Prevalence of concordant and discordant comorbidity in chronic kidney disease: a large cross-sectional study

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Prevalence of comorbidity in chronic kidney disease: a large cross-sectional study

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Abstract

Background Chronic kidney disease (CKD) is commonly comorbid with hypertension, diabetes and cardiovascular disease (CVD). However, the extent of comorbidity in CKD across a range of concordant (shared pathophysiology and/or treatment) conditions and discordant (unrelated pathophysiology and/or different or contradictory treatment) conditions is not well documented.

Aim To ascertain the prevalence of comorbidity (across 39 physical and mental health comorbidities) in adults aged 25 years and over with CKD in a large nationally representative primary care population.

Design and Setting Cross-sectional analysis of a primary care dataset representing 1,274,374 adults in Scotland.

Method Secondary analysis of general practice electronic medical record data. Binary logistic regression models adjusted for age, sex, and socioeconomic status (SES).

Results A total of 98.2% of adults with CKD had at least one comorbidity (vs. 51.8% in controls). After adjustment for age, sex, and deprivation, people with CKD were more likely to have 1 (OR 6.5, 95%CI 6.0-7.1), 2-3 (OR 15.2, 95%CI 14.0-16.5), 4-6 (OR 26.6, 95%CI 24.4-28.9), and ≥7 other conditions (OR 41.9, 95%CI 38.3-45.8). Furthermore, all concordant (7 out of 7) and the majority of discordant physical health conditions (17 out of 24) and mental health conditions (6 out of 8) had significantly positive associations with CKD after adjustment.

Conclusion CKD is associated with extreme comorbidity, across a wide range of mental and physical conditions. Routine care for people with CKD should include recognition and management of comorbidities and clinical guidelines should support clinicians to do this.

Keywords chronic kidney disease, comorbidity, epidemiology, general practice
How this fits in

Chronic kidney disease (CKD) is common and results in significant mortality and morbidity, and is known to be commonly associated with hypertension, diabetes and cardiovascular disease. Despite research indicating that people with CKD and comorbidity of any type are at increased risk of adverse clinical outcomes, little is known about the prevalence of discordant physical and mental health conditions in people with CKD.

Our study finds that almost all people with CKD have co-existing comorbidities, and that extreme comorbidity is over 40 times more common in adults with CKD compared with age-sex-deprivation adjusted controls. The majority of discordant physical and mental health conditions were more common in people with CKD.
**Introduction**

Chronic kidney disease (CKD) is a leading cause of mortality and morbidity\(^1,2\) and commonly occurs in people with coexistent comorbidity\(^3,4\) which is associated with adverse clinical outcomes.\(^5\) Risk of death in CKD rises exponentially as kidney function deteriorates, largely attributable to cardiovascular disease (CVD).\(^6,7\) Diabetes and hypertension are the leading causes of CKD\(^6,8\) and risk factors for the progression of CKD and CVD overlap. Targeting modifiable risk factors can therefore improve survival and quality of life by reducing CVD in those with CKD,\(^9\) and progression of CKD to end-stage renal dysfunction (ESRD).\(^1,7-9\)

CKD is associated with complications that affect all body systems,\(^1\) and people with CKD experience significantly lower health-related quality of life compared with the general population.\(^6\) The coexistence of CKD in the context of both concordant comorbidities (those with shared pathophysiology and/or pharmacological treatments), and non-concordant conditions (where pathophysiology is unrelated and/or where treatments of different conditions are complicating or contradictory) are associated with increased healthcare utilization, length of in-patient hospital stay, and mortality.\(^3,10,11\) Comorbidity and polypharmacy are common in CKD, even in its early stages, and are associated with use of potentially hazardous nephrotoxic medications\(^12\) and significant treatment burden affecting a person’s ability to cope with treatment.\(^4,13\)

There is a marked social gradient in the prevalence of CKD,\(^14\) where low socioeconomic status (SES) is associated with worse CVD and mortality outcomes.\(^15,16\) People of lower SES are over-represented in those who develop CKD.\(^17\) Although CKD is known to be associated with concordant comorbidity, in particular potentially causal diseases such as hypertension and diabetes,\(^11\) the majority of existing literature examines a limited number of comorbid conditions and without reference to SES.\(^3,11\) Thus, there is a gap in evidence regarding the broader range of conditions that are typically managed in primary care, which includes concordant and discordant physical conditions and mental health conditions. This study examines prevalence of a wide range of comorbid conditions in people with and without CKD, using nationally representative primary care data from a large dataset in Scotland.\(^18\)

