Chronic kidney disease and its health-related factors: a case-control study

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Abstract

Background: Chronic kidney disease (CKD) is a non-communicable disease that includes a range of different physiological disorders that are associated with abnormal renal function and progressive decline in glomerular filtration rate (GFR). This study aimed to investigate the associations of several behavioral and health-related factors with CKD in Iranian patients.

Methods: A hospital-based case-control study was conducted on 700 participants (350 cases and 350 controls). Logistic regression was applied to measure the association between the selected factors and CKD.

Results: The mean age of cases and controls were 59.6±12.4 and 58.9±12.2 respectively (p = 0.827). The results of multiple logistic regression suggested that many factors including low birth weight (OR yes/no = 4.07, 95%CI: 1.76–9.37, P = 0.001), history of diabetes (OR yes/no = 3.57, 95%CI: 2.36–5.40, P = 0.001), history of kidney diseases (OR yes/no = 3.35, 95%CI: 2.21–5.00, P = 0.001) and history of chemotherapy (OR yes/no = 2.18, 95%CI: 1.12–4.23, P = 0.02) are associated with the risk of CKD.

Conclusions: The present study covered a large number of potential risk/preventive factors altogether. The results highlighted the importance of collaborative monitoring of kidney function among patients with the above conditions.

Keywords: Chronic kidney disease, Related factors, Case-control

Background

Chronic kidney disease (CKD) is a non-communicable disease that includes a range of different physiological disorders that are associated with an abnormal renal function and progressive decline in glomerular filtration rate (GFR) [1–3]. Chronic kidney disease includes five stages of kidney damage, from mild kidney dysfunction to complete failure [4]. Generally, a person with stage 3 or 4 of CKD is considered as having moderate to severe kidney damage. Stage 3 is broken up into two levels of kidney damage: 3A) a level of GFR between 45 to 59 ml/min/1.73 m², and 3B) a level of GFR between 30 and 44 ml/min/1.73 m². In addition, GFR for stage 4 is 15–29 ml/min/1.73 m² [4, 5]. It is reported that both the prevalence and burden of CKD are increasing worldwide, especially in developing countries [6]. The worldwide prevalence of CKD (all stages) is estimated to be between 8 to 16%, a figure that may indicate millions of deaths annually [7]. According to a meta-analysis, the prevalence of stage 3 to 5 CKD in South Africa, Senegal, and Congo is about 7.6%. In China, Taiwan, and Mongolia the rate of CKD is about 10.06% and in Japan, South Korea, and Oceania the rate is about 11.73%. In Europe the prevalence of CKD is about 11.86% [8], and finally, about 14.44% in the United States and Canada. The prevalence of CKD is estimated to be about 11.68% among the Iranian adult population and about 2.9% of Iranian women and 1.3% of Iranian men are expected to develop CKD annually [9]. Patients with stages 3 or 4 CKD are at
much higher risk of progressing to either end-stage renal disease (ESRD) or death even prior to the development of ESRD [10, 11].

In general, a large number of risk factors including age, sex, family history of kidney disease, primary kidney disease, urinary tract infections, cardiovascular disease, diabetes mellitus, and nephrotoxins (non-steroidal anti-inflammatory drugs, antibiotics) are known as predisposing and initiating factors of CKD [12–14]. However, the existing studies are suffering from a small sample size of individuals with kidney disease, particularly those with ESRD [15].

Despite the fact that the prevalence of CKD in the world, including Iran, is increasing, the factors associated with CKD are explored very little. The present case-control study aimed to investigate the association of several behavioral and health-related factors with CKD in the Iranian population.

Materials and methods
Settings
In this study, participants were selected among individuals who were registered or were visiting Faghihi and Motahari hospitals (two largest referral centers in the South of Iran located in Shiraz (the capital of Fars province). Cases and controls were frequency-matched by sex and age. The GFR values were calculated using the CKD-EPI formula [16, 17].

Data collection
An interview-administered questionnaire and the participant’s medical records were used to obtain the required data. The questionnaire and interview procedure were designed, evaluated, and revised by three experts via conducting a pilot study including 50 cases and 50 controls. The reliability of the questionnaire was measured using the test-retest method (Cronbach’s alpha was 0.75). The interview was conducted by a trained public health nurse at the time of visiting the clinics.

