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# Patient-reported barriers and outcomes associated with poor glycaemic and blood pressure control in co-morbid diabetes and chronic kidney disease

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ABSTRACT

*Aims:* In patients with comorbid diabetes and chronic kidney disease, the extent to which patient-reported barriers to health-care and patient reported outcomes influence the quality of health care is not well established. This study explored the association between patient-reported barriers to health-care, patient activation, quality of life and diabetes self-care, with attainment of glycaemic and blood pressure (BP) targets.
*Methods:* This cross-sectional study recruited adults with diabetes and CKD (eGFR 20 to <60 ml/min/1.73m$^2$) across four hospitals. We combined clinical data with results from a questionnaire comprising measures of patient-identified barriers to care, the Patient Activation Measure (PAM), 12-Item Short Form Survey (SF-12), and the Summary of Diabetes Self-Care Activity (SDSCA).
*Results:* 199 patients, mean age 68.7 (SD 9.6), 70.4% male and 90.0% with type 2 diabetes were studied. Poor glycaemic control was associated with increased odds of patient reported "poor family support" (OR 4.90; 95% CI 1.80 to 13.32, $p < 0.002$). Poor BP control was associated with increased odds of patient reported, "not having a good primary care physician" (OR 6.01; 2.42 to 14.95, $p < 0.001$). The number of barriers was not associated with increased odds of poor control (all $p > 0.05$).
*Conclusions:* Specific patient-reported barriers, lack of patient perceived family and primary care physician support, are associated with increased odds of poor glycaemic and blood pressure control respectively. Interventions addressing these barriers may improve treatment target attainment.



## 1. Introduction

Diabetes is the commonest cause of end-stage kidney disease (ESKD),[1] with approximately 40% of individuals with chronic kidney disease (CKD) and ESKD having co-morbid diabetes.[1] Co-morbid diabetes and CKD is a substantial public health problem and associated with a very high risk of cardiovascular disease.[2] Health-care costs due to co-morbid diabetes and CKD are substantial with $US14,856 million spent by the USA Medicare system for patients aged 65 and older in 2014.[1]

A series of consensus statements have recently been published to optimise management of co-morbid diabetes and CKD.[3–6] Recommendations have included optimising glycaemic and blood pressure management.[3–6] Despite these recommendations, there is evidence

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that many patients still fail to meet glycaemic and blood pressure targets, along with other indicators of quality care (anaemia/haemoglobin targets, HbA1c monitoring and albuminuria screening).[7–9]

To improve the quality of care of patients with complex diseases, including diabetes and CKD, leading health-care and policy organisations have recommended patient-centred models of care.[10,11] Patient-centred care involves the formation of a patient-health provider partnership that is mutual, holistic and prioritises the patient in his or her social and caregiving context. Patient-centred care empowers people through health literacy to make personalised and realistic decisions for health.[12] Additionally, an individual's specific health needs and desired health outcomes drive health care decisions and quality improvement. Consequently, patient perspectives of the barriers to health care and patient reported outcomes (PROs) defined as outcomes reported directly by patients without interpretation by clinicians[13] are important parameters to consider in the design, evaluation and improvement of patient-centred models of care. However, whether these patient-reported barriers and outcomes are associated with attainment of treatment targets in diabetes and CKD is not known.

The objective of this study was to explore the association between patient-reported barriers to health-care and patient reported outcomes (that is patient activation, quality of life and diabetes self-care), with attainment of glycaemic and blood pressure targets. Our hypothesis was that the presence of patient-reported barriers, and poorer health-related quality of life, patient self-care and patient activation scores would be associated with a failure to attain treatment targets.

## 2. Subjects, materials and methods

The design, setting and recruitment of participants for this Australian multi-centre cross-sectional study has been described previously.[14] In brief, this study included adults (over 18 years) with diabetes and CKD stages 3 and 4 specifically with an eGFR between 20 to <60 ml/min/1.73m$^2$. Potential participants were recruited from either outpatient diabetes or renal clinics of each participating tertiary hospital over a 3-month period between January and September 2014 and were fluent in English. We excluded patients with an eGFR <20 ml/min/1.73m$^2$, as once the eGFR progresses to <20, renal replacement therapy is imminent and other management issues besides blood pressure and glycaemic control often take priority.