**Methods**

This study used data obtained from the Primary Care Clinical Informatics Unit at the University of Aberdeen of 1,274,374 adults aged ≥25 years, who were alive and permanently registered with 314 general practices on the 31\(^{st}\) March 2007 (31% of all practices in Scotland). These practices had
recorded routine electronic clinical data as part of the Scottish Programme for Improving Clinical Effectiveness in Primary Care (SPICE-PC), a voluntary scheme run by the Scottish Government. The dataset is a nationally representative sample in terms of patients’ age, sex, and SES, and was created for a previous study examining multimorbidity. 

SES was measured using the Carstairs index, which assigns SES based on postcode of residence and was grouped into deciles (equal tenths of the population ranked by Carstairs Index). This score uses four indicators judged to represent material disadvantage in the population taken from census data (lack of car ownership, low occupational social class, overcrowded households and male unemployment).

The dataset contained information on age, sex, SES, and 40 long-term conditions, made up of 32 physical health (including CKD), and 8 mental health conditions. Of physical health conditions, those categorised as concordant with CKD were hypertension, stroke/Transient Ischaemic Attack (TIA), peripheral vascular disease (PVD), diabetes, heart failure, atrial fibrillation (AF), and coronary heart disease (CHD), according to classification from previous studies. Remaining physical health conditions and mental health conditions were classified as discordant (Table 1).

Individuals were identified as having CKD if their primary care electronic medical record (EMR) contained a code for CKD as part of the CKD disease register for the Quality and Outcomes Framework (QOF – the UK national pay-for performance system which incentivised recording and care for CKD stages 3-5). No individuals had missing data for variables included in this analysis and therefore none were excluded from the study. The control group was defined as the entire population aged ≥25 years without a code for CKD in their EMR.

The overall number of physical and mental health conditions each individual had was documented. We used binary logistic regression models with presence of CKD as the outcome variable and report odds-ratios and 95% confidence intervals (95% CI) for explanatory variables. Unadjusted and models adjusted for age, sex, and SES, were calculated. A P-value of <0.05 was considered statistically significant. All statistical analyses were performed in R version 4.0.2.

Results

Demographics
A total of 1,274,374 individuals were included in the study, of which 33,567 (prevalence=2.6%) had a code for CKD in their EMR. The control group included all individuals without a CKD code (n=1,240,807). Table 2 and Figure 1 show the characteristics of people with and without CKD. Men accounted for 36.4% of the CKD group, compared with 49.2% in the control group. People with CKD were older than those without (mean 74.9 years vs. 50.6 years). Prevalence of CKD differed significantly between the youngest and oldest. Using 45-54 years as the reference age group, the adjusted odds-ratio (aOR) for CKD presence for those aged 25-34 years was 0.12 (95% CI 0.10-0.15) whilst the aOR for those aged ≥ 85 years was 45.7 (95% CI 42.7-48.8). People with CKD were more likely to live in the most deprived areas (aOR vs most affluent 1.39, 95% CI 1.32-1.47), with aORs for deprivation and CKD significant from deprivation decile 7 and above (Figure 1).

**CKD and total comorbidity**
Markedly higher levels of comorbidity were found in people with CKD compared with controls in both unadjusted analysis and age, sex, and deprivation adjusted comparisons. Strikingly, only 1.8% of people with CKD had no comorbidities, compared with 48.2% in the control group (Table 3). People with CKD had a higher mean number of comorbidities than people without CKD (3.8 (SD 2.2) vs. 1.2 (SD 1.6)). The mean number of physical comorbidities in people with CKD was 3.4 (SD 1.9) vs. 0.9 (SD 1.4) in people without. After age-sex-deprivation adjustment, people with CKD were considerably more likely to have 1 condition (aOR 6.5, 95% CI 6.0 – 7.1), 2-3 conditions (aOR 15.2, 95% CI = 14.0-16.5), 4-6 conditions (aOR 26.6, 95% CI = 24.4-28.9), and ≥7 conditions (aOR 41.9, 95% CI = 38.2-45.8).

