Investigation of the coexistence of CKD and non-communicable chronic diseases in a PBM company in South Africa

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Background: Chronic kidney disease (CKD) is a public health problem, with increasing global prevalence. Several factors could influence the prognosis of CKD, including comorbid chronic conditions. This study investigated the coexistence of CKD and non-communicable chronic diseases in the private health sector of South Africa.

Methods: Retrospective medicine claims data from a pharmaceutical benefit management (PBM) company was used to perform this descriptive, quantitative study. The study population consisted of all patients identified with an ICD-10 code for CKD (N18) during the study period of January 1, 2009 to December 31, 2013.

Results: CKD patients represented 0.10% to 0.14% of the total patients on the database from 2009 to 2013. The mean age of the CKD patients over the study period varied between 58 and 61 years. Prevalence was higher in males (male-to-female ratio 1:0.8) and in patients aged 35–64 years (p = 0.014; Cramer’s V = 0.039). The occurrence of chronic conditions in the CKD population was prevalent, with hypertension occurring in more than half the CKD patients.

Conclusion: Several chronic conditions, especially those regarding atherosclerotic risk factors, frequently co-occurred with CKD. Lifestyle management and frequent screening tests of these patients are of the utmost importance to improve the outcome of CKD.

Keywords: chronic kidney disease, comorbid chronic conditions, risk factors, South Africa

Introduction
Chronic kidney disease (CKD) is a global public health problem, with an estimated prevalence of 8%–16% worldwide.1 Prevalence rates of CKD seem to be high in both developing and developed countries,2-4 with an estimated prevalence of 14.3%5 in South Africa.

Early diagnosis of and intervention in CKD can reduce the risk of cardiovascular events, kidney failure and deaths that are associated with CKD.6 Global CKD mortality rates increased to the 18th biggest cause of death in 2010,6 after being ranked in 27th position in 1990. In South Africa, deaths caused by CKD increased by 67% from 1999 to 2006.7

Chronic kidney disease is a silent killer, complicating the diagnosis of the disease. Less than 10% of people with CKD are aware that they have the condition.7 It has few symptoms8 and is nearly always asymptomatic during the early stages of the disease.9 In addition, several clinical conditions such as diabetes mellitus, hypertension and cardiovascular disease (CVD) are risk factors, and patients with these conditions should be closely monitored when CKD is suspected so that the deterioration in renal function can be identified early.8-11 Other risk factors that might increase the risk of CKD include gender, smoking, obesity, age, genetics, metabolic disturbances and chronic use of NSAIDs.8,12

There is a lack of data regarding the prevalence of CKD in the private health sector of South Africa, especially data surrounding the occurrence of comorbid conditions. Chronic kidney disease is one of the conditions on the prescribed minimum benefit (PMB) chronic disease list (CDL) in the private health sector of South Africa. The PMB CDL is a feature of the Medical Schemes Act (Act 131 of 1998) and consists of 26 common conditions that require treatment for more than 12 months and are considered to be life-threatening.12 If provided for by way of a therapeutic algorithm for the condition, all costs relating to the diagnosis, medication, doctors’ consultations and tests must therefore be covered by medical schemes.14,15 The chronic conditions co-occurring with CKD that form part of the PMB CDL conditions include diabetes mellitus, hypertension, dyslipidaemia, and cardiac failure among others.

This study investigated the existence of CKD along with non-communicable chronic diseases in a PBM company in South Africa, in order to create awareness and improve the clinical outcome and prognosis the disease. By increasing our knowledge and understanding regarding the epidemiology of CKD in terms of risk factors and comorbid chronic diseases, we might be able to assess the level of its underdiagnosis8,16 and estimate the potential impact of early screening.

Method
Study design
A descriptive, quantitative study was performed using retrospective medicine claims data obtained from a national pharmaceutical benefit management company (PBM). The PBM currently manages the medicine benefits of 1.7 million beneficiaries on behalf of 40 medical schemes. All of South Africa’s pharmacies and 98% of all dispensing doctors are on this service provider database. The database represented 9% to 13% of the total medical schemes industry in South Africa during the study period.17

Data from January 1, 2009 to December 31, 2013 were used. The database contained information on 1 033 057 (2009), 968 158 (2010), 864 977 (2011), 815 810 (2012) and 809 857 (2013) patients over the five-year study period. Data fields that were
used in the study included patients’ member number and
dependent code, date of birth, gender, date of treatment and
ICD-10 codes of medicine claims.

