood sugar, only 9% reported to have diabetes mellitus and 3.5%% of them were using anti-diabetic agents. Approximately, 16.1% respondents had hypertension, but only 4% of them were using antihypertensive drugs.

Table 3 represents the family history and additional laboratory parameters of the

respondents. Among these 996 respondents, around 10% were reported to have previous skin infection, 2.5% respondents had family history of nephritis, 12.7% had family history of diabetes melitus, and approximately 20% had family history of hypertension. While performing multi stick tests for both urinary albumin (a predictor for detecting chronic kidney disease) and sugar (a predictor for diabetes), it was found that, the level of urinary albumin was "Nil" for 83% of the respondents, 9% respondents showed mild traces of albumin in their urine, 6% reported moderate traces of albumin, and only 2% were reported as having severe traces of albumin in their urine, suspected to have albuminuria. Around 91% of respondents were reported to have "Nil", or no traces of sugar in their urine. Around 1.4% reported to have mild traces of sugar, 4.3% reported to have moderate traces of sugar, and 3.3% of respondents were reported to have severe traces of urinary glucose, suspected to have diabetes.

According to Table 4, the total number of respondents was 996, of which majority is female (807). Average height and weight for all respondents was 149 cm and 51 kg with an SD of 12.2 cm, and 9.7 kg, where female showed both lower body weight and height compared to their male counterparts. Average BMI for female was 23 kg/m^2 with an SD of 5.5 kg/m^2, which is almost like the male respondents, 24 kg/m^2 with an SD of 7 kg/m^2. Average of both systolic and diastolic BP for female showed lower readings compared to their male counterparts. Overall, the average systolic BP was 115 mmHg with an SD of 16 mmHg and the average diastolic BP was 75 mmHg with an SD of 12 mmHg for all respondents. The values for random blood sugar (RBS) and serum creatinine also seemed lower in case of female respondents, compared to male respondents.

According to Table 5, serum creatinine value was available for 99 respondents and when MDRD equation was applied among these 99 respondents, all respondents had fallen into CKD stage I category with an eGFR of more than 90 ml/min/1.73 m^2 and only one respondent had an eGFR of 68ml/min/1.73 m^2, felt into stage II category. Then when a urine dipstick test was run among these 99 respondents, respondent who was in CKD stage II category, showed "+" result, which means the presence of mild traces of albumin in his urine.

According to Table 6, respondents were categorized based on different ranges of systolic blood pressure, i.e., category 1 means respondents with systolic BP, less or equals to 120 mmHg, category 2 means respondents with systolic BP between 121 to 140 mmHg, and category 3 means respondents with systolic BP, more than 140 mmHg [18]. Here it was found that, patients who are younger, with lower body weight and BMI, tends to show lower readings for both systolic and diastolic blood pressure. Additionally, respondents from category 1 showed lowest values for both RBS and Sr. creatinine. Respondents from category 3 showed highest values in terms of BMI, RBS, and Sr. creatinine among these three groups. Statistically

Table 1. Demographic parameters of respondents

Demographic parameters	Categories	Frequency (%)
Sex	Male	189 (19%)
	Female	807 (81%)
Marital Status	Married	816 (82%)
	Unmarried	178 (18%)
Occupation	Housewife	631 (63%)
	Small business	50 (5%)
	Student	146 (15%)
	Service	45 (5%)
	Others	105 (11%)
Education	Illiterate	348 (35%)
	Primary level	312 (31%)
	Secondary level	172 (17%)
	Graduate and above	135 (14%)
Smoking/tobacco	No	553 (56%)
	Yes	433 (43)

Data were collected from 996 respondents from 82 rural areas in the district of Sylhet in Bangladesh. Values are frequency (%) for demographic parameters

significant difference was observed between patients having a systolic BP of less or equal to 120 mmHg and patients with more than 140 mmHg in terms of age, body weight and height. Between patients with systolic BP of less or equal to 120 mmHg and patients with a BP of more than 120 mmHg, statistically significant differences were found in terms of body weight, BMI, and random blood sugar values. No significant differences were found in terms of their height and serum creatinine values.