Methods and results are presented in accordance with the STROBE (Strengthening The Reporting of Observational Studies in Epidemiology) guidelines.[15] Monash Health (12,340 L), Monash University (CF12/4030–2012001924), Alfred Health (526/12), Concord Repatriation Hospital (LNR/12/HAWKE/417; CH62/6/2013–100; LNRSSA/13/CRGH/139), Royal North Shore Hospital (1212-431 M) and University of Sydney (2013/672) human research ethics committees approved the study.

### 2.1. Study conduct and variables

Data collection for each patient consisted of a survey composed of five questionnaires.

Site study staff or the clinician, using standardised procedures, prospectively completed the first questionnaire from the doctor's notes and laboratory results from clinic. Demographic information and disease-specific characteristics such as diabetes duration, type of diabetes treatment, complication status, current HbA1c, systolic and diastolic blood pressure, haemoglobin, CKD duration, CKD stage and current eGFR (Supplementary Appendix S1) was collected.

The second questionnaire was completed by the patient and examined patient-reported barriers to health-care (Supplementary Appendix S2) identified from the content analysis of 12 focus groups of 58 participants with co-morbid diabetes and CKD and 8 semi-structured interviews of carers from our previous multi-centre qualitative study.[16]

The third questionnaire was the validated American version of the Patient Activation Measure (PAM-13)[17] which examined patients' level of engagement in their healthcare (Supplementary Appendix S3). The questionnaire assessed each individual's knowledge, skill and confidence for self-management. Each item of the PAM was scored on a 5-point Likert response scale to yield raw scores (range 13–52) which were transformed from the original metric to a 0–100 metric with higher scores indicating increasing patient involvement.[17]

The fourth questionnaire was the validated Summary of Diabetes Self-Care Activities (SDSCA) questionnaire (Supplementary Appendix S4).[18] The SDSCA has previously been evaluated in numerous studies and settings.[19,20] The scale contains 11 main items, which are subdivided into five sub-scales. These subscales include diet, which is comprised of general diet, and diabetes specific diet, exercise, blood-glucose testing, foot-care and smoking. Scoring was performed on an 8-point Likert scale from 0 to 7.[18] The mean number of days the specific self-care activities were performed over the past 7 days was calculated for each subscale, with reverse scoring done for the item on dietary fat; higher scores signifying better self-care practice.[18] A composite score of self-care activity was generated from SDSCA ratings for general diet, specific diet, exercising, glucose testing, and foot checking.

The fifth questionnaire was the validated English version of the SF-12 and examined Health Related Quality Of Life (HRQoL) (Supplementary Table S5). The SF-12 measures physical and mental functioning. Utilising the two non-disease specific summary measures permitted comparison between other conditions[21] and the general population.[22] Item scores were summed for each scale and transformed on a scale of 0 to 100 with a higher score indicating better HRQoL.[23]

### 2.2. Outcome measures

The main outcome measures were failure to attain glycaemic and blood pressure targets. Poor glycaemic control was defined as an HbA1c ≥ 8% (64 mmol/mol), a target suggested by the American Diabetes Association.[3] Poor blood pressure control was defined as a systolic blood pressure ≥140 mm Hg, a target suggested by the European Renal Best Practice Group[4] and the American Diabetes Association.[3] Systolic blood pressure was used rather than diastolic blood pressure.

### 2.3. Statistical analysis

For baseline characteristics, continuous variables were reported as means and standard deviations or medians with interquartile ranges if distributions were skewed. Categorical variables were reported as frequencies and percentages. Socioeconomic status was analysed as quintiles obtained from the coding of postcodes according to the Index of Relative Social Disadvantage (IRSD),[24] a composite measure based on selected census variables, which include income, educational attainment and employment status. SF 12 physical composite and SF 12 mental composite were stratified according to the general population mean. To analyse barriers, Likert scales were collapsed into 2 categories (disagree and agree).