Avoiding concurrent conditions that their association may interpreted as reverse causation; the questionnaire was designed to define factors preceding at least a year before experiencing CKD first symptoms. Accordingly participants reported their social and demographic characteristics (age, sex, marital status, educational level, place of residency), history of chronic diseases (diabetes, cardiovascular diseases, hypertension, kidney diseases, family history of kidney diseases, autoimmune diseases and thyroid diseases [18]). Also history of other conditions namely (smoking, urinary tract infection (UTI), surgery due to illness or accident, low birth weight, burns, kidney pain (flank pain), chemotherapy, taking drugs for weight loss or obesity, taking non-steroidal anti-inflammatory drugs, and taking antibiotic) before their current condition was started. Many researchers reported recalling birth weight to be reliable for research purposes [19]. Moreover, we asked the participants to report their birth weight as a categorical variable (<2500 g or low, 2500–<3500 g or normal, and >3500 g or overweight). Medical records of the participants were used to confirm/complete the reported data. In the case of contradiction between the self-reported and recorded data, we used the recorded information for our study.

Verbal informed consent was obtained from patients because the majority of the participants were illiterate. The study protocol was reviewed and approved by the ethical committee of Shiraz University of Medical Sciences (approval number: 1399.865).

Sample size
The sample size was calculated to detect an association between the history of using antibiotics (one of our main study variables) and CKD as small as OR = 1.5 [20]. With an alpha value of 0.05 (2-sided) and a power of 80%, the required sample size was estimated as large as $n = 312$ participants for each group.

Selection of cases
The selected clinics deliver medical care to patients from the southern part of the country. In this study, patients with CKD who were registered with the above centers from June to December 2020 were studied. A case was a patient with a GFR < 60 (ml/min/1.73 m²) at least twice in 3 months. According to the latest version of the International Classification of Diseases (2010), Codes N18.3 and N18.4 are assigned to patients who have (GFR = 30–59 (ml/min/1.73 m²) and GFR = 15–29 (ml/min/1.73 m²) respectively [21]. In total, 350 patients who were diagnosed with CKD by a nephrologist during the study period.

Selection of the controls
We used hospital controls to avoid recall-bias. The control participants were selected from patients who were admitted to the general surgery (due to hernia, appendicitis, intestinal obstruction, hemorrhoids, and varicose veins), and orthopedic wards from June to December 2020. Using the level of creatinine in the participants’ serum samples, GFR was calculated and the individuals with normal GFR (GFR = 30–59 (ml/min/1.73 m²) GFR > 60) and those who reported no history of CKD were included ($n = 350$).

Inclusion criteria
Patients were included if they were $\geq 20$ years old and had a definitive diagnosis of CKD by a nephrologist.
Exclusion criteria
Participants were excluded if they were critically ill, had acute kidney injury, those undergone renal transplantation, and those with cognitive impairment.

Statistical analysis
The Chi-square test was used to measure the unadjusted associations between categorical variables and CKD. Multiple logistic regression was applied to measure the adjusted associations for the study variables and CKD. The backward variable selection strategy was used to include variables in the regression model. Odds ratios (ORs) and 95% confidence intervals (CIs) were calculated. All \( p \)-values were two-sided and the results were considered statistically significant at \( p < 0.05 \). All analyses were conducted using Stata version 14.0 (Stata Corporation, College Station, TX, USA).

Results
In total, 350 cases and 350 age and sex-matched controls were included in the analysis. The mean age of cases and controls were 59.6 \( \pm \) 12.4 and 58.9 \( \pm \) 12.2 respectively (\( p = 0.83 \)). Overall, 208 patients (59.4%) and 200 controls (57.1%) were male (\( p = 0.54 \)). Also, 149 patients (42.6%) and 133 controls (38.0%) were illiterate or had elementary education (\( p = 0.001 \)). Most cases (96.9%) and controls (95.7%) were married (\( p = 0.42 \)). The mean GFR for CKD and control groups were 38.6 \( \pm \) 11.4 and 78.3 \( \pm \) 10.2 (ml/min/1.73 m\(^2\)) respectively.