In case of Fig. 1 whether respondents were divided into two clusters based on their age, body mass index, blood pressure, random blood sugar, and sr. creatinine values, it was found that, cluster 1 comprises 75% of the respondents and cluster 2 represents 25% of the respondents. Cluster analysis was performed using a nonhierarchical clustering technique, K-means algorithm, that helped to divide the respondents into non-overlapping groups based on Euclidean distance [19,20]. Based on cluster 1 vs. cluster 2, respondents who are young (approx. 20 years vs 48 years) and have low body mass index (BMI, 22 kg/m^2 vs 27 kg/m^2) possess low systolic and diastolic blood pressure (110 mmHg and 70 mmHg vs 124 mmHg and 78 mmHg), low random blood sugar (RBS, 5.29 mmol/L vs. 6.47 mmol/L) and low Sr. creatinine (0.65 mg/dl vs 1.14 mg/dl) compared to respondents who are aged (approximately 48 years) and have a higher BMI (27 kg/m^2).

Table 2. Clinical findings from the respondents

Clinical findings	Categories	102 (10%)
Random blood sugar (RBS) present?	No	892 (91%)
	Yes	88 (9%)
If the respondent has diabetes mellites?	Yes	86 (9%)
	No	888 (91%)
Antidiabetic agent	Yes	3 (3.5%)
	No	83 (96.5%)
If the respondent has hypertension?	Yes	157 (16.1%)
	No	818 (83.9%)
Antihypertensive agent	Yes	6 (4%)
	No	151 (96%)

Data were collected from 996 respondents from 82 rural areas in the district of Sylhet in Bangladesh. Values are frequency (%) for clinical parameters

Table 3. Family History and laboratory parameters of respondents

Family History and Laboratory findings	Categories	Frequency (%)
Previous skin infection	No	887 (90%)
	Yes	102 (10%)
Family history of nephritis	No	965 (97.5%)
	Yes	25 (2.5%)
Family history of DM	No	865 (87.3%)
	Yes	125 (12.7%)
Family history of HTN	No	787 (80%)
	Yes	202 (20%)
Urinary Albumin (multistick)	Nil	823 (83%)
	+	87 (9%)
	++	55 (6%)
	+++	18 (2%)
Urinary glucose (multistick)	Nil	893 (91%)
	+	14 (1.4%)
	++	42 (4.3%)
	+++	32 (3.3%)

Data were collected from 996 respondents from 82 rural areas in the district of Sylhet in Bangladesh. Values are frequency (%) for clinical parameters. HTN: Hypertension, DM: Diabetes mellitus. For urinary albumin, "nil" indicates "negligible or no traces of albumin", "+" indicates mild traces of albumin, "++" indicates moderate traces of albumin and "+++" indicates severe traces of albumin in urine. For urinary glucose, "nil" indicates "negligible or no traces of glucose", "+" indicates mild traces of glucose, "++" indicates moderate traces of glucose and "+++" indicates severe traces of glucose in urine

Table 4. Anthropometric and laboratory parameters of the respondents

	Male (n)	Female (n)	Total (n)
Age (years)	43.4±17.6 (188)	35.5±15.4 (805)	37±16 (993)
Body weight (kg)	57.5±10.9 (189)	50±8.8 (804)	51.3±9.7 (993)
Height (cm)	155.4±12.4 (189)	147.7±11.6 (801)	149.2±12.2 (990)
BMI (kg/m^2)	24.2±6.8 (189)	23.1±5.5 (801)	23.3±5.8 (990)
Systolic BP (mmHg)	118.7±15.2 (185)	114.5±16 (795)	115.3±16 (980)
Diastolic BP (mmHg)	77.2±12.1 (185)	74.6±11.4 (795)	75.1±11.6 (980)
RBS (mmol/L)	9.7±4.1 (47)	8.3±4.1 (134)	8.7±4.1 (181)
Sr. creatinine (mg/dl)	0.9±0.1 (21)	0.7±0.6 (78)	0.8±0.6 (99)

Data were collected from 996 respondents, 189 males and 807 females from 82 rural areas in the district of Sylhet in Bangladesh. Values are mean ±SD (n) for anthropometric and biochemical parameters

Table 5. Respondent identified as having CKD stage II

n	Age(years)	Sex	Sr. creatinine	eGFR (MDRD equation)	CKD stage	Urine Albumin dipstick test
21	50 (average)	Male	0.9 (average)	94.9 ml/min/1.73 m^2	I	Nil
78	37 (average)	Female	0.7 (average)	100.1 ml/min/1.73 m^2	I	Nil
1	49	Male	1.2 mg/dl	68 ml/min/1.73 m^2	II	"+"

Data were collected from 99 respondents whose sr. creatinine value was available to calculate eGFR using MDRD equation and for whom; urine dipstick test for albumin was done to determine presence of albumin in urine. CKD stages were classified as stage I, >90, stage II, 60-89ml/min/1.73m^2