First, Pearson's chi squared test examined the relationship between study variables and poor glycaemic and blood pressure control. Second, univariable logistic regression analyses were performed to examine the relationship between potential predictor variables and poor glycaemic and blood pressure control. Third, separate multivariable logistic regression models were used to estimate the association between patient predictor variables and the likelihood of poor glycaemic and blood pressure control. Variables that showed a tendency of association with poor glycaemic and blood pressure control ($p < 0.05$) in univariable models inclusive of age, gender and diabetes duration and type were used to build the most parsimonious multivariable models. All logistic regression analyses standard errors were adjusted for clustering by hospital.

A dose response analysis adjusted for clustering by hospital was used to examine the association between the number of patient-

identified barriers and poor glycaemic and blood pressure control. The cohort was divided into quartiles according to the number of identified barriers and a univariable logistic regression examined the association between the number of barriers and poor glycaemic or blood pressure control.

Stata version 13.1 (Statacorp, College Station, TX) was used. Statistical significance was indicated by a $p$ value of <0.05.

## 3. Results

### 3.1. Patient characteristics

A total of 199 patients with diabetes and CKD (with an eGFR 20 to <60 ml/min/1.73 $m^2$) were included in the analysis. Clinical characteristics are reported in Table 1. The mean age was 68.7 (SD 9.6), and most were male (70.4%) and had type 2 diabetes (90.0%) with 36.2%, 38.7% and 25.1% having CKD stages 3a, 3b and 4 respectively. Optimal blood glucose (HbA1c <8%) and blood pressure control (systolic blood pressure < 140mm Hg) were achieved by 58% and 69% of the participants respectively. At least 60% of the participants reported optimal self-care scores (mean SDSCA score > 37.7, range 0 to 70). A third of the participants scored above the general population mean ($\mu = 50$) in the physical composite summary and 53% in the mental composite summary. Participants were evenly distributed across patient activation levels (level 1—19.6%, level 2—22.6%, level 3—29.2% and level 4—28.6%).

**Table 1**
Demographic and clinical characteristics of patients with diabetes and CKD.

| Variable | Mean ± SD or N (%) | Range |
|---|---|---|
| Age (years) | 68.7 ± 9.6 | 36–88 |
| Male (%) | 140 (70.4) | |
| Hospital (N, %) | | |
| A | 58 (29.1) | |
| B | 25 (12.6) | |
| C | 71 (35.7) | |
| D | 45 (22.6) | |
| English speaking | 155 (78.7) | |
| Socio-economic status | | |
| Upper | 38 (19.1) | |
| Higher middle | 45 (22.6) | |
| Middle | 40 (20.1) | |
| Lower middle | 39 (19.6) | |
| Lower | 37 (18.6) | |
| Currently smoking (%) | 9 (6.3) | |
| Weight (kilograms) | 91.9 ± 22.9 | 37–159.8 |
| Diabetes type (%) | | |
| Type 1 | 13 (6.5) | |
| Type 2 | 179 (90.0) | |
| Other | 7 (3.5) | |
| Diabetes duration (median, IQR) years | 18 (10 to 23) | 1–57 |
| HbA1c % | 7.6 ± 1.4 | 4.9–13.3 |
| eGFR categories (%) | | |
| 20–29 | 50 (25.1) | |
| 30–44 | 77 (38.7) | |
| 45–59 | 72 (36.2) | |
| Systolic blood pressure (mm Hg) | 132.1 ± 17.1 | 100–195 |
| Diastolic blood pressure (mm Hg) | 71.3 ± 10.7 | 40–113 |
| Summary of diabetes self-care activities | 37.7 ± 11.1 | 5–60 |
| Patient activation measure | 59.9 ± 15.2 | 32–100 |
| Health related quality of life | | |
| SF-12 Physical Composite Summary | 47.6 ± 11.1 | 17–64 |
| SF-12 Mental Composite Summary | 36.6 ± 11.3 | 10–68 |
| *Medications (%)* | | |
| On insulin only | 74 (37.2) | |
| On oral hypoglycaemic agents and insulin | 58 (29.2) | |
| Oral hypoglycaemic agents | 118 (59.3) | |
| On hypertensives | 187 (94.0) | |
| On renin-angiotensin system blockers | 141 (70.8) | |
| *Complications/other cardiovascular risk factors (%)* | | |
| Heart disease | 99 (50) | |
| Neuropathy | 63 (31.8) | |
| Stroke | 25 (12.6) | |
| Nephropathy | 138 (69.7) | |
| Peripheral vascular disease | 50 (22.2) | |
| Hypertension | 191 (96) | |
| Retinopathy | 76 (38.4) | |
| Dyslipidaemia | 166 (83.4) | |

