2015-09-30

Identifying Chronic Kidney Disease in the Community: The See Kidney Disease Targeted Screening Program

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Identifying Chronic Kidney Disease in the Community: The See Kidney Disease Targeted Screening Program

by

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A THESIS

SUBMITTED TO THE FACULTY OF GRADUATE STUDIES

IN PARTIAL FULFILMENT OF THE REQUIREMENTS FOR THE

DEGREE OF MASTER OF SCIENCE

GRADUATE PROGRAM IN COMMUNITY HEALTH SCIENCES

CALGARY, ALBERTA

SEPTEMBER, 2015

Abstract

Background: Guidelines recommend early identification of chronic kidney disease (CKD), with targeted screening as a potential method.

Methods: The See Kidney Disease (SeeKD) targeted screening program screened 5,194 participants for CKD across Canada. Participant characteristics and clinical measures, including point-of-care creatinine testing for at-risk participants to determine unrecognized CKD (estimated glomerular filtration rate < 60 mL/min/1.73m^2), were obtained. Individual counselling sessions were provided to participants as a behaviour change intervention.

Results: The majority of participants (88.9%) had at least one risk factor for CKD, amongst whom the prevalence of unrecognized CKD was 18.8%. The majority of respondents to the post-screening survey (89.8%) self-reported a health behaviour change 2-4 weeks after their individual counselling session.

Conclusion:

The SeeKD program was able to identify a high prevalence of unrecognized CKD. Individual counselling may be an important component in facilitating health behaviour change among participants at risk of CKD.

Acknowledgements

Thank you to the Kidney Foundation of Canada for the use of the See Kidney Disease Targeted Screening Program dataset. The following thesis work was supported by a Strategic Training Initiative in Health Research Award from Knowledge Translation Canada, along with travel and supplemental funding from the Faculty of Graduate Studies, the Department of Community Health Sciences, the Interdisciplinary Chronic Disease Collaboration (ICDC) and Knowledge Translation Canada. In addition to funding, these organizations provided professional development programs which made substantial contributions to my MSc training.

The completion of this thesis would not have been possible without the support of an incredible team. It truly takes a village. The words “thank you” seem to simultaneously be the most appropriate and underwhelming way to show my immense gratitude to the following people. First, and foremost, I would like to thank my incredible supervisors, Drs. Brenda Hemmelgarn and Paul Ronksley, who have been instrumental in my graduate training. Your encouragement, insight, patience, and impressive availability have provided me with a wonderful and positive learning environment. Thank you both for having faith in me and allowing me the opportunity to push the envelope. Specifically, thank you Brenda for being such an inspiring role model and for teaching me to trust myself and challenge my own limits. You have facilitated both my professional and personal growth, beyond anything I could have asked for. Paul, I sincerely appreciate your flexibility, intellectual perspective, positive demeanor and kindness. Thank you for reinforcing that *it is a process*, and that the deadlines I set myself are often the most unrealistic.

To my supervisory committee (Drs. Braden Manns and Susan Samuel), thank you for your guidance, support and amazing flexibility throughout this short but sweet journey! Dr.

Samuel, I sincerely appreciate your commitment to my thesis work and kind words of praise. Braden, thank you for taking a chance on me way back when, and for daring me to reach for what I really wanted. Your faith in me truly helped me believe in myself.

To the ICDC/Nephrology research team, specifically those in the G200 hall of the Health Sciences Centre. Thank you for the coffee, the laughs, the long walks, and odd talks, the perspective, the chocolate, the life lessons, and procrastination sessions. This team became my work family, without whom I likely would have been just another sleep-deprived, coffee-filled graduate student. Finally, to the most important people in my life, my family. You gave me wings to fly and roots to come home to. Thank you for being the most supportive and understanding bunch anyone could ask for. Thank you for inspiring me to follow my own path, as convoluted as it sometimes may be.

~ To Ryan, Tizita, Fikira and Jason – May you always guide me home

Table of Contents

List of Tables

List of Figures and Illustrations

List of Symbols, Abbreviations and Nomenclature

Symbol	Definition
BIC	Bayesian Information Criterion
BMI	Body Mass Index
CI	Confidence Interval
CKD	Chronic Kidney Disease
CVD	Cardiovascular Disease
eGFR	Estimated Glomerular Filtration Rate
ESRD	End-Stage Renal Disease
FINISHED	First Nations Community Based Screening to Improve Kidney Health and Prevent Dialysis
KDIGO	Kidney Disease | Improving Global Outcomes
KEEP	Kidney Early Evaluation Program
KFOC	Kidney Foundation Of Canada
NHANES	National Health and Nutrition Examination Survey
PRR	Prevalence Rate Ratio
SD	Standard Deviation
SeeKD	See Kidney Disease Targeted Screening Program
USRDS	United States Renal Data System

CHAPTER ONE: INTRODUCTION

Overview

Chronic kidney disease (CKD) is a global public health problem[1,2] with a worldwide prevalence that exceeds 10% [3]. In high income countries, such as Canada, an estimated 7% of the adult population suffers from CKD[4,5]. The prevalence of CKD is increasing, particularly in older populations, where up to 22% of individuals over the age of 70 have CKD [6]. Patients diagnosed with CKD have an increased risk for cardiovascular disease (CVD), cardiovascular death and premature all-cause mortality[7,8]. In fact, the majority of patients with CKD die prematurely from CKD-related complications before progressing to end-stage renal disease (ESRD; kidney failure) [9,10]. However, CKD has been described as "the silent killer" [11-13] due to its asymptomatic nature during early disease stages[14,15] which causes delayed diagnosis until advanced disease progression[16] and an underestimation of the prevalence of CKD [17]. Further, the disease burden of CKD is substantial and translates into significant health care system costs[18,19], exacerbated by increasing incidence.

Screening, defined as periodic physical evaluation for early disease detection[20], is an important component of health services in Canada. Screening has found significant success in preventing premature mortality in areas such as colorectal cancer[21,22] and lung cancer[22]. Current clinical practice guidelines recommend early recognition of CKD [15,23,24] and the use of disease management programs[15,23,24] to provide appropriate preventative interventions to reduce morbidity and mortality[14]. Limited research suggests screening programs as a potential approach to early identification of CKD[1,14,16]. Although population-based screening has not been shown to be cost effective, targeted screening of people with diabetes [16] and hypertension [25] has shown promise as related to its cost-effectiveness. However, paucity of evidence[14,23] on the optimal methods for early identification of CKD has delayed advancements in screening for CKD. As such, we aimed to conduct the first evaluation of a national targeted screening program called

See Kidney Disease (SeeKD) to inform the effectiveness of targeted screening strategies for CKD in Canada. The primary objective of this thesis was to determine the effectiveness of the SeeKD targeted screening program in identifying patients at risk of CKD, and those with unrecognized CKD. Just as screening to identify CKD is critical to improving outcomes for patients, so is promoting health behaviour change as a tool for disease self-management in patients at risk or diagnosed with CKD. Consequently, the second objective sought to determine whether individual counselling and goal setting sessions provided at the SeeKD screening events resulted in a health behaviour change amongst participants. Although each objective reflects a single manuscript to be published independently, together these manuscripts form a coherent body of research. Therefore, the manuscripts are presented together in the framework of a manuscript-based thesis.

Following the background and literature review in chapter one, each manuscript is presented in submission-ready format in chapters two and three. The fourth and final chapter provides a general discussion of the research findings and application within the current literature. In addition, the final chapter presents the clinical implications and recommendations for future work.

Literature Review

1.1 Defining Chronic Kidney Disease

Chronic kidney disease (CKD) is defined by a sustained reduction in kidney function, and classified by six categories of increasing disease severity [14,15]. The international Kidney Disease | Improving Global Outcomes (KDIGO) workgroup published clinical practice guidelines for the evaluation and management of CKD in 2012 [15]. These guidelines recommend using glomerular filtration rate and a urine albumin-creatinine ratio, as important clinical measures for determining

kidney function and classifying CKD [15]. Further, on the basis of high quality studies they recommend using the 2009 Chronic Kidney Disease Epidemiology Collaboration equation to determine estimated GFR (eGFR) [26].

A patient is considered to have CKD if they have had two consecutive measurements, at least 90 days apart, with an eGFR less than 60 mL/min/1.73m^2. Current clinical practice guidelines categorize eGFR into six categories of progressive loss of kidney function. These increasing categories of disease severity are outlined in Table 1.0 [15,23,24].

Table 1.0 Chronic kidney disease categories

Category of CKD:	**eGFR Range**
1 (normal)	eGFR ≥ 90 mL/min/1.73m^2
2 (mildly decreased)	eGFR of 60-89 mL/min/1.73m^2
3a (mildly to moderately decreased)	eGFR of 45-59 mL/min/1.73m^2
3b (moderately to severely decreased)	eGFR of 30-44 mL/min/1.73m^2
4 (severely decreased)	eGFR of 15-29 mL/min/1.73m^2
5 (kidney failure)	eGFR < 15mL/min/1.73m^2

1.2 Incidence and Prevalence of Chronic Kidney Disease

Due to its increasing incidence and prevalence, CKD has been described as a global public health problem [1-3,15]. The United States Renal Data System (USRDS) reports the prevalence of CKD to be 13.6% amongst participants from the population-based National Health and Nutrition Examination Survey (NHANES) [27]. Comparatively, the prevalence of CKD in Canada, based on administrative and laboratory data from the province of Alberta [4], is approximately 7% of the general population. Data from NHANES indicates the greatest increase in CKD prevalence is among category 3 (eGFR 30-60 mL/min/1.73m^2), where the prevalence of adult CKD was 4.5% in 1988-2004 and has increased to 6% in 2007-2012 [27]. Further, the prevalence of CKD is significantly higher among women than men, a trend that has been

consistent over time [27]. The prevalence of CKD among women in the United States was 15.1%, compared to 12.1% for men in 2012 [27].

The increasing prevalence of CKD is of particular concern in aging populations, where up to 22% of individuals aged 70 years and older are reported to have CKD worldwide[6]. This increase in prevalence may be partially explained by the increasing prevalence of risk factors including diabetes and hypertension [28]. A high proportion of participants with CKD in the NHANES population had diabetes (39.2%), hypertension (31.0%) and a body mass index greater than 30 kg/m^2 (16.6%). This is especially important as evidence demonstrates that the presence of CKD augments the risk of adverse events among patients with cardiovascular disease (CVD), diabetes, or hypertension [29].

1.3 Consequences of Chronic Kidney Disease

CKD has been shown to be an independent risk factor for the development of CVD [1], the leading cause of mortality among CKD patients [15,30]. This is supported by a recent systematic review of 39 studies that showed non-dialysis CKD patients are at an increased risk for CVD, as well as cardiovascular and all-cause mortality [7]. However, the burden of comorbidity for patients with CKD extends beyond CVD. James et al. (2008)[31] found that non-dialysis CKD patients also experience an increased risk of bloodstream infections, which increase according to eGFR severity. Patients with category 3b and 4 CKD had a 1.6 and 3.5 fold-increased risk of bloodstream infections, respectively, as compared to individuals with an eGFR ≥60 mL/min/1.73m^2. Additionally, 75% of all infections were community-onset infections, suggesting that improved management of patients with CKD in the primary care setting may help reduce this risk of infection[31]. In addition to the increased risk of bloodstream infection, the odds of hospital-acquired acute kidney injury has been reported to be significantly higher for CKD

categories 3 through 5, highlighting another serious complication of CKD [32]. Comorbid conditions associated with CKD are not restricted to physiological manifestations; a recent study of CKD in adults aged 20 to 59 years reported that a decline in eGFR (CKD category 3a and 3b) was associated with a significant reduction in visual attention and learning performance [33].

Overall, patients with CKD develop complications that are often irreversible and result in an increased risk for morbidity and mortality [7]. Despite recommendations for early recognition of CKD to implement proven effective therapies and improve patient outcomes [14], current practice varies considerably [34,35] and many point of care providers are not aware of the clinical practice guidelines for CKD diagnosis and management [36]. An evidence-informed strategy for early recognition of CKD is necessary to reduce the risk of CKD-related complications and death.

In addition to the significant disease burden of CKD on patients and their families, management of CKD also results in a strain on the health care system. Patients who progress to end-stage renal disease (ESRD; kidney failure), must decide on a treatment option, either renal replacement therapy or conservative management [37]. Renal replacement therapy is a life-sustaining treatment for patients with kidney failure that consists of dialysis (hemodialysis or peritoneal dialysis), or kidney transplantation [38]. Nearly 81% of CKD patients requiring renal replacement therapy are treated with conventional hemodialysis [39] which carries an annual cost of over $64,000 Canadian dollars per patient [16]. This highlights the disproportionate health care system costs of CKD [18,19], where less than 1% of the population (receiving renal replacement therapy) consume 5% of annual health care budgets [15].

1.4 Identifying Chronic Kidney Disease in the Community

Due to the aforementioned complications of CKD, appropriate and effective management of CKD is important, which requires timely diagnosis and early recognition of CKD. Current

clinical practice guidelines [15,23,24] are unanimous in their recommendation for early recognition of CKD. However, they fail to provide tangible recommendations for optimal strategies to identify CKD in early stages. The KDIGO practice guidelines for the evaluation and management of CKD are the international guidelines for CKD care. The Canadian Society of Nephrology published a commentary on these guidelines for CKD with application within the Canadian health care system[23], and highlighted the paucity of evidence on strategies for early recognition of CKD, in addition to the economic considerations and potential adverse personal and insurance-related consequences associated with labeling individuals with CKD. Consequently the Canadian Society of Nephrology recommended that practitioners use case-finding methods amongst those at risk of CKD for screening in clinical practice. Case-finding has been described as a form of screening where the main objective is to detect disease and identify patients for treatment[20].