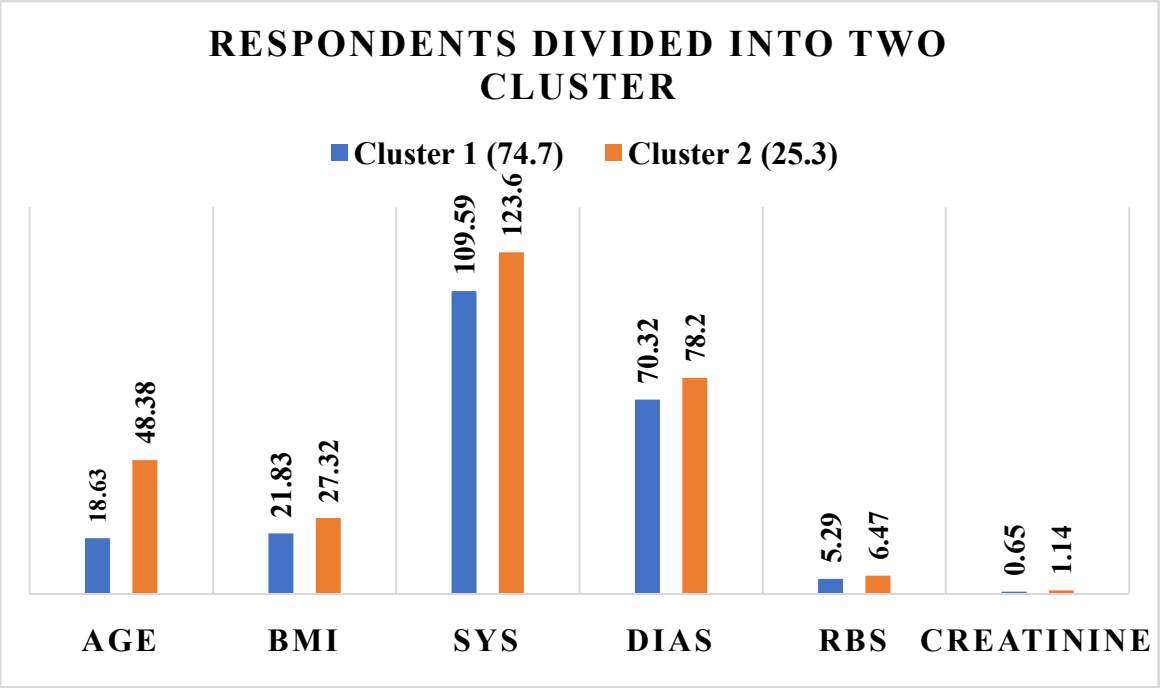

Fig. 1. Respondents divided into two cluster based on age, BMI, BP (systolic and diastolic), RBS and Sr. creatinine using K Means Cluster analysis

Table 6. Parameters based on Systolic BP of respondents

Variables	Systolic Blood Pressure (mmHg)		
	≤120 (n)	121-140 (n)	>140 (n)
Age (years)	35.5±15.5 [a, b, c] (744)	40.3±17.1 [b, a, c] (204)	49.3±14.5 [c, a, b] (29)
Body weight (Kg)	50.5±9.4 [a, b, c] (743)	53.9±9.8 [b, a] (205)	57.0±10.2 [c, a] (29)
Height (cm)	149.7±10.9 (741)	148.3±14.6 (205)	145.0±18.2 (28)
BMI (kg/m2)	22.6±5.1 [a, b, c] (741)	25.1±6.7 [b, a, c] (205)	28.5±9.8 [c, a, b] (28)
Systolic BP (mmHg)	109.0±11.4 [a, b, c] (745)	133.2±5.7 [b, a, c] (206)	152.6±7.7 [c, a, b] (29)
Diastolic BP (mmHg)	71.8±9.3 [a, b, c] (745)	84.2±11.9 [b, a, c] (206)	91.1±8.9 [c, a, b] (29)
Random Blood Sugar (mmol/L)	8.2±4.1 [a, c] (135)	9.9±3.5 [b, c] (40)	13.2±4.6 [c, a, b] (6)
Sr. creatinine (mg/dl)	0.7±0.2 (83)	0.9±0.2 (14)	1.2±0.1 (2)