Result of univariate analysis
Table 1 illustrates the unadjusted associations of demographic and health-related variables with the risk of CKD. Accordingly, significant (unadjusted) associations were found between the risk of CKD and several study variables including education, history of chronic diseases (diabetes, cardiovascular, hypertension, kidney diseases, autoimmune diseases, and hypothyroidism), family history of kidney diseases, smoking, UTI, surgery due to illness or accident, low birth weight, burns, kidney pain, chemotherapy, taking non-steroidal anti-inflammatory drugs, and taking antibiotics (\( p < 0.05 \) for all).

Results of multivariable analysis
Table 2 illustrates the adjusted associations between the study variables and the risk of CKD. Most noticeably, low birth weight (OR \( \text{yes/no} = 4.07 \), 95%CI: 1.76–9.37, \( p = 0.001 \)), history of surgery (OR \( \text{yes/no} = 1.74 \), 95%CI: 1.18–2.54, \( p = 0.004 \)), family history of kidney diseases (OR \( \text{yes/no} = 1.97 \), 95%CI: 1.20–3.23, \( p = 0.007 \)), and history of chemotherapy (OR \( \text{yes/no} = 2.18 \), 95%CI: 2.39–2.97, \( p = 0.29 \)) were the most significant factors for CKD.

Table 1

| Variables                        | Cases (N = 350) | Controls (N = 350) | P-value* |
|----------------------------------|----------------|-------------------|----------|
| Sex                              |                |                   |          |
| Female                           | 142 (40.6)     | 150 (42.9)        | 0.54     |
| Male                             | 208 (59.4)     | 200 (57.1)        |          |
| Age group                        |                |                   |          |
| 20-<40                           | 30 (8.6)       | 32 (9.1)          | 0.989    |
| 40-<50                           | 49 (14.0)      | 50 (14.3)         |          |
| 50-<60                           | 89 (25.4)      | 90 (25.7)         |          |
| \( \geq 60 \)                    | 182 (52.0)     | 178 (50.9)        |          |
| Place of residency               |                |                   |          |
| Rural                            | 93 (26.6)      | 103 (29.4)        | 0.412    |
| Urban                            | 257 (73.4)     | 247 (70.6)        |          |
| Education                        |                |                   |          |
| Illiterate or elementary school   | 149 (42.6)     | 133 (38.0)        | 0.001    |
| Middle school                    | 86 (24.6)      | 68 (19.4)         |          |
| High school                      | 68 (19.4)      | 60 (17.1)         |          |
| College                          | 47 (13.4)      | 89 (25.4)         |          |
| Marriage status                  |                |                   |          |
| Single                           | 11 (3.1)       | 15 (4.3)          | 0.424    |
| Married                          | 399 (96.9)     | 335 (95.7)        |          |
| Job                              |                |                   |          |
| Employed                         | 74 (21.1)      | 64 (18.3)         | 0.154    |
| Unemployed                       | 174 (49.7)     | 160 (45.7)        |          |
| Household                        | 102 (29.1)     | 126 (36)          |          |
| History of diabetes              |                |                   |          |
| No                               | 181 (51.7)     | 292 (83.4)        | 0.001    |
| Yes                              | 169 (48.3)     | 58 (16.6)         |          |
| History of HTN**                 |                |                   |          |
| No                               | 119 (34.0)     | 248 (70.9)        | 0.001    |
| Yes                              | 231 (66.0)     | 102 (29.1)        |          |
| History of cardiovascular diseases|               |                   |          |
| No                               | 212 (60.6)     | 290 (82.9)        | <0.001   |
| Yes                              | 138 (39.4)     | 60 (17.1)         |          |
| History of kidney diseases       |                |                   |          |
| No                               | 170 (48.6)     | 279 (79.7)        | 0.001    |
| Yes                              | 180 (51.4)     | 71 (20.3)         |          |
| Family history of kidney diseases|               |                   |          |
| No                               | 250 (71.43)    | 305 (87.1)        | 0.001    |
| Yes                              | 100 (28.57)    | 45 (12.9)         |          |
| History of smoking               |                |                   |          |
| No                               | 207 (59.1)     | 233 (66.6)        | 0.003    |
| Yes                              | 143 (40.9)     | 117 (33.4)        |          |
| Autoimmune diseases              |                |                   |          |
| No                               | 319 (91.1)     | 335 (95.7)        | 0.015    |
| Yes                              | 31 (8.9)       | 15 (4.3)          |          |
| Hypothyroidism                   |                |                   |          |
| No                               | 298 (85.1)     | 318 (90.9)        | 0.02     |
| Yes                              | 52 (14.9)      | 32 (9.1)          |          |
1.12–4.23, \( P = 0.02 \) were significantly associated with a higher risk of CKD. On the other hand, education (OR college/illiterate or primary = 0.54, 95%CI: 0.31–0.92, \( P = 0.025 \) was found to be inversely associated with CKD.