Due to the asymptomatic nature of CKD [14], early recognition and diagnosis has proven to be challenging for many primary care providers. Recent evidence suggests that 51% of primary care physicians report being unfamiliar with the clinical practice guidelines for CKD. In fact, among the physicians ordering diagnostic testing for CKD, 75% did not adhere to the recommendations for appropriate testing[36]. Although many primary care physicians do not recognize early stages of CKD [40,41], as in other chronic conditions, it has been shown that they deliver better care to CKD patients when a diagnosis is established [41].

1.5 Screening for Disease

Primary prevention strategies seek to abolish disease by protecting the individual and population pre-emptively from an increase in incidence, such as vaccination programs. Early detection of disease, known as secondary prevention, aims to discover and manage conditions

which have produced a pathological change but have not reached a stage at which medical aid is sought spontaneously[20]. Screening is a critical component of early disease detection. While there are many definitions used to describe this term, the most common is "the presumptive identification of unrecognized disease or defect by the application of tests, examinations, or other procedures which can be applied rapidly. Screening tests sort out apparently well persons who probably have a disease from those who probably do not."[42] Importantly, screening tests are not intended to be diagnostic, and individuals who screen positive require confirmatory testing for diagnosis[20]. Further, there are several different methods of screening, ranging from mass screening of whole populations to targeted (selective) screening focused on populations with an increased risk for a particular disease, and may include multiple screening tests in combination (multiphasic)[20].

Screening has generally been conducted as a component of public health initiatives for chronic diseases and conditions for which clinical evidence recommend this method of early disease detection. However, as evidence continually evolves, screening programs which have traditionally been conducted for certain conditions are no longer recommended (e.g. screening for prostate cancer with the prostate-specific antigen test)[43] or in particular patient populations, such as no mammography screening for breast cancer in women aged 40-49[44-47]. Further, some diseases are inappropriate for screening. To be considered for screening a disease should be serious and considered an important health problem, it should have an accepted treatment that can be provided prior to the symptomatic phase and is effective in reducing mortality and morbidity, and the prevalence of the preclinical phase of the disease should be high within the population screened[48]. These criteria fall within the ten key principles of early disease detection, originally developed by Wilson et al., which also includes items such as availability of a suitable

test or examination which must be acceptable to the population being screened, and the natural history of the condition from latent period to declared disease should be adequately understood, etc.[20] Further, there should be pre-determined policy for which patients to treat, the cost of screening should be economically balanced with the potential future expenditure on medical care, and the screening program should be a continuing process[20].

As previously mentioned, CKD has been defined as a public health concern[1,15], it employs reliable and valid clinical testing procedures for diagnosis (e.g. creatinine measure and CKD-EPI equation), and has a well-documented disease trajectory with treatments effective in reducing mortality and CKD-related complications[15,23]. Consequently, CKD shows promise as a disease well-suited for screening as an early disease detection strategy. However, further research is required as the optimal method for screening has yet to be established, which may affect current cost-effectiveness studies and prevalence estimates. According to Hennekens and Buring, the evaluation of a screening program should carefully consider whether the program is feasible and effective[48].

1.6 Screening Strategies for Chronic Kidney Disease

To date, a variety of screening strategies for CKD have been initiated around the world [49-51]. These screening programs include population-based screening (Japan)[51,52] , community-based screening (Australia; Sheffield, UK) [53] [38] and targeted screening (USA, Canada and Scotland)[49,54].

1.6.1 Population-based Screening

Population-based screening, also known as mass screening, is large-scale screening of whole population groups for a specific disease[20]. Population-based screening can be an efficient

method for early disease detection, in particular where disease prevalence is pervasive. For example, the Kidney Disease Screening Program in Japan was originally started in 1972 and sought to screen the general population for kidney function given the high prevalence of proteinuria as well as glomerulonephritis, which is an endemic disease and the leading cause of ESRD in Japan[55]. Though this mass screening program has evolved over time, each evaluation and iteration of the program has shown significant benefit in disease prevalence and improved 10-year survival for ESRD due to glomerulonephritis.[51,56] The prevalence of CKD using a population-based screening approach has consistently been shown to be lower than that of targeted screening, and has been reported as low as 7% in North America,[4,5,35] and as high as 17.5% in Thailand and India [57,58]. The marginally higher prevalence of CKD in Thailand and India is indicative of these populations with a known elevated prevalence of independent risk factors for CKD [57,58].

1.6.2 Community-based Screening

Community-based screening is a term found within the literature which reflects either mass screening or targeted screening depending on the strategy used by the program. A community-based screening program directs screening efforts at specific communities in order to obtain a precise estimate of the prevalence of CKD. Although, community-based screening efforts in the UK report a prevalence of undiagnosed CKD as low as 7.1%[38], typically communities with a high proportion of individuals at risk for CKD are selected, resulting in a targeted screening strategy. Within Canada, the First Nations Community Based Screening to Improve Kidney Health and Prevent Dialysis (FINISHED) project is a mass screening initiative targeting all First Nations people residing in rural and remote communities in Manitoba, Canada[59]. To date, this initiative has not yet reported CKD prevalence, but has screened a mean

of 21% (range: 3.2% - 46.6%) of 11,615 eligible individuals within the 11 First Nations communities enrolled [59]. A community-wide screening program implemented on an isolated Aboriginal island in the Northern Territory of Australia screened 487 adults, an 89% screening rate based on census population estimates [53]. The community is reported to have an ESRD incidence rate of 2700 per million, and the screening initiative found 26% of adults had microalbuminuria and 24% had overt albuminuria, both of which are diagnostic for CKD [53]. This cumulative work suggests that community-based screening, which targets communities with a high proportion of individuals at risk for CKD, may be an effective strategy to identify CKD in the community setting.

1.6.3 Targeted Screening

Targeted screening, also known as selective screening, is defined as the screening of selected high-risk groups in the population[20]. Targeted screening has been found to be an efficient and cost-effective method for early disease detection in certain diseases. For example, targeted screening for colorectal cancer (CRC) in patients over the age of 50 and amongst those with a family history of CRC has been successful in producing a significant decrease in mortality and incidence in the United States[21,60]. Within CKD, targeted screening is defined as screening individuals with risk factors for development of CKD such as patients with diabetes, hypertension, clinically relevant cardiovascular disease, family history of kidney failure, member of a high risk ethnicity (African, Asian, Aboriginal and Hispanic origin) and those aged 60 years and older [15].

Currently in the United States, the National Kidney Foundation conducts targeted screening for CKD through the Kidney Early Evaluation Program (KEEP). This program directs its screening efforts at communities with presumed high risk populations and recruits individuals

on the basis of their increased risk for CKD (including people diagnosed with diabetes or hypertension, or a family history of diabetes, hypertension or CKD) [49,50,61,62]. This program uses a standardized protocol for screening events to identify those at high risk for CKD. The KEEP program has been effective in identifying 28.7% of screened participants with undiagnosed CKD [49].

High quality evidence demonstrates that population-based screening for CKD is not cost effective [16,25,63,64]. However, the cost per quality adjusted life year of targeted screening within diabetic [16] and hypertensive [25] populations for the identification of CKD is comparable to that of other publicly funded health care initiatives. This suggests that a targeted screening approach may be a cost-effective and appropriate strategy for identifying CKD in the community [49,61]. Further, given the lower prevalence of CKD within population-based screening, future studies are required to elucidate features of targeted screening that are most effective in identifying CKD in the community.

1.7 Health Knowledge of Chronic Kidney Disease to Enhance Disease Management

An important component of screening and diagnosis is the opportunity to increase knowledge and understanding about the disease state among those screened. Adequate health knowledge has been shown to enhance disease management, while inadequate health knowledge is a potentially modifiable determinant of poor health outcomes and health inequalities in people with chronic diseases [65-68]. Among patients receiving renal replacement therapy, increased kidney specific knowledge was associated with reduced rates of complications [69] and improved patient self-management behaviours [70]. Studies have reported low patient awareness of hypertension [71], diabetes and cardiovascular disease as risk factors for CKD [72]. Further, people are unaware of the asymptomatic nature of CKD in its initial stages [73] and often attribute risk of

CKD to lifestyle behaviours [72]. As such, the literature highlights the importance of counselling and strongly recommends tailored education focused on risk factors for CKD [72] and encouraging adoption of lifestyle modifications to prevent or slow the progression of CKD [73]. This is also supported by a recent study showing that patients diagnosed with CKD often participated in only one healthy behaviour (e.g. tobacco avoidance, intense physical activity) and did not achieve risk-reduction targets [74]. A recent systematic review has also shown that self-management behaviours are important for reduction of complications related to CKD[68], and highlight the importance of health knowledge in management of chronic disease, including CKD.

1.8 Behaviour Change and Promoting Self-Management in Chronic Disease

Following early disease detection (screening), an important aspect of providing preventative treatment for patients at risk of CKD and those with diagnosed CKD is the adoption of lifestyle changes. Behaviour change interventions aim to promote healthy lifestyles and improve the uptake and optimal use of effective clinical services using a "coordinated set of activities designed to change specified behaviour patterns."[75] In an effort to influence the development of effective and meaningful behaviour change interventions, research from leading scientists in the field of behaviour change and health psychology (Michie and colleagues) suggest several key principles. A behaviour change intervention should first identify the specific behaviour(s) for change and use a theoretically-derived behaviour framework[76] to design an intervention focused on improving the uptake of knowledge and skills, and simultaneously increase motivation and empowerment[77]. Unfortunately, a combination of paucity of evidence and heterogeneous interventions, exacerbated by poor reporting resulting in extensive taxonomy[78], leads to difficulty ascertaining the effectiveness of behaviour change interventions within CKD populations[79].

A famous behaviour framework (The Behaviour Change Wheel) by Michie et al. (2011) describes the generation of a desired behaviour as requiring a 'behaviour system' consisting of capability, motivation and opportunity [75]. Capability includes an individual's psychological and physical capacity to engage in the chosen activity, motivation has been described as the brain processes that "energize and direct behaviour" and opportunity is the factors outside the individual that ensure the behaviour is possible or can prompt it [75]. These components are strongly interconnected and each interacts directly with behaviour generation [75].

Within the chronic disease literature an important focus of behaviour is self-management of a patient's disease. In an attempt to initiate self-management, several behaviour change interventions have been implemented within chronic disease populations, such as diabetes [80,81] and chronic obstructive pulmonary disease [82]. A recent synthesis of the evidence on interventions supporting self-management for people with long-term conditions found that effective self-management interventions are multifaceted and should be tailored to the individual, their beliefs, and the specific condition including the position at which the patient is within the disease trajectory (early versus late stages) [83]. Further, the intervention requires an underlying collaborative relationship between the patient and the healthcare provider [83]. With a focus on patient-centered tailored interventions to facilitate patient behaviour change, 'health coaching', also known as counselling, has been identified as a potential intervention to enhance self-management. There are a variety of approaches to target behaviour change. A patient-centered 4-step counselling program for health behaviour change reported high ratings for motivation, acceptance and feasibility among both primary care physicians and patients [84], and improvement in health behaviours amongst participants [84]. Further, counselling via telephone calls within chronic disease populations has been shown to improve health behaviour and self-efficacy [85].

This was especially true for vulnerable populations who experience barriers to health care access [85]. Moreover, planned telephone counselling and unscripted sessions were the most effective for improving self-management behaviours [85]. The planned aspect allowed for regular contact and long-term assistance, while the unscripted component permitted tailoring of counselling to the patient's individual needs[85].

To date there is limited research on behaviour change within CKD populations. A recent literature review of self-management programs in CKD stages 1-4 concluded that further research was required to determine the effectiveness of self-management programs to change patient behaviour and improve health outcomes [79]. However, one study found individual nutritional counselling produced significant reductions in self-reported symptoms and problems associated with kidney disease in a pre-dialysis CKD population, which shows promise for individual counselling in CKD[86]. Given the results from other chronic conditions, this research suggests that regular and open communication, in the form of individual counselling with healthcare providers may promote behaviour change and thus enhance patient self-management of CKD. Further research is required to illuminate the use of behaviour change interventions for patients with CKD, and was one of the objectives of the SeeKD program.

1.9 The See Kidney Disease Targeted Screening Program

In Canada, the See Kidney Disease (SeeKD) Targeted Screening Program was launched by the Kidney Foundation of Canada in 2011, with the aim of promoting kidney health and disease prevention strategies while encouraging early detection of CKD through a national targeted screening initiative. Comparable to the KEEP program in the United States, the goals of the SeeKD program were to identify individuals who may have CKD, promote self-management

behaviours to prevent or delay the progression of CKD and generate the evidence-base to inform public policy initiatives for prevention, early detection and management of CKD [87].

The Kidney Foundation of Canada consists of eight branches representing the ten provinces across Canada. In undertaking the SeeKD program (initially funded by the Canadian National Railway), the Kidney Foundation of Canada encouraged each branch to secure additional local and provincial resources to support the screening events. The SeeKD program conducted screening events from April 2011 to May 2014.

Based on a post-hoc assessment of the screening events, we broadly categorized the SeeKD screening program into two strategies: *individual-targeted screening,* focused on selectively targeting individuals at risk for CKD, and *community-targeted screening*, which included a broader approach and conducted screening events in a community or location that may be in proximity to a high risk population. Within this body of research we have focused on *unrecognized CKD,* defined as an eGFR <60 mL/min/1.73m^2 and where the patient is unaware of a current diagnosis of CKD, though one could have been made by their primary care physician.

The SeeKD program methods and data have not previously been analyzed or reported, as such this thesis will report the methods and analyze novel data on targeted CKD screening in Canada. The results of this study will provide an estimate of the prevalence of unrecognized CKD in Canada, a comparison of the individual-targeted screening versus community-targeted screening strategies to help inform future events, and will determine if individual goal setting and counselling delivered during screening events elicited healthy behavior change following the event.

1.10 Summary

CKD is a common and important global health problem. Currently, people at high risk for CKD are under-diagnosed and thus do not receive indicated therapy in the primary care setting, highlighting a significant evidence-to-practice gap. A better understanding of optimal screening strategies as a mechanism for early recognition of CKD is required. The SeeKD program provides an opportunity to evaluate a CKD targeted screening program within the Canadian health care system. The results will contribute to the current knowledge-to-practice gap for CKD diagnosis and offer recommendations to decision makers on current screening programs for CKD.