Data were collected from 996 respondents, 189 males and 807 females from 82 rural areas in the district of Sylhet in Bangladesh. Values are mean ±SD (n) for anthropometric and biochemical parameters based on systolic blood pressure of the respondents. Mean values sharing a common superscript were significantly different from each other using a one-way ANOVA test ($p<0.05$)

4. DISCUSSION

Present study conducted for "the detection of chronic kidney disease among rural Bangladeshi disadvantageous population" is the first ever study done in different villages of Sylhet district in this country. In 2010, similar study was done among approximately 1000 respondents in Mirpur area to detect the prevalence of chronic kidney disease among urban disadvantageous population in Bangladesh and the prevalence of CKD was recorded as 13% [21]. One study done in 2012 among rural population in Mymensingh district was reported to have a CKD prevalence of 5% [22]. Another study among people lived near Mymensingh medical college found that, there was a 19% prevalence of CKD and also found association of CKD with risk factors such as hypertension and diabetes [23].

In the current study, only 99 respondents, representing 25% of the study population, had previously recorded serum creatinine value and based on that, all but one respondent had fallen in CKD stage II. Based on urine dipstick test for albumin, 17% of the total (996) respondents were reported to have traces of albumin in their urine in different degree (mild-9%, moderate-6%, or severe-2%). Around 9% of respondents were reported to have diabetes mellitus, and 16% were reported to have hypertension, two important predetermines to be at risk of developing CKD. However, only 0.4% respondents reported to use antidiabetic drug and only 1% of them were reported to be on antihypertensive drug. Among this study cohort, 2.5% had family history of nephritis, 13% had family history of diabetes mellitus, and 20% had family history of hypertension. Another interesting finding that come out from this study is that, younger patients, with a lower body mass index showed lower blood pressure (both systolic and diastolic), and low levels of sr. creatinine and random blood sugar, compared to patients with increased age and a higher body mass index.

To identify the stages of CKD among respondents, it was found that 98 people suffered from stage 1 CKD and only one was suffering from stage II CKD. This result showed similarity to another study where majority of people were suffering from stage I and II CKD [24]. Although we did not show the associations of CKD with other bio-chemical parameters, hypertension, diabetes, smoking, dyslipidemia showed significant associations with CKD [25]. Therefore, we also had some limitation such as- there were missing information for some parameters during data collection at field level and due to cross-sectional nature of the study, no causal relation can be made. However, the number of participants were around 1000 and after doing a cluster analysis, we also found that, age is another important attribute for developing CKD which also support previous studies in this field. In our study, it was found that female were suffered much from CKD than male which was not in line with a study where it was stated that the prevalence of CKD was significantly higher among male compared to female and hypertension was an important factors for that [22].

Bangladesh is one of the developing countries, where there is lack of proper documentation of medical data, especially in renal field. Proper use of modern applications such as multi-kernal support vector machine and fruit fly optimization algorithm [26], hybrid-kernal support vector machine and grey wolf (intelligent) classification algorithm [27], group search

optimizer algorithm [28] will bring a promising outcomes for future research in this field.

5. CONCLUSION

There is a rising trend in the incidence and prevalence of kidney diseases in Bangladesh. Besides the well-known risk factors like hypertension, diabetes, obesity, glomerular diseases, genetic and other unknown emerging risk factors might play a role in the initiation and progression of this disease. Though numerous researches are ongoing worldwide based on CKD, Bangladesh is still far behind. In context of Bangladesh, lots of information is still missing. Despite some efforts, reliable and consistent data concerning various aspects of CKD is unknown. The current study reveals that, around 9 out of 100 people are at risk of developing CKD in context of rural disadvantageous population in Bangladesh. Additionally, very few people in this study population with diabetes and hypertension were on some sorts of medication and most of them were not taking any preventive measures in order to control their hypertension or diabetes. This represents an alarming situation in this area, as both diabetes and hypertension are the two major causes of progression of CKD and it should be controlled to delay the onset of developing CKD. Now, there is an urgent need to design a low-cost program to identify people who are at risk of CKD as well as address their current medical condition as an attempt to early management of the progression of CKD in the rural settings in Bangladesh.

CONSENT

As per international standard or university standard, respondents' written consent has been collected and preserved by the author(s).

ETHICAL APPROVAL

The study was approved by the ethical board of Kidney Foundation Hospital and Research Institute (KFHRI). Formal ethical permission of this study was approved by the ethical boards of KFHRI in Dhaka, Bangladesh.

COMPETING INTERESTS

Authors have declared that no competing interests exist.

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