**CKD and individual concordant and discordant physical comorbidity**
Crude prevalence of the most commonly recorded concordant conditions was hypertension (71.2% vs 17.0% in controls), CHD (34.5% vs 5.6%), and diabetes (26.3% vs 5.2%), while pain (25.4% vs 9.4%), thyroid disorders (16.8% vs 5.3%), and dyspepsia (13.7% vs 6.0%) were the most commonly recorded discordant conditions (Figure 2 and Supplementary Table 1).

All seven concordant conditions and almost all discordant physical health conditions (17 out of 24) were significantly more common in people with CKD after adjustment for age, sex, and deprivation (Figure 2 and Supplementary Table 1). Concordant conditions with the strongest adjusted associations were hypertension (aOR 3.99; 95% CI = 3.89-4.09), heart failure (aOR 3.45, 95% CI = 3.32-3.59), and diabetes (aOR 3.40, 95% CI =3.31-3.49). Discordant conditions with the strongest associations were...
rheumatological conditions (aOR 2.20, 95% CI 2.13-2.27), inflammatory bowel disease (IBD) (aOR 1.78, 95% CI 1.61-1.96), and painful conditions (aOR 1.75, 95% CI 1.70-1.80), viral hepatitis, bronchiectasis, chronic sinusitis, glaucoma, epilepsy, and multiple sclerosis had non-significant associations with CKD. The direction of association for Parkinson’s Disease (PD) reversed following adjustment (OR 3.33, 95% CI 2.91-3.82 vs aOR 0.77, 95% CI 0.67-0.89).

**CKD and individual mental health comorbidities**

Crude prevalence of the most commonly recorded mental health conditions were depression (17.7% vs 10.7% in controls), anxiety and other neurotic stress related and somatoform disorders (11.1% vs 4.1%), and other psychoactive substance misuse (7.3% vs 3.1%). Six of the eight mental health conditions had a significant positive association with CKD after adjustment (Figure 2 and Supplementary Table 1). Schizophrenia and associated conditions (aOR 1.53, 95% CI 1.39-1.69), depression (aOR 1.48, 95% CI 1.43-1.52), and learning disability (aOR 1.46, 95% CI 1.18-1.80) had the strongest associations. Alcohol problems had a non-significant association with CKD. The association between CKD and dementia reversed following adjustment for age, sex, and deprivation and became negative (OR 4.97, 95% CI 4.69-5.27 vs aOR 0.68, 95% CI 0.64-0.72).

**Discussion**

**Summary**

In this analysis of a large, nationally representative primary care dataset, we have found that almost all (98%) of patients with CKD had comorbidity, including concordant and discordant physical conditions, and mental health conditions. Extreme levels of comorbidity were common in CKD. For example, after adjusting for age, sex, and deprivation, having ≥7 conditions was over 40 times more common in the CKD group compared with the rest of the population. Positive associations with CKD were found in all seven concordant physical conditions, 17 of the 24 discordant conditions, and six out of eight mental health conditions after adjustment. Concordant diseases such as hypertension, heart failure, diabetes, CHD, and PVD were diseases with the highest aORs in the CKD group. This is unsurprising given than hypertension, diabetes, and PVD are known to cause CKD, and CVD processes are accelerated in the context of CKD. The majority of discordant diseases, with less research evidence base to explain concurrent prevalence in people with CKD, also showed significant associations with the strongest aORs seen in rheumatological disease, IBD, and pain. Of the mental
health conditions, schizophrenia and associated conditions, depression, and learning disability had the strongest associations with CKD after adjustment.

Our study found that fewer people in the CKD group were male, which could be explained by the higher mean age of the CKD group in the context of lower life expectancy of males compared to females in Scotland.\textsuperscript{22} We also found that people of lower SES are more likely to have CKD after age and sex adjustment. This is an important finding given that individuals of lower SES have greater mortality due to comorbid factors which then predict mortality on an independent basis,\textsuperscript{23} including obesity and associated cardiovascular risk factors.\textsuperscript{17}

Adjusting for age, sex, and deprivation reversed the direction of association for PD and dementia so both had odds-ratios <1. In the case of PD, a possible explanation might be the protective effects of cigarette smoking,\textsuperscript{24} where those who smoke might be more likely to develop CKD as a result of CVD while being protected from PD. With regard to dementia, this finding could relate to survivor effects given that people without CVD and diabetes comorbidity are more likely to survive to an age where Alzheimer’s Disease is very common.