Study population
The study population included all patients with an ICD-10 (the
International Statistical Classification of Disease and related
problems, 10th edition)18 code for CKD (N18) during the study
period of January 1, 2009 to December 31, 2013.

Data analysis
Variables included age, gender and the different comorbid
chronic conditions occurring with CKD as the independent
variables, and the prevalence of CKD as the dependent variable.
The age of the patients was calculated using the date of birth of
the patient and the date of the first prescription or treatment per
year and was categorised as follows:

- >0 years and ≤ 18 years;
- >18 years and ≤ 34 years;
- >34 years and ≤ 65 years;
- >65 years.

The comorbid chronic conditions were analysed according to
the number of conditions, as well as the type or combination of
conditions that occurred with CKD.

The comorbid CDL conditions were identified by using the
different ICD-10 codes. These conditions with their ICD-10 codes are:
Addison’s disease (E27.1), asthma (J45, J45.8, J45.1),
bronchiectasis (J47, Q33.4), cardiac failure (I27.9, I50.0, I50.1),
cardiomyopathy (I42.2, I22.0, I22.2), chronic obstructive pulmonary
disease (J43, J44), coronary artery disease (I20.0, I25.0), Crohn’s
disease (K50.0, K50.8), diabetes insipidus (E23.2), diabetes
mellitus type 2 (E10, E11, E12, O24.0), diabetes mellitus type 1
(E10, E12, O24.0), dysrhythmias (I47.2, I48), epilepsy (G40, G41),
glaucoma (H40, Q15.0), haemophilia (D66, D67), dyslipidaemia
(G45, I20, I21, I22, I24, I25, I63, I65, I66, I70), hypertension (I10, I11,
I13, I15, I12), hypothyroidism (E08.1, E02, E03), multiple sclerosis
(G35), Parkinson’s disease (G20, G21), rheumatoid arthritis (M05,
M06, M08), schizophrenia (F20), systemic lupus erythematosus
(M32, L93, L93.2) and ulcerative colitis (K51, K51.9).14

Statistical analysis
Data management and analysis were carried out using the
Statistical Analysis System® SAS 9.3® (SAS Institute, Cary, NC,
USA) program. To assist with the general computations,
Microsoft® Office Excel 2010 (Microsoft Corp, Redmond, WA,
USA) was used. Variables were described using descriptive
statistics such as frequencies, percentages, means, standard
deviation (SD) and 95% confidence interval (CI). One-way
analysis of variance (ANOVA) with Tukey’s HSD post hoc test was
used to compare mean values between groups. Cohen’s d-value
was used as effect size measure of the difference between
means, with d ≥ 0.8 being regarded as practically significant. The
chi-square test was used to test for associations between
categorical variables and was deemed statistically significant
with a probability of p ≤ 0.05. Practical significance of the results
was computed when p-values were statistically significant
(p ≤ 0.05) by using Cramer’s V statistic. Cramer’s V ≥ 0.1 was
deeemed to be a weak association, Cramer’s V ≥ 0.3 was seen to be
a moderate association and Cramer’s V ≥ 0.5 was regarded as
a large effect/association.

Ethical considerations
Permission to conduct the study was obtained from the Health
Research Ethics Committee of North-West University (NWU-
00179–14-S1). Goodwill permission was furthermore obtained
from the board of directors of the PBM. Data were analysed
anonymously.

Results
Chronic kidney disease patients represented 0.10% to 0.14% of
the total database from 2009 to 2013. The majority of these
patients were males (male-to-female ratio 1:0.8) with prevalence
ranging from 55% to 58% over the five-year study period (see
Table 1). No association was found between the prevalence of
CKD and gender over the study period (p = 0.668).

The mean age of the CKD patients over the study period varied
between 58 and 61 years. The CKD patients were divided into
different age groups (see Table 1). Chronic kidney disease was
mostly present in the age group 35–64 years, presenting
prevalence rates of between 51% and 58% over the study period.
A statistically significant association was found between the
proportion of CKD patients per age group over the study period,
with an increasing trend in most of the age groups (p ≤ 0.05). This
association, however, was very weak (Cramer’s V = 0.039).