CHAPTER TWO: THE SEE KIDNEY DISEASE (SEEKD) TARGETED SCREENING PROGRAM FOR CKD

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2.1 Abstract

Background: The effectiveness of targeted screening for identification of chronic kidney disease (CKD) is largely unknown. The See Kidney Disease (SeeKD) targeted screening project aimed to determine the prevalence of unrecognized CKD in Canada.

Study Design: Cross-sectional.

Setting and Participants: The SeeKD project was conducted across Canada with events to identify adults with risk factors for CKD (i.e. diabetes, hypertension, vascular disease, family history of kidney problems, etc.).

Outcomes and Measurements: Participants with at least one risk factor for CKD received a point-of-care creatinine measurement to identify unrecognized CKD (estimated glomerular filtration rate [eGFR] < 60 mL/min/1.73m^2). Baseline information collected included clinical characteristics, sociodemographics and health knowledge. Semi-structured telephone interviews were conducted with each branch after the screening events to characterize local screening strategies, which were subsequently categorized as individual-targeted (specifically targeting individuals at risk of CKD) and community-targeted (event in a community location in proximity to a high risk population). We calculated the prevalence of unrecognized CKD overall, and by screening strategy.

Results: Between January 2011 and February 2014, 6,329 Canadians participated in the SeeKD screening events. Participants were predominantly female (65.3%), middle-aged (mean=58.5 years), and the majority (88.9%) self-reported at least one risk factor for CKD. Of participants with at least one risk factor, 92.3% (N=5,194) were screened for CKD, of whom 18.8% (95% confidence interval [CI] 17.8–19.9) had unrecognized CKD; the majority (13.8%) had stage 3a CKD (eGFR 45-60 mL/min/1.73m^2). The prevalence of unrecognized CKD was higher for

branches with individual- versus community-targeted events (21.9% (95% CI 20.5-23.4) vs. 14.7% (95% 13.2-16.2)).

Limitations: CKD was defined using a single creatinine measurement.

Conclusions: Targeted screening identified a high proportion of individuals with risk factors for CKD and a high prevalence of unrecognized CKD. Future research will evaluate the ability of targeted screening to promote self-management behaviours addressing priorities for people with CKD.

INDEX WORDS: Chronic kidney disease; targeted screening; mass screening

2.2 Background

Chronic kidney disease (CKD), defined as estimated glomerular filtration rate (eGFR) <60 mL/min/1.73 m^2, is an important public health problem with increasing prevalence worldwide.[1-3] An estimated 2.9 million Canadian adults,[88] and up to 22% of individuals over the age of 70, have CKD.[6] Further, CKD increases the risk of cardiovascular disease and premature all-cause mortality.[7] Clinical practice guidelines recommend early recognition of CKD [15,23] to enable implementation of interventions that can reduce morbidity and premature mortality.[14] However, there is a paucity of evidence to inform the optimal strategy for early recognition of CKD.

Population-based screening for CKD has not been shown to be cost effective, however, targeted screening of people with diabetes [16] and hypertension [25] has been shown to have a similar cost per quality adjusted life year gained as other publicly funded health care initiatives. Targeted screening is directed at individuals with an increased risk of CKD, such as individuals with diabetes, hypertension, clinically relevant cardiovascular disease, family history of kidney failure or aged 60 years and older.[15]

In the United States, the Kidney Early Evaluation Program (KEEP) screening program targeted populations at risk of CKD, and reported a prevalence of undiagnosed CKD of 28.7%.[49] In Canada, the See Kidney Disease (SeeKD) Targeted Screening program was launched by The Kidney Foundation of Canada to identify unrecognized CKD and promote kidney health and disease prevention strategies. In this paper we report the prevalence of unrecognized CKD from the SeeKD program, and describe the targeted screening strategies used.

2.3 Methods

2.3.1 Overview of the SeeKD screening program

Eight Kidney Foundation of Canada branches, spanning 10 provinces, participated in the SeeKD screening program using a standardized protocol. Branches chose the location and target population for their screening events, based on community characteristics. Branches were encouraged to hold screening events in locations where those at risk of CKD would be greatest, participant accessibility was adequate, and with a publicly accessible venue provided free of cost. At least one registered nurse or pharmacist attended each screening event, and used pre-defined guidelines for medical follow-up of patients, if necessary.

Eligible participants were adults 18 years of age and older who provided informed consent. The screening event used a standardized three-step protocol to ensure only those at risk of CKD would receive kidney-specific testing (Appendix A). In step one participants completed a health data form to determine baseline sociodemographic characteristics, risk factors for CKD, knowledge of kidney disease and its risk factors, and current health behaviours. CKD risk was defined as at least one of the following self-reported risk factors: diagnosed diabetes, diagnosed high blood pressure, existing kidney problems, family history of kidney disease, member of high risk ethnic population (Aboriginal, Hispanic, South Asian, Asian or African descent), current vascular disease and currently using tobacco products. Participants identified as at-risk for CKD moved to step two, where clinical measurements, including point-of-care creatinine testing (Stat Sensor) and urinalysis, were obtained. The StatSensor tool has demonstrated good sensitivity (96%) and moderate specificity (79%) for detecting CKD, and has been suggested for screening of CKD[89-91]. Participants with no evidence of risk factors for CKD were provided with information about kidney health and self-management approaches to prevent kidney disease. Glomerular filtration rate (GFR) was estimated using a creatinine measure and the CKD-EPI

equation[26]. Finally, step three included a follow-up health survey sent to participants at risk of CKD within 2-4 weeks after attending the event. Of note, *unrecognized CKD* was defined as an eGFR <60 mL/min/1.73m^2 and where the patient is unaware of a current diagnosis of CKD, though one may have been made by their primary care physician.

2.3.2 Information obtained to characterize screening events

To further characterize the SeeKD screening events we contacted the Kidney Foundation of Canada Branches after the screening events were completed (between July 2014 and September 2014), to obtain additional detailed information. Telephone interviews were scheduled with the person in charge of the event at each branch, or their delegate. The semi-structured interviews, which ranged from 30-60 minutes, obtained information about the population of interest for screening, methods of advertising, location of the screening events, screening criteria and registration, resources utilized, length of events, and approximate number of participants screened per event. Interviews were done by one member of the research team.

Based on this information we categorized the SeeKD events post-hoc into two broad screening strategies: individual-targeted screening (defined as targeting individuals at high risk of CKD) and community-targeted screening (defined as an event in a community location in proximity to a high risk population). The focus of events as individual-targeted or community-targeted was largely dependent upon available resources, as well as opportunities and relationships with communities at high risk of CKD.

2.3.3 Analysis

Descriptive statistics were used to characterize participants, including sociodemographics (age, sex), self-reported motivation to participate in screening, health knowledge of CKD, and risk factors for CKD, and were reported using numbers and proportions for binary and

categorical variables, and means with standard deviations (SD) for continuous variables. Results were further stratified by screening strategy (individual-targeted and community-targeted).

Among individuals with self-reported risk factors for CKD who received point-of-care creatinine testing, we calculated the prevalence of unrecognized CKD, with 95% confidence intervals, overall, and by screening strategy and self-reported risk factors. Finally, we compared participants with unrecognized CKD to those with normal kidney function on sociodemographic data, risk factors for CKD, clinical characteristics (body mass index, urine protein, urine blood, random blood glucose, blood pressure) and whether an individual required immediate medical attention at the screening event. Results were compared using Pearson's chi-square tests for proportions, the Wilcoxon rank sum test for multi-level categorical variables, and t-tests for continuous variables. In a sensitivity analysis we excluded participants that self-reported having kidney problems and had an eGFR < 60 mL/min/1.73m^2, to determine the prevalence of unrecognized CKD among participants without prior knowledge of kidney problems.

Qualitative descriptive methods were used to analyze and explore the variation in screening events collected through the interviews. Analysis was conducted by assigning codes to segments of the collected interview information, using *a priori* defined codes (categories). These segments of data were then organized in tabular format by category. Branches were invited to review and comment on the information to ensure accuracy.

The SeeKD targeted screening program received ethics approval from Health Canada as well as the Conjoint Health Research Ethics Board at the University of Calgary. All statistical analyses were conducted using Stata, version 11.2[92].

2.4 Results

Of the eight Kidney Foundation of Canada branches participating, one did not follow the standardized protocol and was removed from this analysis. As such, we report on the SeeKD program representing nine of the ten Canadian provinces. Of the seven participating branches of the Kidney Foundation of Canada, four conducted individual-targeted screening (screening events that specifically targeted individuals at risk of CKD and commonly had people sign-up in advance of the screening event) (Table 2.1) and three used a community-targeted screening strategy (held their screening events in public locations where high risk individuals were expected, including those with limited health care access) (Table 2.2).

2.4.1 Description of screening events

Among branches that conducted *individual-targeted screening*, the individuals targeted were typically part of ethnic groups at increased risk of CKD or seniors, with events held in community centers or other gathering places, and advertised by the venue or community itself (Table 2.1). Many events required sign-up prior to the event to ensure adequate resources were available and to avoid line-ups for participants. Events were often repeated in the same venue to ensure that high risk individuals had equal opportunity to participate. The number of participants screened also varied, as resources differed between screening events.

Among branches that conducted *community-targeted screening*, events were held at a variety of locations, including grocery stores or community centers, and all were drop-in, with advertisements being optional and varied (Table 2.2). Multiple events were often held in the same venue to foster relationships with communities. The number of participants screened varied, and was dependent on the number of people in the location on that specific day. Additional details and quotes from the qualitative interviews are provided in appendix B.

2.4.2 Results of screening events

Overall 6,329 adults participated in the screening events, of whom 65.3% were female with a mean age of 58.5 years (Table 2.3). Of the 88.9% of participants who indicated at least one risk factor for CKD, being a member of a high risk ethnic population, and a previous diagnosis of hypertension or diabetes were the most common (59.0%, 38.5%, and 22.4% respectively). Fifty percent of participants were motivated to participate due to a personal concern about their health whereas 25.6% of participants identified the recruitment efforts by the branches as their motivation to participate. With respect to their health knowledge of risk factors for CKD, the majority (84.9%) were able to identify at least one risk factor.

There were more participants recruited by individual-targeted events as compared to community-targeted (57.3% vs. 42.8%, respectively). Individual-targeted also identified a higher proportion of participants with risk factors for CKD (92.4% vs. 84.3%, respectively) (Table 2.3). Though participant characteristics were similar by screening strategy, participants' motivation to participate in the screening events varied, with community-targeted events having a higher proportion of participants attending due to recruitment efforts (41.4% vs. 13.9% for individual-targeted), while participants in the individual-targeted screening predominantly chose "concern for personal health status" (54.7% vs. 43.9% for community-targeted).

Of the 5,194 participants at risk of CKD who were screened, fifty people did not report their age and therefore eGFR could not be calculated (Figure 2.1). Among the 5,144 participants with complete data, 18.8% (95% CI 17.8-19.9) had unrecognized CKD, of whom 13.8% (95% CI 12.9-14.7) had category 3a, 4.1% had category 3b and less than 1% had category 4 or 5 CKD (Table 2.4). The prevalence of unrecognized CKD was highest among those with the greatest number of CKD risk factors. The individual-targeted screening identified a higher proportion of

participants with unrecognized CKD overall, when compared to community-targeted (21.9% vs. 14.7%, respectively).

Compared to at-risk participants with no CKD, participants with unrecognized CKD were predominantly female (71.2% vs. 47.8%; p<0.001) and older (mean age= 69.9 years vs. 55.9 years; p<0.001) (Table 2.5). Participants with unrecognized CKD were more likely to have a previous diagnosis of hypertension, diabetes, or vascular disease, but were less likely to smoke compared to those with no CKD. Individuals with unrecognized CKD were also more likely to be overweight or obese, and present with heavy urine protein, hematuria, hypertension, and elevated random blood glucose.

When 753 participants with self-reported generic kidney problems and an eGFR <60 mL/min/1.73 m^2 were excluded, the prevalence of unrecognized CKD was 14.6% (95% CI 13.7-15.7).

2.5 Discussion

In this national targeted screening program of over 6000 Canadians, we found that the majority of participants reported at least one risk factor for CKD. The prevalence of unrecognized CKD in this targeted screening program (18.8%) was higher than previously published population-based estimates (7%) [4,5], demonstrating that targeted screening is able to detect a higher proportion of patients with unrecognized CKD than population based screening. We also found that individual-targeted screening identified a higher proportion of unrecognized CKD (21.9%) than community-targeted screening (14.7%), which may inform future screening strategies aiming to capture the greatest proportion of unrecognized CKD.

Early recognition of CKD, as recommended by the KDIGO clinical practice guidelines [15], provides patients the opportunity for preventative interventions to reduce their risk of

cardiovascular events and slow the progression of CKD. [2,14] With that in mind, several countries have conducted population-based screening programs, such as the national kidney disease mass screening program in Japan[51], in an effort to increase early recognition of CKD and reduce the burden of end-stage renal disease (ESRD). However, population-based screening programs are not cost effective. [16] Targeted screening for CKD has shown promise. A recent systematic review found screening for CKD to be cost-effective among those at highest risk for CKD, namely patients with diabetes or hypertension.[25] Our study highlights the effectiveness of targeted screening for CKD on the basis of diabetes and hypertension, as these self-reported risk factors identified the highest proportion of unrecognized CKD within the SeeKD participant population.