### 3.2. Differences between patients with poor versus good glycaemic or blood pressure control

There were no differences in the proportion of patients with poor glycaemic and blood pressure control across age groups, gender, language, socio economic status, smoking status, eGFR, diabetes duration and activation levels (Table 2).

### 3.3. Clinical factors associated with poor glycaemic or blood pressure control

Higher weight in kilograms (OR 1.02; 1.01 to 1.03, $p < 0.02$) and being on insulin (OR 3.06; 1.74 to 5.40, $p < 0.001$) was associated with an increased odds of poor glycaemic control (Fig. 2, Supplementary Table S1). The presence of retinopathy was associated with an increased odds of poor blood pressure control (OR 3.34; 3.06 to 3.66, $p < 0.001$) (Fig. 3, Supplementary Table S2).

### 3.4. Patient-reported barriers and poor glycaemic and blood pressure control

Patient-reported "poor family support" was associated with increased odds of poor glycaemic control (OR 4.90; 95% CI 1.80 to 13.32, $p < 0.002$) (Fig. 2, Supplementary Table S1). Patient-reported "not having a good primary care physician" (OR 6.01; 2.42 to 14.95, $p < 0.001$) was associated with an increased odds of poor blood pressure control (Fig. 3, Supplementary Table S2). Patient-reported "receiving conflicting advice from specialists", "poor continuity of care", "inadequate understanding and education about CKD" and "trouble maintaining dietary and fluid restrictions" were all not associated with poor glycaemic or blood pressure control. In addition, lower patient activation and lower diabetes self-care behaviour scores, and physical and mental health well-being scores were not associated with poor glycaemic or blood pressure control (all $p > 0.05$, Fig. 1, Supplementary Tables S1 and S2).

### 3.5. Association between number of barriers and poor glycaemic or blood pressure control

An increased number of patient-reported barriers was not associated with increased odds of having poor glycaemic or blood pressure control.

## 4. Discussion

In this study, we sought to identify patient-reported barriers and outcomes associated with failure to attain glycaemic and blood pressure targets in patients with co-morbid diabetes and CKD. Particular patient-reported barriers rather than the total number of barriers or patient activation, diabetes self-care and QOL, were associated with poor glycaemic and blood pressure control. Patient perceived lack of family support was associated with a lack of attainment of glycaemic targets. Patient perceived lack of primary care physician support was associated with a lack of attainment of blood pressure targets. Other patient-reported barriers to health-care such as "receiving conflicting advice from specialists", "poor continuity of care", "inadequate understanding and education about CKD" and "trouble maintaining dietary and fluid restrictions" were not associated with a lack of attainment of glycaemic or blood pressure targets.

Patient-reported "poor family support" was associated with increased odds of poor glycaemic control. This is consistent with the