**Strengths and limitations**

The study has a number of strengths, notably the use of a large nationally representative primary care dataset, including almost one-third of the Scottish population. Like all studies using routine data, identification of CKD relied on how well GPs recorded the disease in the EMR and some under-ascertainment is likely. However, CKD was part of the QOF at the time of data extraction which means GPs were financially incentivised to keep accurate registers. The prevalence of CKD in this study was 2.6% compared to the Global Burden of Disease (GBD) study estimate of 5.2%.\textsuperscript{25} This discrepancy can be explained by the GBD estimated including CKD stages 1 and 2 (accounting for around half of cases) compared to this study examining CKD 3-5. Data was collected in 2007 and prevalence rates of at least some of the diseases are likely to have changed given the 13-year interim period, although patterns of disease relationships are likely to be similar. Clinical detail, such as the stratification of CKD severity by estimated glomerular filtration rate and proteinuria were not available. However, our study included of a wide range of concordant and discordant physical and mental health conditions, allowing an in-depth analysis of the existence of comorbidities by number and type. Due to the cross-sectional nature of the dataset, causal pathways between variables could not be identified. Comparison made with number of comorbidities between those with CKD and those
without may not be a direct comparison because having any one condition already may increase the risk of having other comorbidities. However, in a comparison between those with CKD against those with any other condition it would be difficult to apply any statistical test because both groups are overlapping populations and we recognise this as a limitation, but it is remains clear that people with CKD have very high levels of comorbidity.

**Comparison with existing literature**

A small number of studies have measured the burden of comorbidity in CKD, however to the best of the authors’ knowledge, no existing studies have included a control population. Fraser et al examined comorbidity in a smaller population of 1741 people with CKD stage 3, and looked at the prevalence of a smaller number of comorbidities (11) which were not divided into concordant or discordant relationship with CKD. The study reported that comorbidity was seen in 96% of those with CKD and 40% of those with CKD had two or more comorbidities.

Several studies have examined the relationship between CKD and concordant conditions including CVD and diabetes. Few have examined associations with discordant physical and mental health conditions which are addressed in detail in our study. Bowling et al studied the association between number of chronic conditions stratified by the presence of one or more discordant conditions. They found that at least one discordant comorbidity was associated with higher risks of emergency department (ED) visits, and hospitalisation. A large Canadian study by Tonelli et al studied half a million people with CKD and found that adverse clinical outcomes including mortality, hospitalisation and myocardial infarction were common in all types of comorbidity including concordant, discordant and mental health conditions. A recent systematic review and meta-analysis of multimorbidity and adverse clinical outcomes concluded that there is an association between multimorbidity and increased mortality and morbidity in people with CKD. A key recommendation for future research was describing the prevalence of a wide range of comorbidities associated with CKD, which is addressed in our study.

High levels of comorbidity are commonplace in people with CKD, which means that complex and discordant treatment regimens are likely to be common. These regimens can be challenging to adhere to in the context of poor coping mechanisms, and a lack of knowledge about self-management strategies and social support. Clinicians can also find the management of CKD in the context of
multimorbidity challenging, given that the majority of clinical guidance relates to single-disease models often with conflicting advice between conditions. Such guidance can drive cumulative polypharmacy, without providing direction on how best to prioritise recommendations for individuals in whom treatment burden will sometimes be overwhelming.31

**Conclusions**

The findings of this study show that not only concordant, but discordant physical and mental health conditions were significantly more common in individuals with CKD. It is clear that integrated guidance and combined generalist and specialist expertise is required to ensure that appropriate care is delivered to people with CKD, recognising the complexity of their health needs. Further prospective cohort studies are required to determine the sequence in which different types of comorbidities and individual conditions emerge over the life course in people with CKD and evaluate generalist approaches to CKD care.

**Additional Information**

**Funding**

This study was funded by the Chief Scientist Office of the Scottish Government Health and Social Care Directorate (Applied Research Programme Grant ARPG/07/1). Data were provided by the Primary Care Clinical Informatics Unit at the University of Aberdeen.

**Ethical approval**

NHS Grampian Research Ethics Service approved the anonymous use of data for research purposes.

**Competing interests**

The authors have declared no competing interests.