The SeeKD targeted screening program is similar to the Kidney Early Evaluation Program (KEEP) in the United States, led by the National Kidney Foundation. Although both programs recruit individuals based on their risk factors for CKD, the KEEP concentrates their efforts on African-American populations, while the SeeKD considered other ethnic groups (Aboriginal, Hispanic, South Asian, Asian, and African) as being a risk factor for CKD[61]. Targeting individuals from high-risk ethnic groups is not uncommon given the disproportionate burden of ESRD among different ethnic groups, and such screening programs have been established in Australia [93] and Canada [94]. Further, the KEEP used a limited number of risk factors (personal history of diabetes or hypertension, or a family history of diabetes, hypertension or CKD) [49,50,61] compared to the SeeKD program (diabetes, hypertension, existing kidney problems, family history of kidney disease, member of high risk ethnic population, current vascular disease or currently using tobacco products). The use of characteristics such as smoking and a broad definition of cardiovascular disease as risk factors for CKD may have included individuals with lower CKD risk. This may explain the lower prevalence of

unrecognized CKD within the SeeKD program (18.8%) as compared to the KEEP (28.7%), or it may relate to differences in the ethnicity of the groups screened. This is highlighted by a higher proportion of participants with diabetes (25% vs. 22.4%), hypertension (52.8% vs. 38.5%) and family history of kidney disease (24% vs. 12.8%) within the KEEP compared to the SeeKD program.

Both the KEEP and SeeKD programs identified a higher proportion of unrecognized CKD than population based programs in the United States [49] and Canada[4], where prevalence rates of 13% and 7% respectively have been reported. When we excluded participants with self-reported kidney problems and an eGFR <60 mL/min/1.73 m^2, the prevalence of unrecognized CKD in the SeeKD program was 14.6%. As targeted screening aims to include all individuals at risk for CKD, and given the lack of detail available to determine the underlying kidney problems, the SeeKD program included participants with self-reported kidney problems. Importantly we also found that individual-targeted screening, which included pre-selecting individuals with risk factors for CKD and often signing them up for the screening events in advance, identified an even higher proportion of patients with unrecognized CKD. Features of these screening strategies may be incorporated into future screening activities to increase the proportion of patients with unrecognized CKD.

Our results suggest that the SeeKD targeted screening program was successful in identifying a high proportion of individuals with risk factors and subsequently those with unrecognized CKD, therefore demonstrating potential as an effective method for early recognition of CKD. In fact, the majority of individuals with unrecognized CKD had category 3a CKD, emphasizing that targeted screening provides an important opportunity for early intervention to slow the progression of CKD. While these results demonstrate the feasibility of

targeted screening for CKD, they also reveal the complexities of conducting targeted screening. The optimal strategies for targeted screening, including individual-targeted vs. community-targeted, remain unknown due to the current paucity of evidence[14,23]. Further research is required to determine the key components of a successful targeted screening program for CKD.

The SeeKD targeted screening program should be interpreted in light of its limitations. Firstly, there may be volunteer bias as participants self-selected to participate and therefore may be systematically different from those who do not participate.[95] This is evident by the SeeKD participant characteristics, where the majority of participants were older females who indicated that they participated due to a personal concern for their health, which may limit the generalizability of the study results. Further, there is potential misclassification of CKD as participants were considered to have unrecognized CKD on the basis of a single creatinine measurement and eGFR <60 mL/min/1.73m^2.

2.6 Conclusion

The SeeKD screening program is the first national targeted screening initiative undertaken in Canada, was able to identify a high proportion of participants at risk of CKD and a greater proportion of participants with unrecognized CKD, as compared to population-based estimates. These results highlight the importance of targeted screening for CKD, and demonstrate differences between two broad strategies for targeted screening (individual-targeted vs. community-targeted screening) for CKD in Canada. Future research will evaluate the effectiveness of individual goal setting and counselling held at the SeeKD targeted screening events for eliciting a health behaviour change amongst participants.

ACKNOWLEDGEMENTS

The authors thank the many Kidney Foundation of Canada staff, volunteers, nurses and pharmacists who helped make the SeeKD program possible.

Contributions:

LB has made substantial contributions to the qualitative data collection and data summary; LG conducted data cleaning and analysis; LG, LB, PR, and BH have made substantial contributions to interpretation of results; all authors have been involved in drafting the manuscript or revising it critically for important intellectual content; all authors agree to be accountable for all aspects of the work in ensuring that questions related to the accuracy or integrity of any part of the work are appropriately investigated and resolved.

Support and Financial Disclosure Declaration:

Support: The See Kidney Disease targeted screening program was supported by the Kidney Foundation of Canada through a partnership with Canadian National Railway. The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. LG is supported by a strategic training in health research award from Knowledge Translation Canada, MJ is supported by postdoctoral fellowships from the Canadian Institutes of Health Research (CIHR), Albertan Innovates Health Solutions (AIHS) and an early career fellowship from the National Health and Medical Research Council of Australia (NHMRC), BM is supported by the Svare Professorship in Health Economics and BH is supported by the Roy and Vi Baay Chair in Kidney Research.

Financial Disclosure: The authors declare that they have no competing interests.

Table 2.1 Description of individual-targeted screening events, by Kidney Foundation of Canada branch

	BC	Southern Alberta	Northern Alberta	Ontario
Who was targeted?	First Nations South Asian / Asian Seniors Work Safe BC for those at-risk	Chinese	Seniors	Chinese African
How were events advertised?	Self-advertised by the venue, but if enough people did not sign up the event was advertised externally	Through local community center, using their radio and print media	Advertised in the program section of senior's residence	Advertised in the community, promoted by community partners in their newsletters, word of mouth
Where were the events held?	Community centers Friendship centers Religious centers	Community center	Senior's residence	Community center or church
Screening criteria	Only those at-risk	Anyone in targeted ethnic group	Any senior (as all considered at-risk)	Anyone in targeted ethnic group
Drop in or sign up?	Only sign up	Sign up or drop in	Sign up, but drop in allowed if space allowed	Drop-in
What unpaid resources were required for the events?	1 pharmacist, provided by Superstore. Translators as needed from community center	1 pharmacist provided by Loblaws Translators from community center	Kidney Foundation volunteers to hand out information	Volunteers to help set up the tables and work the room
What paid resources were required for the events?	1 nurse for testing 2 nurses to discuss results with the patient 1 KFOC* staff	1 to 3 nurses 1 to 2 KFOC staff	1 nurse 1 KFOC staff	2 to 3 nurses, who speak the dialect and/or represent the community 1 to 2 KFOC staff
Other supplies needed for events	Expectation of food (at a minimum juice and raisins)			Expectation of full meal if staying for screening (e.g., after a church service) in some communities
Length of events	Either 1 full day or 1 half day	1 to 3 full days	1 full day	3 to 5 hours
How many screened per event	50 people per full day	20 people per day	25 to 35 people per day	50 to 60 people per event

* KFOC = Kidney Foundation of Canada

Table 2.2 Description of community-targeted screening events, by Kidney Foundation of Canada Branch

	Saskatchewan	Manitoba	Atlantic
Where were the events usually held?	Safeway, usually near senior's residence	Grocery stores or health centre buildings	Communities at large that do not have a lot of health care access / opportunity
How were events advertised?	Never advertised; when the screening event was set up Safeway would announce over the loudspeaker the availability to be tested.	Social media. Venue may put up posters. Sometimes a media release if it coincided with Diabetes Month or Kidney Month.	In each community health professionals were asked to do on the ground advertising. Radio stations and newspapers would run ads for free as well.
Drop in or sign up?	Drop in	Drop in	Drop in
What unpaid resources were required for the events?	1 pharmacist, provided by Safeway	1 to 2 pharmacists	
What paid resources were required for the events?	1 nurse 1 KFOC* staff	1 to 2 nurses 1 KFOC staff	1 nurse 1 KFOC staff
Other supplies needed for events	None	None	None
Length of events	1 day, 5 to 6 hours	1 day, 4 hours	1 day, 8 hours
How many screened per event	10 to 20 people	20 to 30 people	30 to 35 people

* KFOC = Kidney Foundation of Canada

Table 2.3 Participant characteristics overall and by screening strategy

	All participants	**Individual-targeted events**	**Community-targeted events**
	N=6,329	N=3,623	N=2,706
Gender, male, n (%)	2,197 (34.7)	1,234 (34.1)	963 (35.6)
Age (years), mean (SD)	58.5 (15.9)	60.5 (14.6)	55.9 (17.2)
Motivation for participating, n (%)			
Concern for personal health status	3,170 (50.1)	1,983 (54.7)	1,187 (43.9)
Influence from external source	1,425 (22.5)	776 (21.4)	649 (24.0)
Recruitment efforts	1,623 (25.6)	504 (13.9)	1,119 (41.4)
None	1,026 (16.2)	745 (20.6)	281 (10.4)
Self-reported risk factors for CKD, n (%)			
At least one risk factor	5,627 (88.9)	3,346 (92.4)	2,281 (84.3)
No risk factors	702 (11.1)	277 (7.7)	425 (15.7)
Self-reported risk factors, n (%)			
Diagnosed diabetes	1,416 (22.4)	704 (19.4)	712 (26.3)
Diagnosed hypertension	2,439 (38.5)	1,336 (36.9)	1,103 (40.8)
Problems with kidneys	753 (11.9)	464 (12.8)	289 (10.7)
High-risk ethnic groups	3,735 (59.0)	2,565 (70.8)	1,170 (43.2)
Vascular disease	1,217 (19.2)	677 (18.7)	540 (19.9)
Family history of kidney problems	811 (12.8)	401 (11.1)	410 (15.2)
Smoking or tobacco use	1,003 (15.9)	256 (7.1)	747 (27.6)
Health knowledge: recognition of risk factors for CKD, n (%)			
Yes	5,375 (84.9)	2,946 (81.3)	2,429 (89.8)
No	954 (15.1)	677 (18.7)	277 (10.2)

* Participants available

Abbreviations: SD = standard deviation; CKD = chronic kidney disease

Table 2.4 Prevalence of unrecognized CKD overall and by screening strategy

	All participants	Individual-targeted events	Community-targeted events
	N=5,144*	N=2,968	N=2,176
eGFR (mL/min/1.73 m^2), mean (SD)	81.4 (22.8)	78.9 (22.2)	84.9 (23.2)
CKD (eGFR <60 mL/min/1.73 m^2), n (%; 95% CI)	969 (18.8; 17.8-19.9)	650 (21.9; 20.5-23.4)	319 (14.7; 13.2-16.2)
CKD Categories, n (%; 95% CI)			
Category 1 (eGFR ≥ 90 mL/min/1.73m^2)	1,918 (37.3; 36.0-38.6)	960 (32.3; 30.7-34.1)	958 (44.0; 42.0-46.1)
Category 2 (eGFR 60-89 mL/min/1.73m^2)	2,257 (43.9; 42.5-45.2)	1,358 (45.8; 44.0-47.6)	899 (41.3; 39.3-43.4)
Category 3a (eGFR 45-59 mL/min/1.73m^2)	708 (13.8; 12.9-14.7)	489 (16.5; 15.2-17.9)	219 (10.1; 8.9-11.4)
Category 3b (eGFR 30-44 mL/min/1.73m^2)	212 (4.1; 3.6-4.7)	141 (4.8; 4.0-5.6)	71 (3.3; 2.6-4.1)
Category 4 (eGFR 15-29 mL/min/1.73m^2)	43 (0.8; 0.6-1.1)	19 (0.6; 0.4-1.0)	24 (1.1; 0.74-1.6)
Category 5 (eGFR < 15 mL/min/1.73m^2)	6 (0.1; 0.06-0.26)	1 (0.03; 0.0-0.2)	5 (0.2; 0.1-0.5)
Prevalence of CKD (eGFR <60 mL/min/1.73 m^2) for subgroups of patients with specific risk factors, n (%; 95% CI)			
Diabetes or hypertension	670 (13.0; 12.1-14.0)	431 (14.5; 11.2-17.8)	239 (10.9; 9.7-12.4)
Diabetes, hypertension or vascular disease	739 (14.4; 13.4-15.4)	480 (16.2; 12.9-19.5)	259 (11.9; 10.6-13.3)
Diabetes, hypertension cardiovascular disease or family history	773 (15.0; 14.1-16.0)	503 (16.9; 13.6-17.2)	270 (12.4; 11.1-13.9)
Diabetes, hypertension cardiovascular disease, family history or member of high-risk ethnic population	920 (17.9; 16.9-18.9)	619 (20.9; 17.7-24.1)	301 (13.8; 12.4-15.4)

*Participants with at least one risk factor for CKD and screened for CKD who had complete data on risk factors, creatinine measure, age, and sex.
Abbreviations: SD = standard deviation; eGFR = estimated glomerular filtration rate; CKD = chronic kidney disease

Table 2.5 Characteristics of participants with unrecognized CKD compared to those without CKD

	CKD (N=969)	**No CKD** (N=4,175)	**p-value**
Gender, male, n (%)	279 (28.8)	2,178 (52.2)	*<0.001*
Age (years), mean (SD)	69.9 (12.0)	55.9 (15.7)	*<0.001*
Self-reported risk factors, n (%)			
Diagnosed diabetes	299 (30.9)	1,066 (25.5)	*0.001*
Diagnosed hypertension	590 (60.9)	1,709 (40.9)	*<0.001*
Problems with kidneys	253 (26.1)	458 (11.0)	*<0.001*
High-risk ethnic population	528 (54.5)	2,824 (67.6)	*<0.001*
Vascular disease	317 (32.7)	821 (19.7)	*<0.001*
Family history of kidney problems	138 (14.2)	639 (15.3)	*0.41*
Smoking or tobacco use	154 (15.9)	798 (19.1)	*<0.05*
Body Mass Index, n (%)			*<0.01*
Underweight (<18.5 kg/m^2)	10 (1.1)	71 (1.8)	
Normal (18.5 – 24.9 kg/m^2)	246 (26.3)	1,213 (30.5)	
Overweight (25.0 – 29.9 kg/m^2)	327 (34.9)	1,317 (33.1)	
Obese (≥30.0 kg/m^2)	353 (37.7)	1,373 (34.6)	
Proteinuria, n (%)			*<0.001*
Normal (negative)	576 (65.7)	2,635 (76.2)	
Mild (trace and 1+)	255 (29.1)	756 (21.9)	
Heavy (2+, 3+, 4+)	46 (5.3)	67 (1.9)	
Hematuria (trace, 1-4+), n (%)	190 (21.8)	609 (17.6)	*<0.01*
Hypertension**, n (%)	507 (52.3)	1,932 (46.9)	*<0.01*
Blood Pressure, mean (SD)			
Systolic Blood Pressure	136.3 (20.5)	131.9 (19.7)	*<0.001*
Diastolic Blood Pressure	77.7 (11.6)	80.3 (11.3)	*<0.001*
Sent to Physician Immediately, n (%)	28 (3.0)	105 (2.7)	*0.56*
Check Blood Glucose	6 (0.7)	44 (1.1)	*0.21*
Check Blood Pressure	10 (1.1)	51 (1.3)	*0.62*
Check Urinalysis	7 (0.8)	46 (1.2)	*0.29*
Other	16 (1.7)	32 (0.8)	*0.01*

*Percentages may not sum to 100% as the denominator varied according to available data.
Abbreviations: SD = standard deviation
**Hypertension defined as a systolic blood pressure ≥140 mmHg or a diastolic blood pressure ≥90 mmHg in any participant without self-reported diabetes. In those with diabetes, hypertension was defined as a systolic blood pressure ≥130 mmHg or a diastolic blood pressure ≥80 mmHg.