### Discussion

The results of the present study suggested that several variables including, education, history of diabetes, history of hypertension, history of kidney diseases or a family history of kidney diseases, history of surgery due to illness or accident, low birth weight, history of chemotherapy, history of taking non-steroidal anti-inflammatory drugs, and history of taking antibiotics may affect the risk of CKD.

In our study, the level of education was inversely associated with the risk of CKD. This finding is in accordance with the results of a study conducted by K Lambert et al., who suggested that illiteracy or elementary education may raise the risk of CKD [22]. The fact that education level is associated with health literacy may partly explain our results that lower education and inadequate health literacy in individuals with CKD is associated with worse health outcomes.
health outcomes including poorer control of biochemical parameters, higher risk of cardiovascular diseases (CVDs); a higher rate of hospitalization, and a higher rate of infections [23].

In the current study, the history of diabetes was associated with a higher risk of CKD. This finding is consistent with the results of other studies on the same subject [20, 21, 24–27]. It is not surprising that people with diabetes have an increased risk of CKD as diabetes is an important detrimental factor for kidney functioning as approximately, 40% of patients with diabetes develop CKD [27].

The other variable that was associated with an increased risk of CKD was a history of hypertension. Our result is consistent with the results of several other studies [20, 24, 25, 28]. It is reported that hypertension is both a cause and effect of CKD and accelerates the progression of the CKD to ESRD [29].

After controlling for other variables, a significant association was observed between family history of kidney diseases and risk of CKD. Published studies suggested the same pattern [24]. Inherited kidney diseases (IKDs) are considered as the foremost reasons for the initiation of CKD and are accounted for about 10–15% of kidney replacement therapies (KRT) in adults [30].

The importance of the history of surgery due to illness or accident in this study is rarely investigated by other researchers who reported the effect of surgery in patients with acute kidney injury (AKI), and major abdominal and cardiac surgeries [31, 32] on the risk of CKD. Also, AKI is associated with an increased risk of CKD with progression in various clinical settings [33–35]. In a study by Mizota et.al, although most AKI cases recovered completely within 7 days after major abdominal surgery, they were at higher risk of 1-year mortality and chronic kidney disease compared to those without AKI [31].

The present study also showed that low birth weight is a significant risk factor for CKD. This finding is consistent with the results of some other studies. However, the results of very few studies on the association between birth weight and risk of CKD are controversial as some suggested a significant association [19, 36, 37] whereas others suggested otherwise [36]. This may be explained by the relatively smaller size and volume of kidneys in LBW infants compared to infants that are normally grown [38]. This can lead to long-term complications in adolescence and adulthood including hypertension, decreased glomerular filtration, albuminuria, and cardiovascular diseases. Eventually, these long-term complications can also cause CKD [39].

Another important result of the current study is the association between chemotherapy for treating cancers and the risk of CKD. According to a study on chemotherapy for testicular cancer by Inai et al., 1 year after chemotherapy 23% of the patients showed CKD [40]. Another study suggested that the prevalence of stage 3 CKD among patients with cancer was 12, and <1% of patients had stage 4 CKD [41, 42]. Other studies have shown an even higher prevalence of CKD among cancer patients. For instance, only 38.6% of patients with breast cancer, 38.9% of patients with lung cancer, 38.3% of patients with prostate cancer, 27.5% of patients with gynecologic cancer, and 27.2% of patients with colorectal cancer had a GFR ≥ 90 (ml/min/1.73 m²) at the time of therapy initiation [43, 44]. The overall prevalence of CKD ranges from 12 to 25% across many cancer patients [45–47]. These results clearly demonstrate that, when patients with cancer develop acute or chronic kidney disease, outcomes are inferior, and the promise of curative therapeutic regimens is lessened.