The majority (50% to 53%) of the CKD patients had either one or
two other chronic conditions along with CKD, to a maximum of
seven other chronic conditions (0.02%) over the study period.
The prevalence of CKD patients with three comorbid chronic
conditions (17.36% to 15.14%) was about double the prevalence
of CKD patients with four comorbid conditions (8.16% to 6.16%),
whereas patients with only CKD and CKD along with one other
condition had prevalence rates ranging from 20.16% to 24.11%,
and 24.09% to 27.59%, respectively (p = 0.263; Cramer’s V =
0.039). We observed no practically significant difference in the
mean number of CDL conditions over the study period (2009–
2013) (d = 0.145) (see Table 1).

Hypertension was the most prevalent comorbid condition,
occurring in 47% to 55% of the CKD patients. The occurrence of
dyslipidaemia in CKD patients increased from 36% to 43% over the
study period, whereas diabetes mellitus type 2 increased from 20%
to 25% from 2009 to 2013. Table 2 lists the four most prevalent
chronic conditions co-occurring with CKD. A statistically significant
but ‘weak’ practical association was found between the occurrence
of hypertension, dyslipidaemia, diabetes mellitus type 2 and cardiac
failure in CKD patients over the study period (see Table 2).

The top five chronic condition pairings are listed in Table 3. The
CKD–hypertension pairing was the most prevalent combination,
occurring in one in every six CKD patients. Hypertension and
dyslipidaemia were prevalent in 6% to 8% of the CKD population
with two other CDL conditions. The top three comorbid chronic
conditions (hypertension, dyslipidaemia and diabetes mellitus type 2) combined with CKD to double in prevalence from 3% to
6% over the study period.

Discussion
The CKD prevalence of 0.10% to 0.14% found in our study was
considerably lower than the estimated global CKD prevalence
(8% to 16%)1 and the prevalence rates of countries such as the
United States (16%),20 Canada (12.50%)21 and England (6.76%).22
This prevalence was also significantly lower than the estimated
CKD prevalence in South Africa (14%).23 Chronic kidney disease
can be an underlying cause for several other chronic conditions.23
The disease can also present differently, depending on the stage and cause of the disease, as well as individual factors such as age. This can result in a differential diagnosis for CKD that is therefore not registered as CKD. Patients with chronic renal insufficiency could thus not have been diagnosed as having CKD.

In this study, CKD patients were predominantly male. Possible reasons for the gender differences in CKD could include diet, renal/nephron mass, glomerular haemodynamics and direct effects of sex hormones. Similar results were found in the USA, and provided a good basis for comparison with our study, since

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### Table 1: CKD patient demographics

| Study variables | CKD prevalence by year, n (%) | p-value | Cramer's V |
|----------------|--------------------------------|---------|------------|
|                | 2009  | 2010 | 2011 | 2012 | 2013 |        |
| Total number of patients on database (N) | 103 3057 | 968 158 | 864 977 | 815 810 | 809 857 |        |
| CKD patients on database (%) | 1057 (0.10) | 1081 (0.11) | 1017 (0.12) | 1158 (0.14) | 1120 (0.14) |        |
| Gender |        |        |         |        |        |        |
| Male | 581 (54.97) | 600 (55.50) | 565 (55.56) | 648 (55.96) | 649 (57.95) | p = 0.668 0.021 |
| Female | 476 (45.03) | 481 (44.50) | 452 (44.44) | 510 (44.14) | 471 (42.05) |        |
| Age groups (years) |        |        |         |        |        |        |
| > 0 and ≤ 18 | 17 (1.61) | 13 (1.20) | 13 (1.28) | 17 (1.47) | 25 (2.23) | p = 0.014 0.039 |
| > 18 and ≤ 34 | 57 (5.39) | 57 (5.27) | 46 (4.52) | 62 (5.35) | 68 (6.07) |        |
| > 34 and ≤ 65 | 567 (53.64) | 556 (51.43) | 535 (52.61) | 626 (54.06) | 651 (58.13) |        |
| > 65 years | 416 (39.36) | 455 (42.09) | 423 (41.59) | 453 (39.12) | 376 (33.57) |        |
| Mean age (mean ± SD (95% CI)) | 59.66 ± 16.81 | 60.53 ± 16.52 | 61.05 ± 16.38 | 59.94 ± 16.30 | 57.84 ± 16.09 |        |
| Number of co-morbid chronic conditions |        |        |         |        |        |        |
| Only CKD | 222 (21.00) | 241 (22.29) | 205 (20.16) | 255 (22.02) | 270 (24.11) | p = 0.263 0.039 |
| CKD + 1 | 275 (26.02) | 272 (25.16) | 261 (25.66) | 279 (24.09) | 309 (27.59) |        |
| CKD + 2 | 283 (26.77) | 270 (24.98) | 257 (25.27) | 289 (24.96) | 272 (24.29) |        |
| CKD + 3 | 160 (15.14) | 194 (17.95) | 181 (17.80) | 201 (17.36) | 177 (15.80) |        |
| CKD + 4 | 81 (7.66) | 78 (7.22) | 83 (8.16) | 87 (7.51) | 69 (6.16) |        |
| CKD + 5 | 31 (2.93) | 20 (1.85) | 23 (2.26) | 38 (3.28) | 21 (1.88) |        |
| CKD + 6 | 5 (0.47) | 5 (0.46) | 7 (0.69) | 9 (0.78) | 2 (1.88) |        |
| CKD + 7 | 0 | 1 (0.09) | 0 | 0 | 0 |        |
| Mean number of co-morbid chronic conditions (mean ± SD (95% CI)) | 1.73 ± 1.35 | 1.70 ± 1.34 | 1.78 ± 1.35 | 1.77 ± 1.40 | 1.59 ± 1.30 |        |