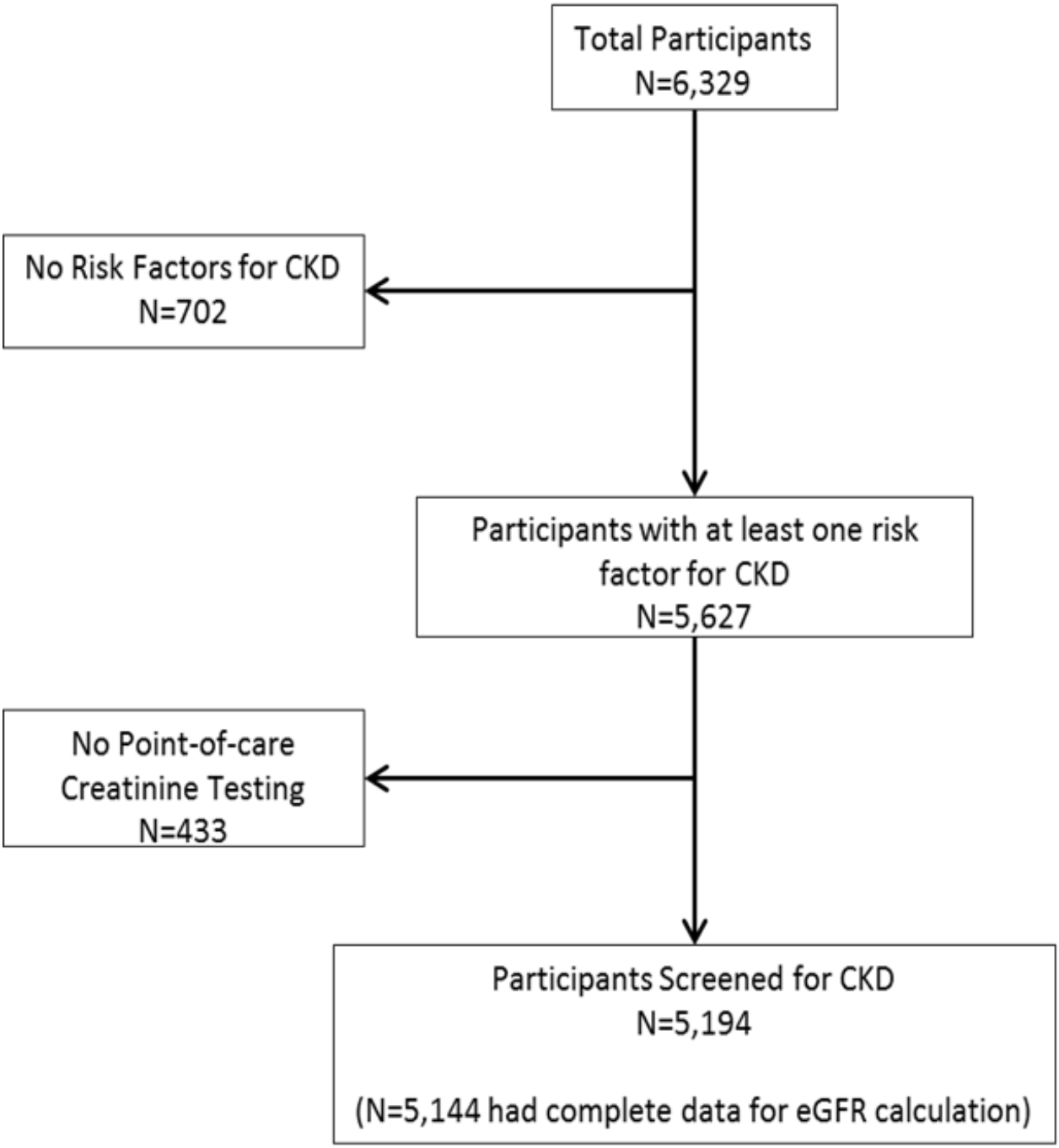

Figure 2.1 Participant flow chart

Appendix A: **STANDARDIZED THREE-STEP PROTOCOL**

Step 1: Identification of eligible participants	**Step 2 – People identified at risk for CKD**	**Step 3 –Follow-up**
1. Age 18 years or over 2. Completion of health data form to obtain: a. Demographic information (age and gender) b. Individual health history (self-reported diagnosis of diabetes, high blood pressure, problems with kidneys, member of high-risk population, have vascular disease, smoke or use tobacco products) c. Family health history (family member has been on dialysis or has kidney disease).	1. StatSensor Point-of-care testing was used to measure whole blood creatinine. (The StatSensor point-of-care testing device uses a drop of blood from the participant's finger, done by finger prick with a safety lancet)	1. Following the event (2 to 4 weeks later), all participants who consented to receiving a follow-up survey, received a post-SeeKD event survey by e-mail or by post. (This survey included questions regarding kidney health knowledge, anticipated and/or implemented lifestyle changes since the SeeKD event, follow-up visits to patients' family physician including recent diagnoses and medication changes.)
3. Clinical measurements obtained (weight, height, BMI, waist circumference, blood pressure, random blood glucose)	2. Urinalysis: Participants were given a urine collection container and asked to collect mid-stream urine. (The health care professional took the urine collection and used urine dipsticks to detect the presence of blood or protein in the urine.)	
4. Results provided to participant and if out of range, with participant consent, were shared with the family physician. 5. If no evidence of risk for CKD, participant provided with information about kidney health and self-management approaches to prevent chronic disease	3. Participants provided results and if necessary, and with participant consent, the results were forwarded to the family physician. 4. Participants were provided with information about recommended lifestyle changes and advised to seek medical follow-up.	

Appendix B: **CONSIDERATIONS FOR SUCCESSFUL SCREENING EVENT AS IDENTIFIED BY THE KIDNEY FOUNDATION OF CANADA BRANCHES**

Considerations identified	**Impact**	**Specific to individual-targeted**	**Specific to community-targeted**
Very positive feedback from participants	Nurses/pharmacists noted "the ones that actually needed us, feels like we are saving them"	Yes	Yes
Amount of time participants spend with nurse or pharmacist	Participants wanted to discuss health issues beyond their risk for kidney disease	Yes	Yes
Unique opportunity for undivided attention with a health care professional	Take advantage of one-on-one time to educate participants on: • Kidney disease and its risk factors • Other barriers to care they may have • Kidney Foundation of Canada mission and activities	Yes	Yes
If targeting specific ethnicities	Essential to have all the necessary literature translated in the relevant language	Yes	Yes
Pre-existing strong relationship between the community and the Kidney Foundation of Canada	• Increase success rate and effectiveness of screening • Further strengthen the connection and enable future access	Yes	Yes
Conducting less structured recruiting	Difficult to attract people who may be at risk of CKD, while respecting their privacy in a public area	No	Yes
Holding a "meet and greet" the evening before	Effective way to gain trust within community	No	Yes
Participants from certain ethnic groups may be accompanied by large support networks	• Can limit the physical space available for screening • Prior registration for screening was key for preparation	Yes	No

CHAPTER THREE: THE ASSOCIATION BETWEEN INDIVIDUAL COUNSELLING AND HEALTH BEHAVIOUR CHANGE: THE SEE KIDNEY DISEASE (SEEKD) TARGETED SCREENING PROGRAM FOR CHRONIC KIDNEY DISEASE

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3.1 Abstract

Background: Health behaviour change is an important aspect of management for patients with chronic kidney disease (CKD). The optimal method to promote health behaviour change for self-management of CKD is unknown. The See Kidney Disease (SeeKD) targeted screening program screened Canadians at risk for CKD and promoted health behaviour change through individual counselling and goal-setting. We present the results of individual counselling sessions for eliciting behaviour change, and describe participant characteristics associated with behaviour change.

Methods: The SeeKD targeted screening program conducted screening events at sites across Canada to identify individuals with unrecognized CKD. An individual counselling session was provided to participants by allied health care professionals to promote health behaviour change. Health behaviour change was defined as a self-reported change in lifestyle, including dietary changes or medication adherence. A survey was mailed to all participants at risk of CKD within 2-4 weeks following the screening event to determine if behaviour changes had been initiated. Descriptive statistics were used to describe respondent characteristics and self-reported behaviour change following screening events. Results were stratified by the presence or absence of unrecognized CKD. Log binomial regression analysis was used to determine predictors of behaviour change.

Results: Of the 5,194 participants screened, the majority (84.6%) were sent a survey, with 26% responding. The majority (89.8%) of respondents reported making a health behaviour change after the screening event. Respondents who were overweight (body mass index [BMI] 25-29.9 kg/m^2) or obese (BMI $\geq$ 30.0 kg/m^2) were more likely to report a behaviour change (prevalence rate ratio; PRR: 0.66, 95% confidence interval; CI: 0.44-0.99 and PRR: 0.49, 95% CI: 0.30-0.80, respectively). Further, participants

with a prior intent to change their behaviour were more likely to make a behaviour change (PRR: 0.58, 95% CI: 0.35-0.96). Results did not vary by CKD status.

Conclusions: Individual counselling and goal setting provided at screening events may stimulate behaviour change amongst individuals at risk for CKD. However, further research is required to determine if this behaviour change is sustained, and the impact on CKD progression and outcomes.

3.2 Background

Chronic kidney disease (CKD) is associated with an increased risk for cardiovascular disease and concomitant chronic illness[7,8]. Progression to end-stage renal disease (ESRD) has traditionally been considered the most serious complication of CKD [15] given its association with high morbidity and mortality [96,97]. However, the majority of patients with CKD die prematurely from CKD-related complications before progressing to ESRD[9,10]. Consequently, compliance with chronic disease management, such as blood pressure control, [98,99] glycemic control, [100-102] and use of statins,[40] is critical to slowing the progression to ESRD, preventing vascular-related adverse outcomes and reducing the risk of premature mortality [14,15]. In addition to the use of medications, management of chronic medical conditions, including CKD, requires lifestyle (behaviour) changes. Consequently, promoting behaviour change, through improving patient motivation and health knowledge, has been identified as a key component of chronic disease management[103,104].

Michie et al. (2011) identified three core components to behaviour change: capability, motivation, and opportunity[75]. While educational interventions build capability for behaviour change[105-107], research suggests that health care professionals play an important role in providing motivation and opportunity for behaviour change[108]. Specifically, individual counselling has been identified as a potentially effective intervention to improve health behavior change within various chronic conditions (diabetes and hypertension)[109,110]. Although evidence is limited in CKD, behaviour change interventions have shown promise in reducing CKD-related symptoms and complications [86]. Given the heterogeneous interventions published and a paucity of evidence, the optimal method to elicit behaviour change within the CKD population remains unknown[79].

The Kidney Foundation of Canada launched the See Kidney Disease (SeeKD) targeted screening program for Canadians at risk of CKD to promote early detection of CKD and to improve health knowledge in CKD management through individual counselling and goal-setting provided at screening events. We sought to determine the effectiveness of the individual counselling sessions for eliciting behaviour change amongst participants and to describe the participant characteristics associated with self-reported behaviour change.

3.3 Methods

The Kidney Foundation of Canada conducted the SeeKD targeted screening program from 2011 to 2014, and recruited 6,329 individuals across nine Canadian provinces, of whom 5,194 were screened for CKD. Eligible participants were adults 18 years of age and older who provided informed consent. Details of the SeeKD program and methodology have previously been reported [111]. In brief, participants at screening events were surveyed to gather baseline sociodemographic characteristics, risk factors for CKD, knowledge of kidney disease, current health behaviours, and to determine those at risk of CKD. *At risk of CKD* was defined as having at least one of the following self-reported risk factors: diagnosed diabetes, diagnosed high blood pressure, existing kidney problems, family history of kidney disease, member of high risk ethnic population, current vascular disease and currently using tobacco products. Only participants determined to be at risk of CKD were screened, using point-of-care creatinine measurements. All surveys and educational documents were translated into the participant's language of preference by the Kidney Foundation of Canada.

Immediately following kidney-specific testing, an individual counselling and goal setting session was provided to each participant screened for CKD, with the goal

of promoting health behaviour change amongst participants. Each one-on-one counselling session lasted approximately 20 minutes and was delivered by a registered nurse, pharmacist or dietician specializing in kidney disease (Appendix D). Counselling sessions were tailored to the participants' needs on the basis of clinical measures taken during screening and participants' responses to the pre-screening survey. In the pre-screening survey participants answered questions about their health knowledge of CKD (e.g. "Which of the following are risk factors for kidney disease?"), their motivation to participate in the screening event (e.g. "What made you participate in the SeeKD screening event today?") and intent to change their health behaviours (e.g. "Are you planning to make any changes to improve your health?" and "If you could change a health behaviour which one or two would be most important?"). We categorized intent to change behaviour as: no intent to change any health behaviours, an expressed intent to change health behaviours, and preliminary health behaviour changes recently started.