In our study, the history of taking nephrotoxic agents (antibiotics or NSAIDs drugs) was associated with a higher risk of CKD. Our result is following the results reported by other studies [48, 49]. Common agents that are associated with AKI include NSAIDs are different drugs including antibiotics, iodinated contrast media, and chemotherapeutic drugs [50].

**Strengths and limitations of our study**

Our study used a reasonably large sample size. In addition, a considerably large number of study variables was included in the study. With a very high participation rate, trained nurses conducted the interviews with the case and control participants in the same setting. However, histories of exposures are prone to recall error (bias), a common issue in the case-control studies. It is to be mentioned that the method of selecting controls (hospital controls) should have reduced the risk of recall bias when reporting the required information. In addition, we used the participants’ medical records to complete/confirm the reported data. Although the design of the present study was not able to confirm a causal association between the associated variables and CKD, the potential importance and modifiable nature of the associated factors makes the results potentially valuable and easily applicable in the prevention of CKD.

**Conclusions**

Given that, chemotherapy is an important risk factor for CKD, we suggest the imperative for collaborative care between oncologists and nephrologists in the early diagnosis and treatment of kidney diseases in patients with cancer. Training clinicians and patients are important to reduce the risk of nephrotoxicity. Electronic medical records can simultaneously be used to monitor prescription practices, responsiveness to alerts and prompts, the incidence of CKD, and detecting barriers...
to the effective implementation of preventive measures [51]. Routine follow-up and management of diabetic patients is also important for the prevention of CKD. We suggest a tight collaboration between endocrinologists and nephrologists to take care of diabetic patients with kidney problems. In addition, surgeons in major operations should refer patients, especially patients with AKI, to a nephrologist for proper care related to their kidney function. Treatment of hypertension is among the most important interventions to slow down the progression of CKD [12]. Moreover, all patients with newly diagnosed hypertension should be screened for CKD. We suggest all patients with diabetes have their GFR and urine albumin-to-creatinine ratio (UACR) checked annually. Finally, the aging population and obesity cause the absolute numbers of people with diabetes and kidney diseases to raise significantly. This will require a more integrated approach between diabetologists/nephrologists and the primary care teams (55).

Abbreviations
CKD: Chronic kidney disease; ESRD: End-stage renal disease; GFR: Glomerular filtration rate; RRT: Renal replacement treatment; UTI: Urinary tract infection; OR: Odds ratios; CI: Confidence intervals; HTN: Hypertension; AKI: Acute kidney injury.

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Authors' contributions
MGG: Conceptualization, Methodology, Statistical analysis, Investigation, and writing the draft of the manuscript. MP: were involved in methodology, writing the draft of the manuscript, and clinical consultation. MS: was involved in the methodology and statistical analysis. MF: was involved in conceptualization, methodology, supervision, writing, and reviewing the manuscript. The authors read and approved the final manuscript.

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Availability of data and materials
The datasets generated and/or analyzed during the current study are not publicly available due to their being the intellectual property of Shiraz University of Medical Sciences but are available from the corresponding author on reasonable request.

Declarations
Ethics approval and consent to participate
The study protocol was reviewed and approved by the ethical committee of Shiraz University of Medical Sciences (approval number: 1399.865). All methods were performed in accordance with the relevant guidelines and regulations of the Declaration of Helsinki. The participants were assured that their information is used for research purposes only. Because of the illiteracy of a considerable number of the patients, verbal informed consent was obtained from the participants. Using verbal informed consent was also granted by the ethical committee of Shiraz University of Medical Sciences.

Consent for publication
Not applicable.

Competing interests
None of the authors declare disclosures of direct relevance to the submitted work.