### Table 2: Most prevalent comorbid chronic conditions occurring with CKD

| Comorbid chronic condition, n (%) | 2009 | 2010 | 2011 | 2012 | 2013 | p-value | Cramer's V |
|----------------------------------|------|------|------|------|------|---------|------------|
| Hypertension | 581 | 576 | 552 | 62 | 525 | 0.001 | 0.060 |
| (54.97) | (53.28) | (54.28) | (53.54) | (46.88) |        |
| Dyslipidaemia | 380 | 398 | 397 | 463 | 477 | 0.012 | 0.049 |
| (35.95) | (36.82) | (39.04) | (39.98) | (42.59) |        |
| Diabetes mellitus type 2 | 204 | 228 | 232 | 280 | 275 | 0.017 | 0.047 |
| (19.30) | (21.09) | (22.81) | (24.18) | (24.55) |        |
| Cardiac failure | 146 | 142 | 162 | 185 | 102 | <0.0001 | 0.074 |
| (13.81) | (13.14) | (15.93) | (15.98) | (9.11) |        |
Hypertension not only contributes to CKD and its progression, but plays an important role in the high cardiovascular morbidity and mortality of the disease.44 The kidneys are protected from arterial blood pressure increases in arterial blood pressure can cause vascular and glomerular damage, resulting in a reduced kidney function.46 An elevation in blood pressure in CKD patients thus increases the rate at which GFR (glomerular filtration rate) and resulting kidney function decline.44 It is estimated that about 20%–40% of diabetes mellitus type 2 patients encounter a moderate to severe decline in renal function.46 Diabetes results in a rise in the body’s blood sugar levels, which is referred to as hyperglycaemia.48 This rise in blood sugar levels causes disturbances in protein metabolism, which results in several complications such as retinopathy, diabetic nephropathy and neuropathy.50 Diabetes can damage the kidneys through several mechanisms, including damage to blood vessels of the kidneys, which results in albuminuria and damage to the nerves around the bladder, which increases the load on the kidneys by not fully emptying the bladder.50,51 Diabetic nephropathy steadily increases proteinuria along with elevation of blood pressure, which results in a progressive decrease in kidney function and, if not controlled, can result in kidney failure.51

Taking the pathology into account, it seems that most of the above-mentioned comorbidities can be linked to non-modifiable or modifiable risk factors of atherosclerosis, such as age, male gender, smoking, obesity, physical inactivity, lipid disorder, hypertension, diabetes, and stress.52 Following from this are relevant risk factors for CVD that include proteinuria and a decreased eGFR, with diet and gender having a definite influence on the decline in GFR again.53

**Limitations of this study**
Since the study population was based solely on ICD codes, the results can be generalised only to this specific database and study population. The database employed in this study also lacked clinical data such as GFR, serum creatinine and blood urea nitrogen (BUN) levels. The extent to which risk factors such as age and comorbid chronic conditions influenced the kidneys could therefore not be analysed.

**Conclusion and recommendations**
Our study showed that CKD co-occurs with several chronic conditions, particularly hypertension. This indicates that these patients are at risk of developing CKD and should be monitored closely, especially in the presence of atherosclerotic risk factors. Early detection and timely interventions are of the utmost importance in order to prevent CKD. An open-eyed approach to atherosclerosis and its risk factors is required, with good monitoring. There is room for research regarding the causes of early-life CKD, lifestyle interventions, and CKD screening in groups that are more at risk.
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