**Table 2**
Demographic and clinical characteristics stratified according to glycaemic and blood pressure targets.

| Variables | Sample distribution ($n = 199$) | HbA1c < 8% ($n = 115$) | HbA1c ≥ 8% ($n = 67$) | Systolic blood pressure < 140 mm Hg ($n = 137$) | Systolic blood pressure ≥ 140 mm Hg ($n = 57$) |
|---|---|---|---|---|---|
| Age (mean ± SD) yrs. | 68.7 ± 9.6 | 68.9 ± 9.3 | 68.1 ± 9.6 | 68.5 ± 9.9 | 69.2 ± 1.2 |
| Gender: | | | | | |
| Male | 140 (70.4) | 81 (70.4) | 48 (71.6) | 96 (70.1) | 42 (73.7) |
| Female | 59 (29.6) | 34 (29.6) | 19 (29.4) | 41 (29.9) | 15 (26.3) |
| English speaking | | | | | |
| Yes | 155 (78.7) | 91 (79.8) | 54 (80.6) | 107 (79.3) | 46 (80.7) |
| No | 42 (21.3) | 23 (20.2) | 13 (19.4) | 28 (20.3) | 11 (19.3) |
| Socioeconomic status | | | | | |
| Upper | 38 (19.1) | 26 (22.6) | 11 (16.4) | 22 (16.1) | 14 (24.6) |
| Higher middle | 45 (22.6) | 23 (20.0) | 19 (28.4) | 30 (21.9) | 14 (24.6) |
| Middle | 40 (20.1) | 22 (19.1) | 13 (19.4) | 31 (22.6) | 8 (14.0) |
| Lower middle | 39 (19.6) | 20 (17.4) | 14 (20.9) | 29 (21.2) | 9 (15.8) |
| Lower | 37 (18.6) | 24 (20.9) | 10 (14.9) | 25 (18.3) | 12 (21.1) |
| Smoking | | | | | |
| Yes | 9 (6.3) | 6 (7.5) | 3 (5.8) | 6 (5.9) | 3 (7.7) |
| No | 134 (93.7) | 74 (92.5) | 49 (94.2) | 95 (94.1) | 36 (92.3) |
| eGFR | | | | | |
| 20–29 | 50 (25.1) | 27 (23.5) | 20 (29.9) | 32 (23.4) | 16 (28.1) |
| 30–44 | 77 (38.7) | 43 (37.4) | 24 (35.8) | 58 (42.3) | 17 (29.8) |
| 45–59 | 72 (36.2) | 45 (39.1) | 23 (34.3) | 47 (34.3) | 24 (42.1) |
| Diabetes duration | 18 (10 to 23) | 19 (7 to 23) | 17 (11 to 24) | 18 (10.5 to 23) | 17 (8 to 22) |
| Patient activation | | | | | |
| 1 | 39 (19.6) | 23 (20.0) | 13 (19.4) | 29 (21.2) | 10 (17.5) |
| 2 | 45 (22.6) | 27 (23.5) | 11 (16.4) | 30 (21.9) | 15 (26.3) |
| 3 | 58 (29.2) | 41 (35.7) | 26 (38.8) | 46 (33.6) | 21 (36.8) |
| 4 | 57 (28.6) | 24 (20.8) | 17 (25.4) | 32 (23.4) | 11 (19.3) |
| Self-care score (0–70) | 37.7 ± 11.1 | 37.3 ± 11.7 | 38.4 ± 10.4 | 36.9 ± 10.7 | 38.7 ± 11.5 |
| Physical composite | | | | | |
| <50 | 152 (82.6) | 91 (85.0) | 53 (85.5) | 110 (85.9) | 43 (84.3) |
| ≥50 | 32 (17.4) | 16 (15.0) | 9 (14.5) | 18 (14.1) | 8 (15.7) |
| Mental composite | | | | | |
| <50 | 87 (47.3) | 53 (49.5) | 32 (51.6) | 63 (49.2) | 28 (54.9) |
| ≥50 | 97 (52.7) | 54 (50.5) | 30 (48.4) | 65 (50.8) | 23 (45.1) |

No significant differences in mean (SD), median (IQR) and proportions were found for all variables ($p > 0.05$ for all variables); SF 12 physical composite (0−100) and SF 12 mental composite (0–100) were stratified by the general population mean ($\mu = 50$). Diabetes duration was measured in years (median, IQR). Patient activation levels were categorised into 4 levels thus Level 1−(<47), Level 2−(47.1–55.1), Level 3−(55.2–67) and Level 4−(>67).

majority of studies in patients with diabetes, although the results in type 2 diabetes are mixed. A 2013 systematic review of observational studies examining the association between social support and glycaemic control found that adequate family support was most frequently associated with a lower HbA1c.[25] Similarly, more recent observational studies have shown that obstructive family behaviours are associated with a higher HbA1c either directly[26] or indirectly through an association with self-care.[27] Here we advance the literature by showing that patient-reported "poor support from their family", is associated with poor glycaemic control, in a complex sub-population of patients with diabetes and CKD. These findings support the consideration of increasing awareness and engagement of family members in diabetes education and management activities and targeting family support.