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References
1. Ghelichi Ghojogh M, Salarlak S, Taghezadeh Afshari A, Khalikhali HR, Mohammadi-Fallah MR, Mikhodooni K. The effect of body mass index on patient and graft survival rate in kidney transplanted patients in Iran. NephrEurol Monthly. 2017;9(4):e14386.
2. Zeba Z, Fatema K, Sumit AF, Zinnat R, Ali L. Early screening of chronic kidney disease patients among the asymptomatic adult population in Bangladesh. J Prev Epidemiol. 2020;5(1):e10–e.
3. Mahajan C, Tiwari V, Divyaveer SS, Patil MR, Banerjee A, Bagur V, et al. Spectrum of renal biopsies, a three-year data from a tertiary care Centre of eastern India. J Nephropharmacol. 2020;9(2):e20–e.
4. Kimura K, Hosoya T, Uchida S, Inaba M, Makino H, Marayama S, et al. Febuxostat therapy for patients with stage 3 CKD and asymptomatic Hyperuricemia. a randomized trial. Am J Kidney Dis. 2018;72(6):798–810.
5. Foster MC, Hwang S-J, Larson MG, Lichtman JH, Pankhi NL, Vasan RS, et al. Overweight, obesity, and the development of stage 3 CKD: the Framingham heart study. Am J Kidney Dis. 2008;52(1):39–48.
6. Rachmi CN, Agho KE, Li M, Baur LA. Stunting, underweight and overweight in children aged 2.0–4.9 years in Indonesia: prevalence trends and associated risk factors. PloS One. 2016;11(5):e0154756.
7. Asghari G, Momenan M, Yuzbashian E, Mirmiran P, Aaziz F. Dietary pattern and incidence of chronic kidney disease among adults: a population-based study. Nutr Metab. 2018;15(1):11–11.
8. Ruggles DR, Freymann RL, Oxenham AJ. Influence of musical training on understanding voiced and whispered speech in noise. PloS One. 2014;9(1):e86680.
9. Moazzeni SS, Arani RH, Hashemnia M, Tohid M, Azizi F, Hadaegh F. High incidence of chronic kidney disease among Iranian diabetic adults: using CKD-EPI and MDRD equations for estimated glomerular filtration rate. Korean Diabetes J. 2021;45(S):684–97.
10. Salam SN, Eastell R, Khwaja A. Fragility fractures and osteoporosis in CKD: pathophysiology and diagnostic methods. Am J Kidney Dis. 2014;63(6):1049–59.
11. Zahmatkesh M, Tamadon MR. World kidney day 2018; chronic kidney disease in women. J Nephropathol. 2017;7(1):4–6.
12. Noble R, Taal MW. Epidemiology and causes of chronic kidney disease. Medicine. 2019;47(9):562–6.
13. Lopez-Garcia E, Schulze MB, Fung TT, Meigs JB, Rifai N, Manson JE, et al. Major dietary patterns are related to plasma concentrations of markers of inflammation and endothelial dysfunction. Am J Clin Nutr. 2004;80(4):1029–35.
14. Sepahi MA, Niknafs B. Multifaceted role of apolipoprotein L1 risk variants and nephropathy. J Nephropathol. 2020;9(1):1–13.
15. Cohen JB, Tsvkovsky-CM, Landa ST, Williams NN, Duman KR. National postoperative bariatric surgery outcomes in patients with chronic kidney disease and end-stage kidney disease. Obes Surg. 2019;29(3):975–82.
16. Levey AS, Androlewicz SP, DuBose T, Provenzano R, Collins AJ. Chronic kidney disease: common, harmful and treatable—world kidney day 2007. Am J Nephrol. 2007;27(1):108–12.

17. Argulian E, Sherd J, Messerli FH. Misconceptions and facts about hypertrophic cardiomyopathy. Am J Med. 2016;129(2):148–52.

18. Rhee CM. The interaction between thyroid and kidney disease: an overview of the evidence. Curr Opin Endocrinol Diabetes Obes. 2016;23(5):407.

19. Al Salmi I, Hoy WE, Kondevala-Chennakes C, Wang Z, Healy H, Shaw JE. Birth weight and stages of CKD: a case-control study in an Australian population. Am J Kidney Dis. 2008;52(6):1070–8.

20. Yazoo B, Habib H, Lahdo A, Al Ali R, Varabedian L, Atalla A, et al. Association between smoking and chronic kidney disease: a case control study. BMC Public Health. 2010;10(1):1–6.

21. Saucier NA, Sinha MK, Liang KV, Krambeck AE, Bergstralh EJ, et al. Risk factors for CKD in persons with kidney stones: a case-control study in Olmsted County, Minnesota. Am J Kidney Dis. 2010;55(1):61–8.