Approximately 2-4 weeks after the SeeKD screening events a follow-up survey was mailed to participants who provided consent to be contacted. The post-screening survey sought to determine whether participants had begun to make health behaviour changes, as recommended through the individual counselling sessions. The primary outcome of "health behaviour change" was defined as a self-reported positive response to the post-screening question "Have you made any changes to improve your health in the past two weeks?" Participants could choose more than one response from a predetermined list of health behaviour changes, which were broadly categorized into dietary changes (e.g. reducing fat or salt intake, or adhering to Canada's Food Guide), improving adherence to recommendations and prescriptions from health care providers (e.g. taking medications as prescribed, monitoring blood pressure or sugars,

or routine visits to physician), reducing health-risk behaviours (e.g. quitting smoking or reducing alcohol intake), and daily lifestyle changes (increasing daily activity, reducing stress, or weight-loss). Responses from participants who chose "other" and indicated a specific health behaviour change were manually coded into the binary behavior change variable during data cleaning. The response of "no health behaviour change" was determined if the participant did not choose any of the suggested behaviour changes on the predetermined list, or if they selected other and indicated they had not made any behaviour changes following the SeeKD screening event.

3.3.1 Analysis

Descriptive statistics were used to characterize participants that responded to both the pre- and post-screening surveys. These characteristics include sociodemographics (age, sex), clinical characteristics (unrecognized CKD, body mass index (BMI), self-reported risk factors for CKD, self-reported motivation to participate in screening, health knowledge of risk factors for CKD, and self-reported behaviour change. Specifically, age was categorized as ≤49, 50-64, ≥65 years and BMI was categorized as: ≤24.9, 25-29.9, ≥30 kg/m^2. Motivation to participate was reported in four groups (no specified motivation, concerned for personal health status, influenced by external sources, and recruitment efforts), while self-reported health knowledge and behavior change were reported as dichotomous (Yes/No) variables. Participant characteristics were also compared among those that did and did not respond to the post survey to determine whether these groups differed systematically. Descriptive statistics were reported using numbers and proportions for categorical variables, and means with standard deviations (SD) for normally distributed continuous variables.

We fit multivariable log binomial regression models to determine the prevalence rate ratios (PRR) for characteristics associated with the primary outcome of health behaviour change. Given that the prevalence of self-reported health behaviour change was very high (89.8%), we modeled the outcome of *no behaviour change*. The interpretation of a negative outcome (no behaviour change) is difficult. For example, a PRR <1.0 translates to a participant being less likely to make no behaviour change (alternatively stated, more likely to make a behaviour change). Consequently, we interpret the PRR and 95% confidence intervals (CI) in terms of a positive self-reported health behaviour change in our results and discussion section.

We constructed models and tested variables for inclusion (using $p<0.05$) that had been identified a priori as being potentially associated with the outcome. These candidate predictors of behaviour change were considered on the basis of previous literature and clinical relevance. Variables that were independent predictors of behaviour change through bivariate analysis, along with age and sex, were then used to create a full model. Backward elimination was used to create the most parsimonious model. Model fit was assessed using the BIC (Bayesian information criterion), where the model with the lowest BIC is preferred.

Regression analysis using CKD status as a potential effect modifier was attempted but the model did not converge due to small sample size. Consequently a stratified analysis was conducted to determine if characteristics related to health behaviour change varied by the presence or absence of CKD. Specifically, we hypothesized that participants who were identified as having unrecognized CKD may be more likely to change their behaviour given their recent diagnosis at the screening event. Variables independently associated with the outcome of health behaviour change, determined through log binomial regression, were stratified between

unrecognized CKD (estimated glomerular filtration rate [eGFR] <60 mL/min/1.73 m^2) and those with normal kidney function (eGFR >60 mL/min/1.73 m^2). Results were compared using Pearson's chi-square tests for proportions, the Wilcoxon rank sum test for multi-level categorical variables, and t-tests for continuous variables. Finally, we conducted a sensitivity analysis excluding participants who self-reported having kidney problems among those with an eGFR <60 mL/min/1.73 m^2 to determine the potential influence on participant characteristics and whether those with a new diagnosis of CKD were more motivated to change their behaviour than those with more longstanding kidney disease.

The SeeKD targeted screening program obtained Research Ethics Board approval from Health Canada. Ethics approval for analysis was also obtained from the Conjoint Health Research Ethics Board at the University of Calgary. All statistical analyses were conducted using Stata, version 11.2 [92].

3.4 Results

Overall 5,194 participants of the SeeKD program were screened for CKD, of whom the majority (84.6%) consented to receiving a post-screening follow-up survey, and 26% responded (Figure 3.1). The majority of the 1,129 participants who responded were female (70.1%) with a mean age of 63.8 years, and were overweight or obese (33.3% and 27.9%, respectively) (Table 3.1). Approximately one in five (20.6%) respondents had unrecognized CKD, and the most common self-reported risk factors for CKD were hypertension (45.5%) and member of a high-risk ethnic population (45.1%). The majority of respondents were aware of at least one risk factor for CKD (health knowledge; 90.1%), and their predominant motivation for participating in the screening events was a personal concern for health status (54.7%).

When comparing individuals who responded to the post-screening survey to those who did not, we found that a higher proportion of respondents were female (70.1% vs. 65.6%), older (mean age 63.8 years vs. 56.5 years), and had a BMI in the normal or underweight category (BMI ≤ 24.9) (34.1% vs. 31.1%) (Appendix C). Further, more respondents self-reported hypertension (45.5% vs. 36.3%, respectively), although non-respondents were more likely to be members of high-risk ethnic groups. Finally, respondents were more likely to be aware of the risk factors for CKD (health knowledge) than non-respondents (90.1% vs. 87.7%, respectively).

The majority (89.8%) of participants self-reported a health behaviour change in the post-screening survey. Amongst those who reported making a health behaviour change, most people indicated making dietary changes (79.9%), improving their adherence to recommendations provided by their health care providers (65.7%), and making daily lifestyle changes (75.8%). A small proportion (6.4%) of respondents indicated quitting smoking, chewing tobacco or reducing alcohol intake as their health behaviour change (Table 3.2).

We identified four significant predictors of behaviour change (Figure 3.2). Individuals classified as overweight (BMI 25.0-29.9 kg/m^2) and obese (BMI ≥30 kg/m^2) were more likely to make a behaviour change (PRR: 0.66, 95% CI: 0.44-0.99 and PRR: 0.49, 95% CI: 0.30-0.80), as compared to those with a normal or underweight BMI (≤ 24.9 kg/m^2). Further, participants unaware of risk factors for CKD were less likely (PRR: 1.75, 95% CI: 1.07-2.87) to make a behaviour change. Conversely, respondents who reported no particular motivation to participate in the screening events were more likely (PRR: 0.44, 95% CI: 0.22-0.88) to make a behaviour change following the screening event. Finally, individuals who indicated intent to make health behaviour changes during the pre-screening survey were more

likely to self-report making a behaviour change (PRR: 0.58, 95% CI: 0.35-0.96), and those who said they had initiated preliminary behaviour changes were more likely to continue to make health behaviour changes (PRR: 0.45, 95% CI: 0.29-0.68).

Within our stratified analysis, the proportion of participants who self-reported a behaviour change was similar among those with and without unrecognized CKD for most patient characteristics (Figure 3.3). However, a significantly higher proportion of females with CKD (79% vs. 66%, respectively) and individuals over 65 years old with CKD (78% vs. 46%, respectively) self-reported behaviour change as compared to the non-CKD group. Finally, results were similar in a sensitivity analysis excluding the 156 participants who self-reported having kidney problems and had an eGFR <60 mL/min/1.73 m^2.

3.5 Discussion

In this national targeted screening program to identify patients with unrecognized CKD we found that individual counselling and goal setting was able to elicit a self-reported health behaviour change in the majority (89.8%) of respondents. Participants unaware of the risk factors for CKD (limited health knowledge) were less likely to make a health behaviour change. However, individuals who were clinically overweight or obese, those with no self-identified motivation to participate in the screening event, and those who indicated an intent to change their behaviour were more likely to report a health behaviour change. Results were similar for patients with and without CKD except for age and gender, where a higher proportion of women over 65 years of age with unrecognized CKD made a behaviour change as compared to their non-CKD counterparts.

Behaviour change interventions aim to promote healthy lifestyles and improve the uptake and optimal use of effective clinical services using a "coordinated set of activities designed to change specified behaviour patterns."[75] Unfortunately, a combination of paucity of evidence, heterogeneous interventions, and poor reporting[78] leads to difficulty ascertaining the effectiveness of behaviour change interventions within CKD populations[79]. Although multifaceted educational interventions used to support behaviour change [108] have been shown to be effective in lowering blood pressure, improving blood sugars and increasing health knowledge for various chronic conditions (diabetes and hypertension) [105], research to date has only shown effectiveness in improving knowledge [106] and prompting belief changes [107] within CKD. Given the difficulty in designing effective behaviour change interventions [75], recent evidence suggests that these interventions should be tailored to the individual and their disease trajectory [83,108]. In fact, an individualised nutritional counselling intervention reported significant reductions in self-reported symptoms and problems associated with kidney disease in a pre-dialysis CKD population, which shows promise for individual counselling in CKD [86]. Further research is required to understand the use of behaviour change interventions for patients with CKD. Our study highlights the use of individual counselling and goal setting to promote behaviour change following a targeted screening clinic.

Our results suggest that individual counselling and goal setting provided during targeted screening may be effective in eliciting behaviour change in certain groups of participants. We found that participants who were overweight or obese were more likely to change their behaviour, which could be attributed to a realization of poor health status at the screening event. In fact, recent evidence suggests goal setting is associated with weight reduction in patients with diabetes.[112] However, further

research is required to determine if these interventions result in sustained behaviour change long-term.

Overall, the SeeKD individual counselling and goal setting intervention provided knowledge and skills on risk factors for kidney disease and prevention strategies (capability), external factors to prompt behaviour (opportunity), as well as some motivation (habitual or emotional processes to direct behaviour) to participants; all which differentially affected participant groups. For example, participants with an intent to change likely required opportunity and additional motivation, while those who had begun preliminary changes were simply reinforced to continue their behaviour change, thus highlighting pre-existing motivation in both groups. This is consistent with Proshaska and DiClemente's model on the stages of behaviour change[113]. Participants with an intent to change are in the "preparation" stage, while those who had begun preliminary changes would be in the beginning of the "action" stage[113,114]. Further, participants with no health knowledge of CKD (unaware of risk factors) were less likely to make a behaviour change. While this group may have low health literacy, which is associated with poor health outcomes and poor use of health care services[115], we cannot overlook the potential confounding effect of socioeconomic status [116]. Unfortunately, this information was not collected at the screening events. Finally, participants with no self-identified motivation to participate may be generally unaware of their personal health status, but given the knowledge and skills, accompanied by externally-derived motivation, are able to leverage the opportunity to make a behaviour change. Our work suggests that future screening programs may consider using individual counselling as a component of a health behaviour change intervention, but perhaps a different intervention is necessary when targeting individuals with low health knowledge. In general, counselling sessions

should first identify the specific behaviour(s) for change and, using a behaviour framework[76], design an intervention focused on improving the uptake of knowledge and skills, and simultaneously increasing motivation and empowerment[77], in order to improve the extent of behaviour change and engage those less likely to change.

Consideration should be given to limitations of the SeeKD screening program when interpreting these results. As all participants screened for CKD were provided with the intervention (individual counselling sessions), and given the lack of a control group, we are unable to determine the true effectiveness of the behaviour change intervention. There may also be volunteer bias as participants self-selected to participate and may be systematically different from those who did not participate.[95] This is evident by the respondent characteristics, where the majority of participants were older females who participated due to a personal concern for their health. Finally follow-up bias is of concern as survey respondents differed from the original study population. These potential selection biases may limit generalizability of the study population to the Canadian population at risk for CKD. Social desirability bias, a type of reporting bias whereby participants have a tendency to present a favourable image of themselves (e.g. over-report behaviour change), is of particular concern given the high proportion of participants who self-reported a behaviour change (90%).

3.6 Conclusion

In this national survey of participants with risk factors for CKD we found the use of individual counselling and goal setting may be an effective intervention for stimulating behaviour change. This study highlights the importance of targeting specific groups with behaviour change interventions for optimal uptake. However, the current findings should be interpreted with caution given the study limitations.

Despite the high rate of reported behaviour change amongst participants, future research is required to determine the key components of individual counselling as a behaviour change intervention, particularly within CKD populations.

ACKNOWLEDGEMENTS

The authors thank the many Kidney Foundation of Canada staff, volunteers, nurses and pharmacists who helped make the SeeKD program possible.

Contributions: LG conducted data cleaning, analysis and drafting the manuscript. LG, PR, BH participated in interpretation of the results, and all authors were involved in critically revising the manuscript for important intellectual content. All authors agree to be accountable for the entirety of the work and ensuring that questions related to the integrity of any part of the work are appropriately investigated and resolved.

SUPPORT AND FINANCIAL DISCLOSURE DECLARATION:

Support: The See Kidney Disease targeted screening program was supported by the Kidney Foundation of Canada through a partnership with Canadian National Railway. The sponsors of the study had no role in study design, data collection, data analysis, data interpretation, or writing of the report. LG is supported by a strategic training in health research award from Knowledge Translation Canada, PR is supported by the Roy and Vi Baay Chair assistant professorship, SS is supported by a Canadian Institutes of Health Research operating grant, BM is supported by the Svare Professorship in Health Economics and BH is supported by the Roy and Vi Baay Chair in Kidney Research.

Financial Disclosure: The authors declare that they have no competing interests.

Table 3.1 Participant characteristics among respondents to post-screening survey.