**Acknowledgements**

SWM and BG conceived the idea of the study. CM drafted the literature review and paper. DH carried out statistical analysis and designed visual data representations. All authors contributed to draft revisions.
References


### Table 1. Classification of diseases according to type in association with CKD

<table>
<thead>
<tr>
<th>Concordant physical health condition</th>
<th>Discordant physical health condition</th>
<th>Mental health condition</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hypertension</td>
<td>Rheumatological Conditions</td>
<td>Depression</td>
</tr>
<tr>
<td>Peripheral Vascular Disease (PVD)</td>
<td>Inflammatory Bowel Disease (IBD)</td>
<td>Anxiety and other neurotic stress related and somatoform disorders</td>
</tr>
<tr>
<td>Heart Failure</td>
<td>Painful Condition</td>
<td>Alcohol Problems</td>
</tr>
<tr>
<td>Stroke and Transient Ischaemic Attack</td>
<td>Thyroid Disorders</td>
<td>Other Psychoactive Substance Misuse</td>
</tr>
<tr>
<td>Atrial Fibrillation (AF)</td>
<td>Chronic Obstructive Pulmonary Disease</td>
<td>Schizophrenia or Bipolar Affective Disorder</td>
</tr>
<tr>
<td>Diabetes</td>
<td>Bronchiectasis</td>
<td>Dementia</td>
</tr>
<tr>
<td>Coronary Heart Disease (CHD)</td>
<td>Chronic Sinusitis</td>
<td>Learning Disability</td>
</tr>
<tr>
<td></td>
<td>Migraine</td>
<td>Anorexia or Bulimia</td>
</tr>
<tr>
<td></td>
<td>Diverticular Disease of Intestine</td>
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<tr>
<td></td>
<td>Viral Hepatitis</td>
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<tr>
<td></td>
<td>Irritable Bowel Disease</td>
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<tr>
<td></td>
<td>Constipation</td>
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<td></td>
<td>Psoriasis or Eczema</td>
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<td></td>
<td>Prostate Disorders</td>
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<tr>
<td></td>
<td>Epilepsy</td>
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<td></td>
<td>Hearing Loss</td>
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<tr>
<td></td>
<td>Glaucoma</td>
<td></td>
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<td></td>
<td>Chronic Liver Disease</td>
<td></td>
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<tr>
<td></td>
<td>Blindness and Low Vision</td>
<td></td>
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<tr>
<td></td>
<td>New Diagnosis of Cancer in last 5 Years</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Parkinson’s Disease (PD)</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Multiple Sclerosis</td>
<td></td>
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<tr>
<td></td>
<td>Dyspepsia</td>
<td></td>
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<tr>
<td></td>
<td>Asthma</td>
<td></td>
</tr>
</tbody>
</table>
Table 2. Demographics by CKD status