Patient-reported "not having a good primary care physician" was associated with poor blood pressure control. This may be a reflection of the Australian publicly funded health system, where primary care physicians play a key role in patient management and care co-ordination with referrals from primary care required for patients to access allied health and both public and private specialist services. The finding emphasises the importance of primary care for the attainment of treatment targets in patients with co-morbid diabetes and CKD. This is especially the case when patients are primarily managed by their primary care physician.[28,29] In contrast, previous studies of primary care identified poor communication and coordination of care with specialty services and poor knowledge and awareness about CKD as barriers.[29–31] Interventions supporting primary care by improving coordination of care and communication between specialist care and primary care, and improving primary care knowledge and management of co-morbid diabetes and CKD may improve patient care and treatment target attainment.

Of note, patient activation was not associated with poor glycaemic and blood pressure control in patients with co-morbid diabetes and CKD. Previous studies examining the association between patient activation and glycaemic control amongst patients with diabetes have mainly reported a positive association.[32–35] Similarly, studies examining the association between blood pressure control and patient activation have not only shown mixed results but have occurred in a heterogeneous population with not all patients having both diabetes and CKD.[36,37] In a study of patients with diabetes, better patient activation was associated with better blood pressure control.[36] Conversely in another study in black patients with 61% having diabetes and/or CKD there was no association between patient activation and good blood pressure control.[37] Here we studied patients with both diabetes and CKD. The lack of an association is of interest and may be a reflection of the management of complex co-morbidity but needs to be further examined by longitudinal studies.

In our study, lower diabetes self-care behaviour or self-management scores as evaluated by the SDSCA were not associated with poor glycaemic control. Previous studies have examined this association in patients with diabetes and reported no[38] or a weak association.[39,40] The lack of consistency in these studies and ours may reflect subjective patient reporting of diabetes self-care. In addition, health related quality of life (as measured by lower physical and mental health well-being scores on the SF-12) was not associated with poor glycaemic and blood pressure control. Our study is consistent with previous studies showing no association between HRQOL and glycaemic control[41–43] in patients with diabetes alone. However, it differs from studies of patients with hypertension that have reported an association between better blood pressure control and better HRQOL.[44–47] These difference could