	Respondents (N=1,129*)
Gender, male, n (%)	337 (29.9)
Age (years), mean (SD)	63.8 (14.3)
Age (years), n (%)	
≤ 49	183 (16.3)
50-64	345 (30.8)
≥65	594 (52.9)
CKD (eGFR <60 mL/min/1.73 m^2), n (%)	208 (20.6)
Self-reported behaviour change, n (%)	1,018 (90.2)
Motivation for participating, n (%)	
Concern for personal health status	618 (54.7)
Influence from external source	227 (20.1)
Recruitment efforts	361 (32.0)
None	110 (9.7)
Self-reported risk factors, n (%)	
Diagnosed diabetes	274 (24.3)
Diagnosed hypertension	524 (45.5)
Problems with kidneys	156 (13.8)
High-risk ethnic groups	509 (45.1)
Vascular disease	268 (23.7)
Family history of kidney problems	166 (14.7)
Smoking or tobacco use	128 (11.3)
Knowledge of risk factors for CKD, n (%)	
Yes	1,017 (90.1)
No	110 (9.7)
Body Mass Index, n (%)	
Normal/Underweight (≤ 24.9 kg/m^2)	385 (34.1)
Overweight (25.0 – 29.9 kg/m^2)	376 (33.3)
Obese (≥30.0 kg/m^2)	315 (27.9)

*Denominator varied for each variable depending on the number of participants with complete data available.
Abbreviations: SD = standard deviation; CKD = chronic kidney disease; eGFR=estimated glomerular filtration rate

Table 3.2 Proportion of respondents who self-reported a behaviour change, by category

Categories of behaviour change	**Respondents** (N=1,014)
Dietary, n (%)	810 (79.9)
Improving adherence, n (%)	666 (65.7)
Reducing risk-behaviours, n (%)	65 (6.4)
Daily lifestyle, n (%)	769 (75.8)

* proportions do not total to 100%, as respondents may chose more than one category

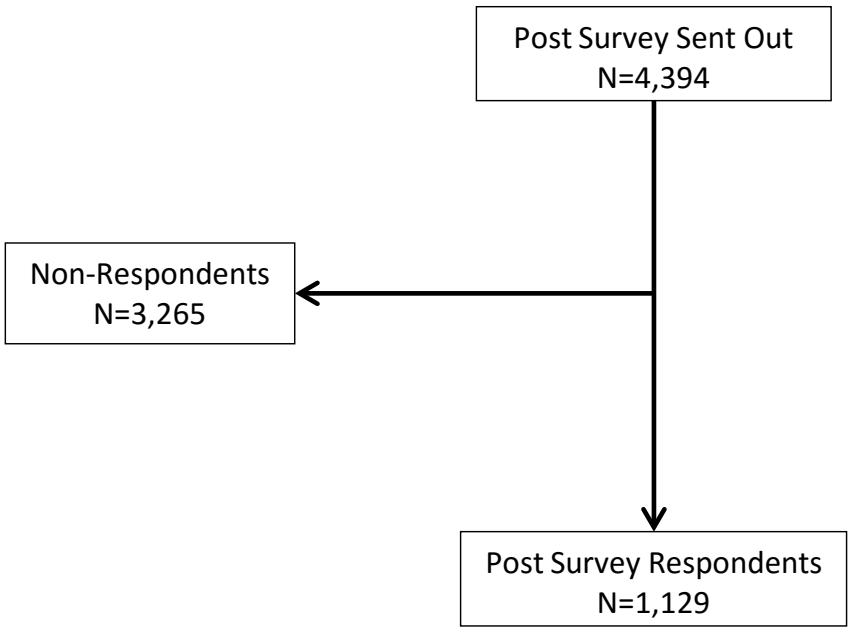

Figure 3.1 Participant flow chart

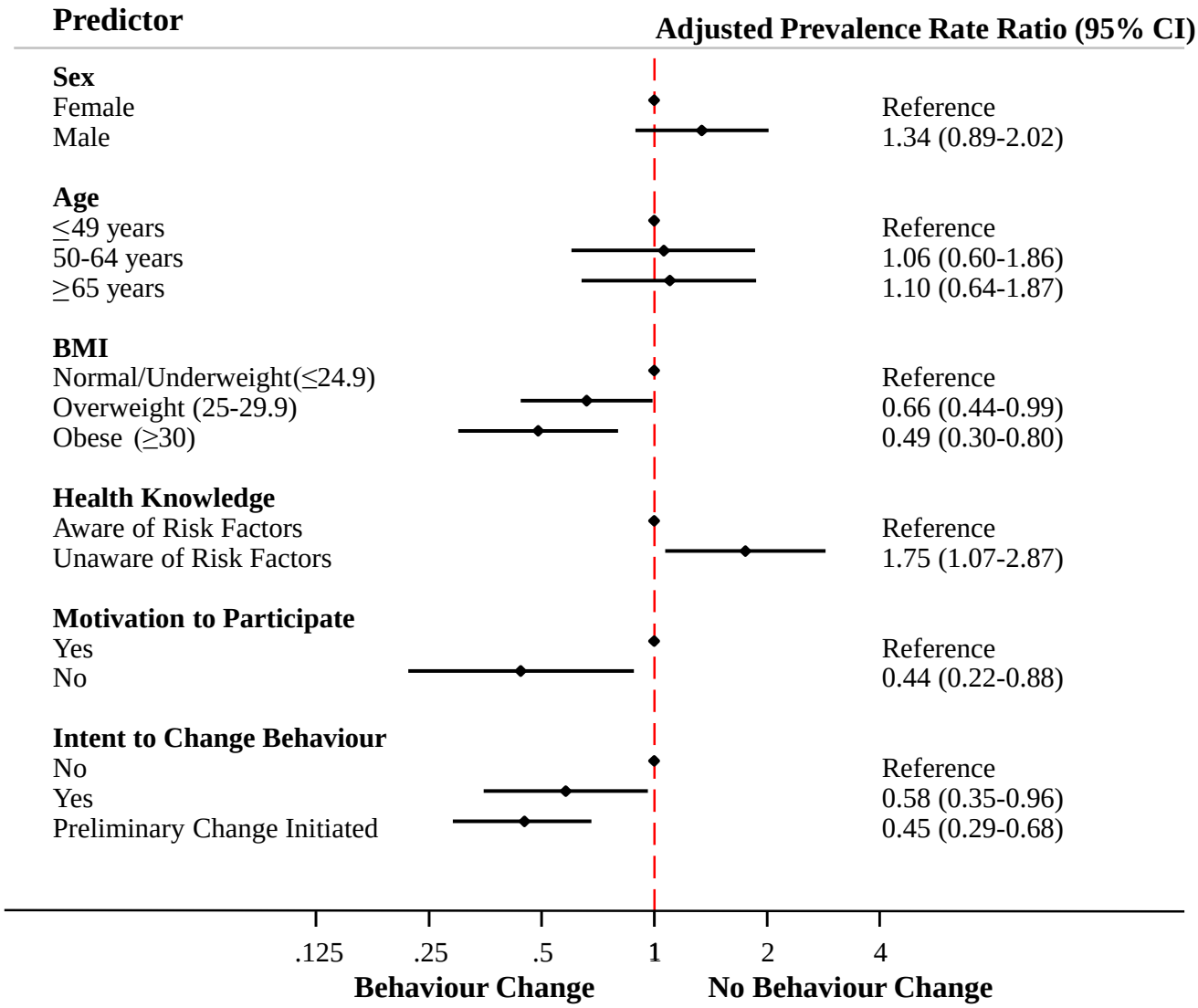

Figure 3.2 Adjusted prevalence rate ratio (PRR) for the association between participant characteristics and likelihood of behaviour change.

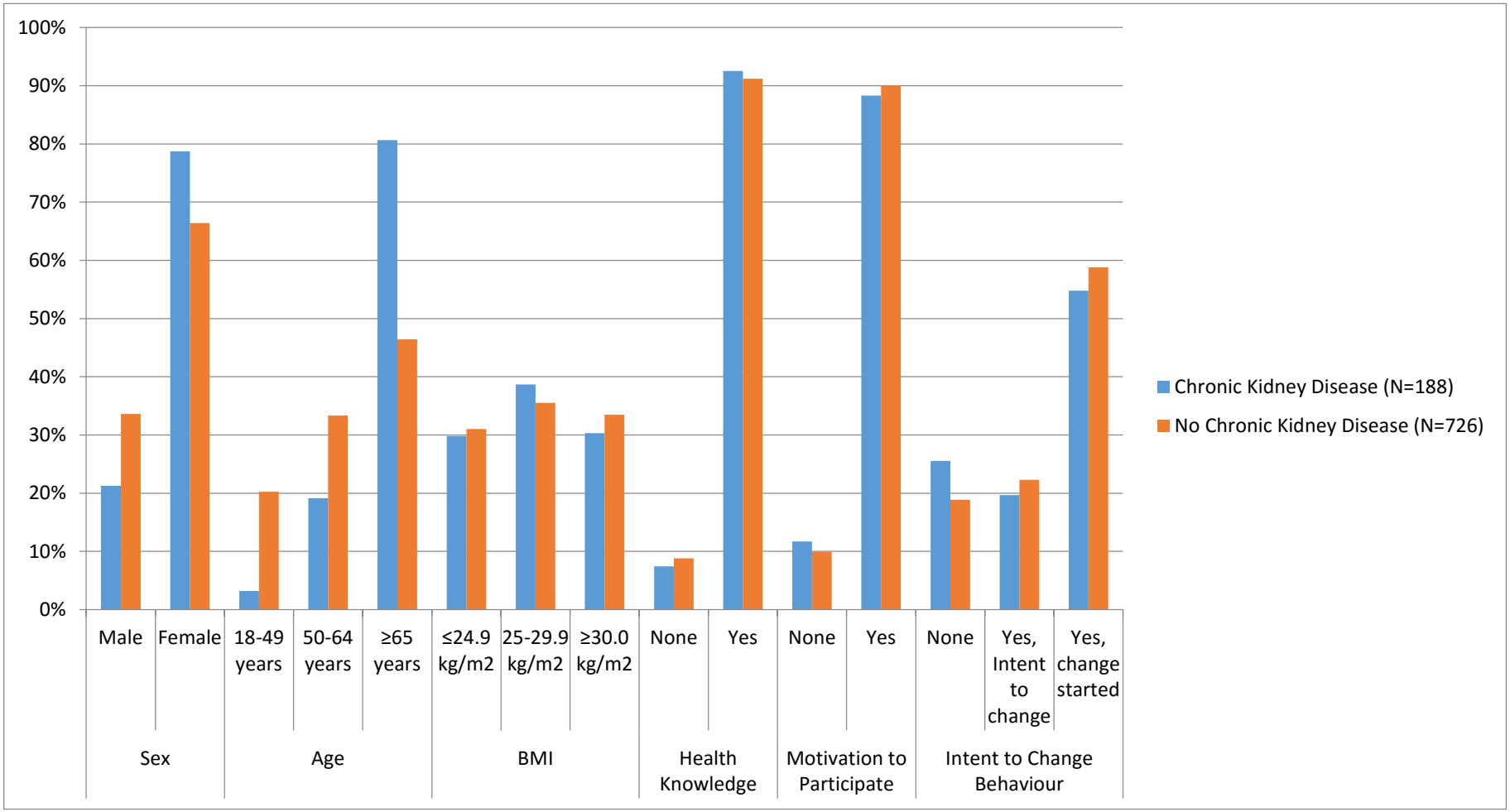

Figure 3.3 Proportion of participants who self-reported behaviour change by participant characteristics and CKD status.

CKD defined as eGFR <60 mL/min/1.73 m^2.

Appendix C: **COMPARISON OF RESPONDENTS TO NON-RESPONDENTS**

	Respondents (N=1,129*)	**Non-respondents** (N=3,265*)
Gender, male, n (%)	337 (29.9)	1,119 (34.4)
Age (years), mean (SD)	63.8 (14.3)	56.5 (15.4)
CKD (eGFR <60 mL/min/1.73 m^2), n (%)	208 (20.6)	509 (17.3)
Motivation for participating, n (%)		
Concern for personal health status	618 (54.7)	1,761 (53.9)
Influence from external source	227 (20.1)	803 (24.6)
Recruitment efforts	361 (32.0)	789 (24.2)
None	110 (9.7)	424 (13.0)
Self-reported risk factors, n (%)		
Diagnosed diabetes	274 (24.3)	693 (21.2)
Diagnosed hypertension	524 (45.5)	1,186 (36.3)
Problems with kidneys	156 (13.8)	422 (12.9)
High-risk ethnic groups	509 (45.1)	2,026 (62.1)
Vascular disease	268 (23.7)	614 (18.8)
Family history of kidney problems	166 (14.7)	454 (13.9)
Smoking or tobacco use	128 (11.3)	541 (16.6)
Knowledge of risk factors for CKD, n (%)		
Yes	1,017 (90.1)	2,862 (87.7)
No	110 (9.7)	403 (12.3)
Body Mass Index, n (%)		
Normal/Underweight (≤ 24.9 kg/m^2)	385 (34.1)	1,015 (31.1)
Overweight (25.0 – 29.9 kg/m^2)	376 (33.3)	1,057 (32.4)
Obese (≥30.0 kg/m^2)	315 (27.9)	1,070 (32.8)

*Denominator varied for each variable depending on the number of participants with complete data available.
Abbreviations: SD = standard deviation; CKD = chronic kidney disease

Appendix D: **BEHAVIOUR CHANGE INTERVENTION**

The behaviour change intervention, defined as an individual counselling and goal setting session conducted at each of the SeeKD screening events, followed the SeeKD protocol developed by the Kidney Foundation of Canada. The behaviour change intervention was carried out by a registered nurse, a pharmacist or a dietician with experience in CKD, who tailored recommendations and strategies for behaviour change to each participant based on their risk factors and clinical measurements documented on their health data form. These sessions were allotted 20 minutes for discussion of kidney disease and how the participant may reduce their risk of developing CKD and CKD-related complications. Each screening event included a private counselling area. Brochures on kidney disease, its risk factors and prevention, generated by the Kidney Foundation of Canada, as well as copies of the Canada Food Guide, and Canada Fitness Guide, were also provided to participants. These documents were translated into the participants' language of preference by the Kidney Foundation of Canada where possible.