<table>
<thead>
<tr>
<th></th>
<th>CKD n = 33,567</th>
<th>No CKD n = 1,240,807</th>
<th>Unadjusted OR (95% CI)</th>
<th>Age-sex-deprivation adjusted aOR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Total, n (%)</strong></td>
<td>33567 (2.6)</td>
<td>1240807 (97.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Men, n (%)</strong></td>
<td>12225 (36.4)</td>
<td>610680 (49.2)</td>
<td>0.59 (0.58-0.6)</td>
<td>0.81 (0.79-0.83)</td>
</tr>
<tr>
<td><strong>Mean age, years (SD)</strong></td>
<td>74.9 (10.9)</td>
<td>50.6 (16.2)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Age group, years, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>25-34</td>
<td>117 (0.3)</td>
<td>229477 (18.5)</td>
<td>0.12 (0.1-0.15)</td>
<td>0.12 (0.1-0.15)</td>
</tr>
<tr>
<td>35-44</td>
<td>420 (1.3)</td>
<td>278929 (22.5)</td>
<td>0.36 (0.32-0.4)</td>
<td>0.36 (0.32-0.4)</td>
</tr>
<tr>
<td>45-54</td>
<td>1054 (3.1)</td>
<td>253110 (20.4)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>55-64</td>
<td>3536 (10.5)</td>
<td>216168 (17.4)</td>
<td>3.93 (3.67-4.21)</td>
<td>3.94 (3.68-4.22)</td>
</tr>
<tr>
<td>65-74</td>
<td>9136 (27.2)</td>
<td>146356 (11.8)</td>
<td>14.9 (14.1-16.0)</td>
<td>14.9 (14.0-15.9)</td>
</tr>
<tr>
<td>75-84</td>
<td>13238 (39.4)</td>
<td>86223 (6.9)</td>
<td>36.9 (34.6-39.2)</td>
<td>36.1 (33.9-38.5)</td>
</tr>
<tr>
<td>85+</td>
<td>6066 (18.1)</td>
<td>30544 (2.5)</td>
<td>47.7 (44.6-51.0)</td>
<td>45.7 (42.7-48.8)</td>
</tr>
<tr>
<td><strong>Deprivation decile, n (%)</strong></td>
<td></td>
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<tr>
<td>1 (least)</td>
<td>3032 (9.0)</td>
<td>116316 (9.4)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>2</td>
<td>3470 (10.3)</td>
<td>123215 (9.9)</td>
<td>1.08 (1.03-1.14)</td>
<td>1.16 (1.1-1.22)</td>
</tr>
<tr>
<td>3</td>
<td>3197 (9.5)</td>
<td>120684 (9.7)</td>
<td>1.02 (0.97-1.07)</td>
<td>0.94 (0.89-0.99)</td>
</tr>
<tr>
<td>4</td>
<td>4048 (12.1)</td>
<td>147848 (11.9)</td>
<td>1.05 (1-1.1)</td>
<td>1.04 (0.99-1.1)</td>
</tr>
<tr>
<td>5</td>
<td>3816 (11.4)</td>
<td>142850 (11.5)</td>
<td>1.02 (0.98-1.08)</td>
<td>1.05 (1-1.1)</td>
</tr>
<tr>
<td>6</td>
<td>3213 (9.6)</td>
<td>140072 (11.3)</td>
<td>0.88 (0.84-0.93)</td>
<td>0.93 (0.88-0.98)</td>
</tr>
<tr>
<td>7</td>
<td>3436 (10.2)</td>
<td>130990 (10.6)</td>
<td>1.01 (0.96-1.06)</td>
<td>1.12 (1.07-1.18)</td>
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<tr>
<td>8</td>
<td>3086 (9.2)</td>
<td>104384 (8.4)</td>
<td>1.13 (1.08-1.19)</td>
<td>1.25 (1.18-1.32)</td>
</tr>
<tr>
<td>9</td>
<td>3453 (10.3)</td>
<td>113568 (9.2)</td>
<td>1.17 (1.11-1.23)</td>
<td>1.26 (1.2-1.33)</td>
</tr>
<tr>
<td>10 (most)</td>
<td>2816 (8.4)</td>
<td>100880 (8.1)</td>
<td>1.07 (1.02-1.13)</td>
<td>1.39 (1.32-1.47)</td>
</tr>
</tbody>
</table>
Figure 1. Age, sex, deprivation adjusted odds ratios for demographics by CKD status

Odds Ratio with 95% CI
(log scale)

- Male (ref Female)
- Age Group: 25-34
- 35-44
- 45-54 (ref)
- 55-64
- 65-74
- 75-84
- 85+
- Deprivation Decile 1 (ref)
- 2
- 3
- 4
- 5
- 6
- 7
- 8
- 9
- 10 - most deprived

CKD group = 33,567
Non-CKD group = 1,240,807
Table 3. Number of comorbidities by CKD status