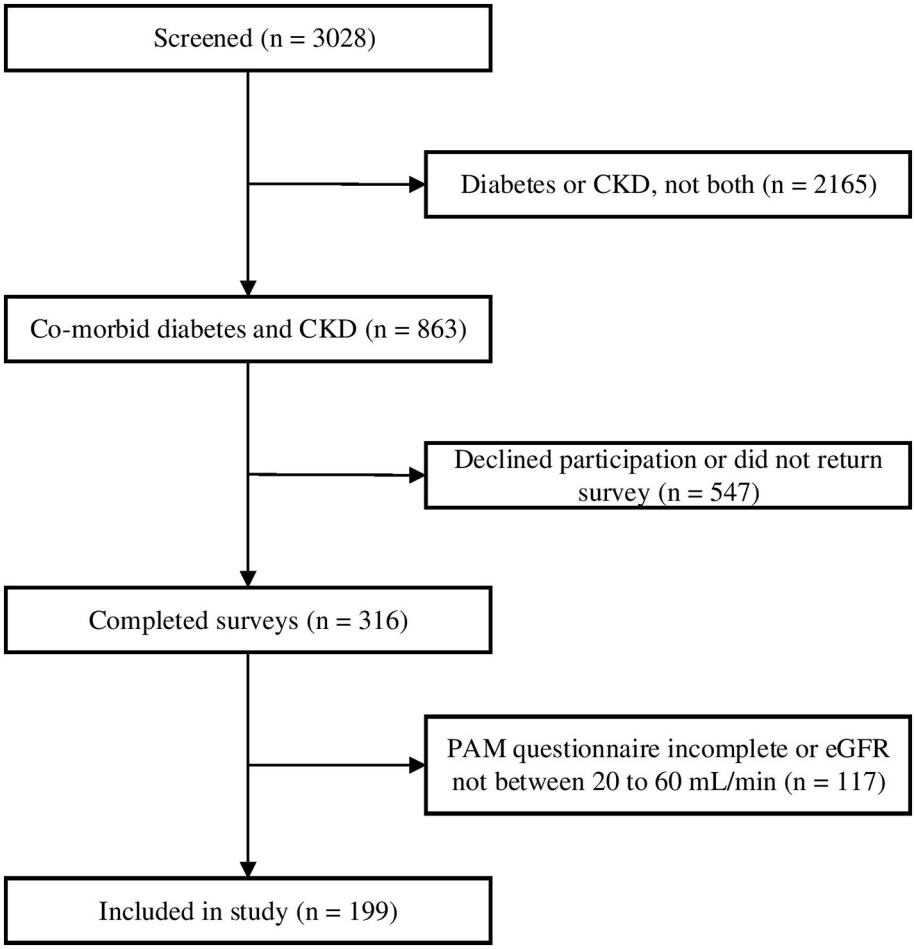


**Fig. 1.** Patient recruitment.

be explained by differences in the populations studied.[44–46] Together with our results, the overall evidence suggests that achieving good glycaemic and blood pressure control does not seem to adversely impact patients' HRQOL and vice versa, and may even be associated with greater levels of HRQOL in patients with co-morbid diabetes and CKD (excluding ESKD).

Our study's strengths include multi-site patient recruitment from geographically distinct large metropolitan areas, ensuring generalisability to urban populations. However, due to the cross-sectional study design, we were unable to make definitive causal inferences. In addition, despite the test–retest reliability not being performed for the patient-reported barriers questionnaire, partnering with patients in developing this survey ensured a form of reliability in the study. We were also unable to account for the individualisation of patient care, especially when therapeutic goals are appropriately different from treatment targets. Finally, because only participants speaking English were included, our findings cannot be generalised to culturally and linguistically diverse (CALD) populations.

In summary, specific patient-reported barriers, rather than the total number of barriers or lower scores on patient activation, diabetes self-care and QOL, were associated with poor glycaemic and blood pressure

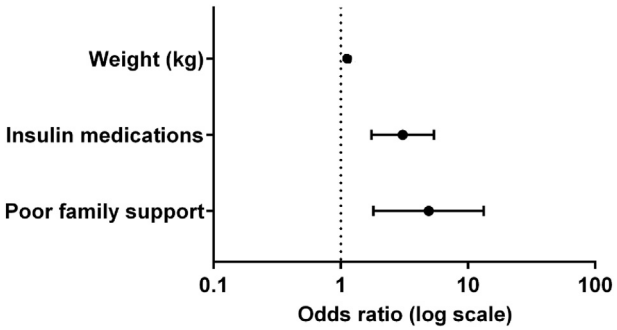


**Fig. 2.** Factors associated with poor glycaemic control (weight OR: 1.02 CI-1.01 to 1.03, insulin medications OR: 3.06 CI–1.74 to 5.40 and patient-reported "poor family support" OR: 4.90 CI–1.80 to 13.3).

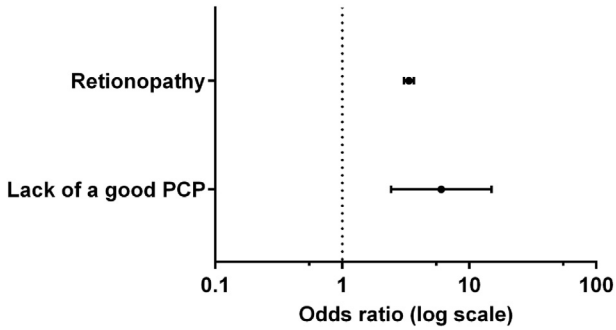


**Fig. 3.** Risk factors associated with poor blood pressure control (retinopathy OR: 3.34 CI–3.06 to 3.66 and patient-reported "lack of a good primary care physician [PCP]" OR: 6.01 CI–2.42 to 15.0).

control. Lack of patient perceived family and primary care physician support were associated with increased odds of poor glycaemic and blood pressure control respectively. Interventions building the capacity of the family to support an individual with chronic disease, and which support primary care in managing co-morbid diabetes and CKD may improve patient care and treatment target attainment.

Supplementary data to this article can be found online at https://doi.org/10.1016/j.jdiacomp.2018.09.020.

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