22. Lambert K, Mullan J, Mansfield K, Lonergan M. A cross-sectional comparison of health literacy deficits among patients with chronic kidney disease. J Health Commun. 2015;20(sup2):16–23.

23. Fraser SD, Rodenick PI, Casey M, Taal MW, Yuen HM, Nutbeam D. Prevalence and associations of limited health literacy in chronic kidney disease: a systematic review. Nephrol Dial Transplant. 2013;28(1):129–37.

24. J MY, Park YS, Y SE. A case-control study to identify the risk factors of school accidents. Korean J Epidemiol. 2005;27(2):80–94.

25. Khajehdehi P, Malekmakan L, Pakfetrat M, Roozbeh J, Sayadi M. Prevalence of chronic kidney disease and its contributing risk factors in southern Iran a cross-sectional adult population-based study. 2014.

26. Li H, Lu W, Wang A, Jiang H, Liu J. Changing epidemiology of chronic kidney disease as a result of type 2 diabetes mellitus from 1990 to 2017: estimates from global burden of disease 2017. J Diabetes Investig. 2021;12(3):346.

27. Xu Y, Surapaneni A, Akas J, Evans M, Shin J H, Selvin E, et al. Glycemic control and the risk of acute kidney injury in patients with type 2 diabetes and chronic kidney disease: parallel population-based cohort studies in US and Swedish routine care. Diabetes Care. 2020;43(12):2975–82.

28. Sepanlou SG, Barahimi H, Najafi J, Kamangar F, Pouparti H, Shakeri R, et al. Prevalence and determinants of chronic kidney disease in northeast of Iran: results of the Golestan cohort study. PLoS One. 2017;12(5):e0176540.

29. Pugh D, Gallagher PJ, Dhaun N. Management of hypertension in chronic kidney disease. Drugs. 2019;79(4):365–70.

30. Torra SG, Furlano M, Ortiz A, Coughlin KB, et al. Genetic kidney diseases as an under-recognized cause of chronic kidney disease: the key role of international registry reports. Clin Kidney J. 2021;14(8):1879-85.

31. Mizota T, Dong L, Takeda C, Shiraki A, Matsukawa S, Shimizu S, et al. Transection of type 1 diabetes mellitus from 1990 to 2017: estimates from global burden of disease 2017. J Diabetes Investig. 2021;12(3):346.

32. Newsome BB, Warnock DG, McClellan WM, Herzog CA, Kiefe CI, Eger CI, Eggert AL. Genetic kidney diseases as an under-recognized cause of chronic kidney disease: the key role of international registry reports. Clin Kidney J. 2021;14(8):1879-85.

33. Madsen NL, Goldstein SL, Freselov T, Christiansen CF, Olsen M. Cardiac surgery in patients with congenital heart disease is associated with acute kidney injury and the risk of chronic kidney disease. Kidney Int. 2017;92(3):751–6.

34. Torra SG, Furlano M, Ortiz A, Coughlin KB, et al. Genetic kidney diseases as an under-recognized cause of chronic kidney disease: the key role of international registry reports. Clin Kidney J. 2021;14(8):1879-85.

35. Kitchlu A, McArthur E, Amir E, Booth CM, Sutradhar R, Majeed H, et al. Acute kidney injury in patients receiving systemic treatment for Cancer: a population-based cohort study. J Natl Cancer Inst. 2019;111(7):727–36.

36. Rabinovitch S, Goldstein SL, Mottes T, Simpson K, Barclay C, Neuthing S, Haslam DB, et al. A sustained quality improvement program reduces nephrotic syndrome medication-associated acute kidney injury. Kidney Int. 2016;90(1):212–21.

37. Menon S, Kirkendall ES, Nguyen H, Goldstein SL. Acute kidney injury associated with high nephrotic syndrome medication exposure leads to chronic kidney disease after 6 months. J Pediatr. 2014;165(3):522–7.e2.

38. Peraza-Medina A, Torre-Campos D, Gómez-Herrera E, García-García G, Gómez-Llamas S, Peñas-Herrera D, et al. Reduction in major risk factors for chronic kidney disease. Kidney Int Suppl. 2017;72(7):71–87.