<table>
<thead>
<tr>
<th>Comorbidity Category</th>
<th>CKD n = 33,567</th>
<th>No CKD n = 1,240,807</th>
<th>Unadjusted OR (95% CI)</th>
<th>Age, sex, and deprivation adjusted aOR (95% CI)</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Mean comorbidities, n (SD)</strong></td>
<td>3.8 (2.2)</td>
<td>1.2 (1.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Total comorbidities, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>614 (1.8)</td>
<td>598194 (48.2)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>3553 (10.6)</td>
<td>278807 (22.5)</td>
<td>12.4 (11.4 – 13.5)</td>
<td>6.5 (6.0 – 7.1)</td>
</tr>
<tr>
<td>2-3</td>
<td>12472 (37.2)</td>
<td>248971 (20.1)</td>
<td>48.8 (45.0 – 53.0)</td>
<td>15.2 (14.0 – 16.5)</td>
</tr>
<tr>
<td>4-6</td>
<td>13000 (38.7)</td>
<td>99779 (8.0)</td>
<td>126.9 (117.0 to 137.7)</td>
<td>26.6 (24.4 – 28.9)</td>
</tr>
<tr>
<td>≥7</td>
<td>3928 (11.7)</td>
<td>15056 (1.2)</td>
<td>254.2 (233.1 to 277.2)</td>
<td>41.9 (38.3 – 45.8)</td>
</tr>
<tr>
<td><strong>Mean physical health comorbidities, n (SD)</strong></td>
<td>3.4 (1.9)</td>
<td>0.9 (1.4)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Physical comorbidities, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>801 (2.4)</td>
<td>669088 (53.9)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>4356 (13.0)</td>
<td>275611 (22.2)</td>
<td>13.2 (12.2 – 14.2)</td>
<td>6.5 (6.0 – 7.0)</td>
</tr>
<tr>
<td>2-3</td>
<td>14130 (42.1)</td>
<td>220654 (17.8)</td>
<td>53.5 (49.9 – 15.2)</td>
<td>15.2 (14.1 – 16.4)</td>
</tr>
<tr>
<td>4-6</td>
<td>12070 (36.0)</td>
<td>69280 (5.6)</td>
<td>145.5 (135.4 to 156.4)</td>
<td>28.4 (26.3 – 30.6)</td>
</tr>
<tr>
<td>≥7</td>
<td>2210 (6.6)</td>
<td>6174 (0.5)</td>
<td>299.0 (274.7 to 325.4)</td>
<td>49.0 (44.8 – 53.5)</td>
</tr>
<tr>
<td><strong>Mean mental health comorbidities, n (SD)</strong></td>
<td>0.4 (0.8)</td>
<td>0.2 (0.6)</td>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Mental comorbidities, n (%)</strong></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>0</td>
<td>22980 (68.5)</td>
<td>1022283 (82.4)</td>
<td>1.00</td>
<td>1.00</td>
</tr>
<tr>
<td>1</td>
<td>7016 (20.9)</td>
<td>159527 (12.9)</td>
<td>2.0 (1.9 – 2.0)</td>
<td>1.3 (1.2 – 1.3)</td>
</tr>
<tr>
<td>2-3</td>
<td>3464 (10.3)</td>
<td>57091 (4.6)</td>
<td>2.7 (2.6 – 2.8)</td>
<td>1.4 (1.3 – 1.4)</td>
</tr>
<tr>
<td>≥4</td>
<td>107 (0.3)</td>
<td>1906 (0.2)</td>
<td>2.5 (2.05 to 3.04)</td>
<td>1.37 (1.11 to 1.69)</td>
</tr>
</tbody>
</table>
Figure 2. Age, sex, deprivation adjusted odds ratios for physical and mental comorbidities

Concordant Physical Conditions
- Hypertension (71.2%)
- Heart Failure (13.0%)
- Diabetes (26.3%)
- Coronary Heart Disease (34.5%)
- Peripheral Vascular Disease (8.6%)
- Atrial Fibrillation (12.1%)
- Stroke and Transient Ischaemic Attack (15.4%)

Discordant Physical Conditions
- Rheumatological Conditions (16.9%)
- Inflammatory Bowel Disease (1.4%)
- Painful Condition (25.4%)
- Thyroid Disorders (16.8%)
- Chronic Liver Disease (0.3%)
- Psoriasis or Eczema (1.3%)
- Viral Hepatitis (<0.1%)
- Chronic Obstructive Pulmonary Disease (11.5%)
- New Diagnosis of Cancer in last 5 Years (10.0%)
- Prostate Disorders (3.6%)
- Diverticular Disease of Intestine (10.7%)
- Migraine (0.6%)
- Dyspepsia (13.7%)
- Asthma (7.2%)
- Blindness and Low Vision (3.0%)
- Irritable Bowel Disease (4.5%)
- Constipation (12.0%)
- Bronchiectasis (0.5%)
- Hearing Loss (10.9%)
- Chronic Sinusitis (0.7%)
- Glaucoma (4.6%)
- Epilepsy (1.0%)
- Multiple Sclerosis (0.2%)
- Parkinson’s disease (0.7%)

Mental Health Conditions
- Schizophrenia or Bipolar Affective Disorder (1.5%)
- Depression (17.7%)
- Learning Disability (0.3%)
- Anxiety and associated conditions (11.1%)
- Anorexia or Bulimia (0.3%)
- Other Psychoactive Substance Misuse (7.3%)
- Alcohol Problems (2.5%)
- Dementia (4.0%)

Odds ratios and 95% CI (log scale)
Disease labels show % of people with CKD who also have this disease.