CHAPTER FOUR: DISCUSSION

4.1 Summary of Research Findings

The findings generated from this thesis address a significant knowledge gap on early identification of CKD and provide evidence for the effectiveness of targeted screening programs for CKD. In our evaluation of the See Kidney Disease national targeted screening program, which included over 6000 Canadians, we showed that targeted screening strategies detected a prevalence of unrecognized CKD of 18.8%, higher than previously published population-based estimates of 7%.[4] Further, in a post-hoc analysis that categorized screening events into two broad strategies, individual-targeted and community-targeted, we found that individual-targeted screening identified a higher proportion of unrecognized CKD (21.9%) than community-targeted screening (14.7%).

Screening programs may include an educational or counselling component in an effort to promote health behaviours and disease management for participants at-risk or with a new diagnosis. The SeeKD program provided individual counselling and goal setting sessions to all participants screened for CKD. We found that this intervention was able to elicit a self-reported health behaviour change in the majority (89.8%) of respondents. Significant predictors of positive health behaviour change included clinical obesity, no self-identified motivation to participate in screening, a prior intent to change one's behaviour and preliminary initiation of a behaviour change. In contrast, only respondents who had no health knowledge of risk factors for CKD were less likely to make a behaviour change.

4.2 Results of the SeeKD Program within the Context of Existing Literature

4.2.1 Targeted Screening

Clinical practice guidelines recommend early recognition of CKD along with preventative treatments as critical factors in the public health effort to reduce the burden of CKD [1,15,23,24]. However, paucity of evidence makes it difficult to develop a recommendation statement on the best methods for early identification of CKD [16,23,117], resulting in a need to prioritize research on systematic screening strategies for this disease[118]. Given the significant burden of CKD on patients and healthcare systems alike, several countries have forgone waiting for systematic evidence and guideline recommendations to implement screening programs. For example, Japan implemented a national kidney disease mass screening program [51]. While this population-based strategy identified a high proportion of participants with asymptomatic proteinuria[55], the cost associated with this program was high. Additional research has found that population-based screening programs are not cost effective.[16,25,64] Targeted (selective) screening for CKD has shown promise. A systematic review found screening for CKD to be cost-effective among those at highest risk for CKD, namely patients with diabetes or hypertension.[25] Targeted screening is defined as selective identification of individuals with an increased risk of CKD. But, it can also focus on whole populations at risk of CKD as well (a.k.a. community-based screening), such as Aboriginal communities in Canada[94] and Australia[93]. Targeted screening of individuals at risk of CKD has seen success in the United States with the Kidney Early Evaluation Program (KEEP)[61], and preliminary success in the current evaluation of the SeeKD program.

In many ways the KEEP and the SeeKD program are similar; both were run by national governing bodies, both used standardized protocols and a targeted screening

strategy to identify CKD in the community. However, there are several differences, as discussed in Chapter 2. Predominantly, the KEEP found a higher prevalence of CKD as compared to the SeeKD program. This may be explained by the fact that the KEEP targeted African-American populations and considered fewer risk factors which have a stronger association with CKD in their inclusion criteria[49,50,61], while SeeKD permitted a broader definition of risk factors for CKD and targeted mostly Chinese and Aboriginal populations. Overall, the SeeKD program provides a Canadian perspective to the current landscape of targeted screening for CKD.

4.2.2 Behaviour Change Intervention

Following the early recognition of CKD, disease management and prevention strategies are a critical step in slowing the progression of disease and potentially mitigating future adverse health outcomes. To date, few screening programs for CKD have provided patients with disease management strategies [51,93,119] beyond basic educational materials (e.g. pamphlets on kidney disease, hypertension and diabetes) and encouraging the patient to follow-up with a healthcare practitioner[58,61]. Although multifaceted educational interventions used to support behaviour change [108] have been shown to be effective in lowering blood pressure, improving blood sugars and increasing health knowledge for various chronic conditions (diabetes and hypertension) [105], research to date has only shown these interventions to be effective in improving knowledge [106] and prompting belief changes [107] within CKD. Unfortunately, the paucity of evidence, heterogeneous interventions, and poor study reporting[78] have led to difficulty in ascertaining the effectiveness of behaviour change interventions within CKD populations[79]. Recent evidence suggests that tailoring these interventions to the individual and their disease may improve uptake[83,108], such as

individualized nutritional counselling which was successful in reducing self-reported symptoms and problems associated with CKD. We found that individual counselling and goal setting sessions provided through the SeeKD program were able to elicit self-reported behaviour change in a large proportion of participants, thus further supporting the use of tailored counselling as a potential component of effective behaviour change interventions.

4.3 Thesis Results

Identifying a high proportion of individuals with risk factors for CKD, and a high prevalence of unrecognized CKD shows promise for targeted screening of CKD. As this is the first program of its kind in Canada, a comparison can only be made to similar screening programs in other countries, such as the United States. While the KEEP and SeeKD programs (mentioned previously) have many similarities, there are some important differences in recruitment that affect the reported prevalence rates. Regardless, both the SeeKD and KEEP initiatives found a higher prevalence of CKD as compared to their population-based counterparts[4,49], where prevalence rates of 13% and 7% respectively have been reported. This provides evidence that targeted screening may be more effective in identifying patients with unrecognized CKD than population based screening. Even when participants with self-reported kidney problems and an eGFR <60 mL/min/1.73 m^2 were excluded from our analyses, the prevalence of unrecognized CKD remained slightly higher (14.6%) than population-based estimates. In a post-hoc analysis which categorized the targeted screening events into two broad screening strategies, we found that individual-targeted screening identified an even higher proportion of patients with unrecognized CKD (21.9%) as compared to community-targeted screening (14.7%). This finding may

inform the development of future screening strategies as it shows promise for determining the most efficient method of identifying unrecognized CKD.

The goal of screening for CKD is the recognition of early stages of disease, and implementation of proven therapies to ultimately delay disease progression. As the majority of individuals with unrecognized CKD had category 3a CKD, this emphasizes that screening could play an important role in early intervention for these patients. These results simultaneously highlight the feasibility and complexity of conducting targeted screening for CKD. As optimal strategies for early recognition remain unknown, determining the key components (e.g. which risk factors to target, how to recruit, etc.) of successful targeted screening for CKD are increasingly important given the current increasing incidence worldwide [1-3].

Our results suggest that individual counselling and goal setting sessions provided through the SeeKD program may contribute to behaviour change. This intervention appears to have promoted behaviour change amongst the majority of respondents, although lack of a control group limits the conclusions that can be drawn. Important predictors of positive behaviour change identified in this study include body mass index (overweight and obesity), health knowledge of risk factors and one's personal motivation regarding their health status (e.g. to participate in screening and their intent to change health behaviours).

4.4 Limitations

The study results should be interpreted in light of the limitations of the SeeKD screening program. With regards to selection bias, there may be volunteer bias as participants self-selected to participate, and self-selected to respond to the post-screening survey (also known as follow-up bias). Consequently the participant

population screened and the respondent population may each be systematically different from those who did not participate or respond to the screening surveys.[95] This is highlighted by both the SeeKD participant characteristics in the first manuscript (Table 2.2) and the respondent characteristics in the second manuscript (Appendix C); where both demonstrate that participants and respondents were more likely to be female, older, and concerned for their health. Volunteer bias could result in a lower prevalence of unrecognized CKD and a higher prevalence of behaviour change, as participants and respondents may be more likely to monitor their health status. Potential selection biases may limit generalizability of the study population to the Canadian population at risk for CKD.

Further, there may be misclassification bias in the form of social desirability bias, a type of reporting bias whereby participants have a tendency to present a favourable image of themselves (e.g. over-report behaviour change). This is of particular concern given the high proportion of participants who self-reported a behaviour change (90%). Moreover, although the post-screening survey allowed participants to self-report from a select list of different health behaviours they may have initiated, it did not offer a negative option (e.g. no behaviour change made). Consequently, respondents were required to leave the question blank or choose "other" and explicitly indicate no behaviour change, which likely contributed to an overestimation of the prevalence of behaviour change. Social desirability bias may also have occurred when collecting sociodemographic information (e.g. age, comorbidities, tobacco use). In the case of the SeeKD program, where only individuals with risk factors for CKD could participate and be screened for CKD, participants may have exaggerated their risk for CKD by over-reporting comorbidities and lifestyle factors. However, as the SeeKD program targeted communities and

individuals with risk factors for CKD, this bias is unlikely to have affected the results. In addition, as the measurement of urine protein was done solely by urine dipstick we could not quantify the amount of proteinuria a participant may have and therefore could not determine whether they had unrecognized CKD on the basis of proteinuria. This may have resulted in an underestimation of the prevalence of unrecognized CKD. Finally, there is potential misclassification of CKD as participants were considered to have unrecognized CKD on the basis of a single creatinine measurement and eGFR <60 mL/min/1.73m^2. The StatSensor point-of-care testing instrument has been suggested as an appropriate tool for screening of CKD[89,91] as it has good sensitivity (96%) and moderate specificity (79%) for detecting CKD[89-91]. However, as a result of the specificity, the StatSensor may produce a higher rate of false positives resulting in a higher than expected prevalence of unrecognized CKD. As screening programs are not intended to be diagnostic, but rather refer patients with positive findings to their physician for diagnosis and necessary treatment, this is not a large concern and would have minimal impact on the observed prevalence estimates obtained for unrecognized CKD.

4.4.1 Targeted Screening

The division of the SeeKD screening events into individual-targeted and community-targeted screening strategies was done in a post-hoc analysis. As this was not included in the a priori design of the SeeKD program, we increase the risk of making a type one error. However, it was pertinent to explore the two strategies of targeted screening in order to illustrate the variability of how the SeeKD screening events were conducted and to capture the commonalities. Further research is required

to explore the differences and complexities of differential methods for targeted screening.

4.4.2 Behaviour Change Intervention

The most important limitation of the behaviour change intervention is the lack of a control group for comparison, as all participants were provided with individual counselling and goal setting. Consequently, we were unable to conduct a comparative analysis of the intervention to usual care or an alternative intervention, resulting in difficulty to ascertain the effectiveness of the behaviour change intervention. Further, given the period between the intervention (individual counselling) and the follow-up survey to assess behaviour change was short (2-4 weeks), we cannot determine if the intervention truly resulted in health behaviour change among participants or whether the effect lasted beyond a couple of weeks. Future research should aim to conduct a randomized controlled trial with a long-term follow-up period to determine the effectiveness of individual counselling for promoting sustained health behaviour change.

4.5 Future Directions

The results of this work present important findings that contribute to the body of research on targeted screening and behaviour change interventions for CKD populations. However, given a lack of evidence in these areas, significant knowledge-gaps remain. Further research is necessary to make an informed decision on optimal methods for early recognition of CKD and effective chronic disease management programs. As previously discussed, targeted screening appears to be a more effective method of identifying unrecognized CKD in the community. However, cumulative

evidence is needed to inform who should be screened and how to do this exactly. Thus several questions remain, such as which risk factors are the most sensitive to identify high risk patients with CKD, how can we efficiently recruit individuals with these risk factors, and does individual counselling at screening events result in long term changes in behaviour. Given the interesting differences between individual-targeted and community-targeted screening events, it would be beneficial to conduct a community trial of screening strategies to determine whether these differences persist in a controlled setting.

With regards to behaviour change interventions, the current findings are preliminary and only begin to highlight potential effects of these interventions. Individual counselling shows promise for eliciting behaviour change, however further research is needed to understanding how individual counselling may play a role in sustained behaviour change. Details such as the duration of counselling sessions, or whether they should be tailored to the individual based on certain attributes or disease trajectory need to be explored. Given the absence of a control group in the SeeKD program, a randomized controlled trial, comparing a behaviour change intervention group (individual counselling in combination with other methods), a modified-intervention (individual counselling only), and a control group (no intervention or usual care), with a minimum follow-up of one year is required to determine the true effectiveness of individual counselling as a component of behaviour change interventions.

As the first national program of its kind in Canada, the SeeKD targeted screening program offers a novel contribution to the literature on screening for CKD. As knowledge translation is a critical component of research, this thesis work has followed the Knowledge-to-Action cycle[120]. The current research lies within the

knowledge creation funnel, and through the engagement of key stakeholders and decision-makers in Alberta and Canada, we will disseminate the key findings and implications of this work. In addition, the two manuscripts included in this thesis will be published in empirical journals in an effort to target the scientific community and contribute to the current literature on screening for CKD and behaviour change interventions. Once published, the final articles will be circulated within the supervisory committee, which includes decision-makers and key stakeholders, who may choose to distribute further to interested and appropriate networks. Reports will also be provided to the Kidney Foundation of Canada, including summary results in lay language, for the general population and those with CKD. To date, a knowledge synthesis (systematic review) has not been conducted on screening for CKD. Future research should aim to publish a review in this area in order to systematically determine what is known and where the gaps in the literature lie.

4.6 Conclusions

In conclusion, this body of research shows promise of targeted screening for identification of CKD through several key findings. First, targeted screening was able to identify a high proportion of individuals with risk factors for CKD, and a high prevalence of unrecognized CKD in a community setting. Second, individual counselling may be a key component of effective behaviour change interventions for eliciting lifestyle changes.

While there are limitations to this work, this research provides valuable and novel information on the effectiveness of targeted screening for CKD in the community setting. The SeeKD screening program is the first national screening program targeting individuals at risk for CKD within Canada. Therefore, these results

will provide the first Canada-wide data on targeted screening for CKD. In addition, the SeeKD dataset has not previously been analysed and published, as such, this research will report novel contributions to the knowledge-to-practice gap within CKD diagnosis and screening strategies in Canada, and are potentially applicable to health care systems around the world.

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