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CLINICAL RESEARCH

High Prevalence and Low Awareness of Albuminuria in the Community Setting in the KDSAP

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Introduction: Albuminuria is a sign of kidney disease and associated with adverse outcomes. However, most individuals with albuminuria are unaware of it. The Kidney Disease Screening and Awareness Program (KDSAP) aims for early detection and raising awareness of albuminuria, targeting underserved populations in communities. This study will assess the prevalence and awareness of albuminuria and identify associated risk factors among KDSAP participants.

Methods: KDSAP participants ≥18 years old without a history of dialysis or kidney transplant were included. Albuminuria was identified by dipstick urinalysis. Individuals with albuminuria who answered *yes* to either of the following 2 questions were defined as being aware: (i) Have you ever had protein in the urine? (ii) Do you have kidney disease?

Results: Among 2304 participants, 461 (20.0%) had albuminuria: 16.3% with trace or 1+ (low degree) and 3.7% with 2+ or more (high degree). Correlating factors of albuminuria included young age, male sex, African American descent, self-reported diabetes, hypertension, family history of kidney disease, and smoking. Overall albuminuria awareness was 15.8%, but awareness inversely correlated to younger age groups: 7.0% for ages 18–39 years, 13.5% for ages 40–59 years, and 24.0% for ages ≥60 years ($P < 0.001$). A high degree of albuminuria (vs. low, odds ratio: 5.04, $P < 0.001$) and concurrent hematuria (odds ratio: 2.12, P=0.024) were both associated with higher awareness; conversely, risk factors for low awareness included African American and better self-assessments of health.

Conclusions: There was a high albuminuria prevalence among KDSAP participants, yet low awareness. KDSAP can potentially be a useful model for detecting albuminuria and raising awareness in communities.

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Chronic kidney disease (CKD) is a public health issue in the United States. According to the National Health and Nutrition Examination Survey 2013–2016, the prevalence of CKD among adults in the general population is 14.8%, or 30 million people.[1] In 2016, CKD accounted for more than $79 billion in Medicare costs; combined with the cost of treatment for 700,000 individuals suffering from end-stage renal disease (ESRD), Medicare expenditures on kidney disease topped $114 billion, a staggering 23% of total Medicare spending.[1] As prevalence of CKD is projected to rise owing to increasing aging population, prevalence of diabetes, hypertension, and obesity,[2] slowing the progression of CKD and preventing ESRD have become a challenge. Despite CKD's pervasiveness, general awareness remains low. Only 10% of individuals in the United States with CKD, stages 1–4, were aware they had kidney disease.[1,3] Currently, there is a deficit of effective strategies for improving awareness of kidney disease.

Albuminuria is an indication of kidney disease and independently predicts adverse clinical outcomes,

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including CKD progression, ESRD, cardiovascular events, and all-cause mortality.[4-7] The prevalence of albuminuria, defined as a urine albumin-to-creatinine ratio of ≥30 mg/g, was found to be 10.1% among the general population in the United States and even higher among individuals with reduced kidney function.[1] Although 8.6% of individuals with an estimated glomerular filtration rate (eGFR) >60 ml/min per 1.73 m^2 had albuminuria, it was identified in approximately 75% of individuals with advanced CKD (eGFR <30 ml/min per 1.73 m^2).[1] However, the awareness of kidney disease among individuals with eGFR <60 ml/min per 1.73 m^2 was markedly higher if albuminuria was present.[1] Despite its significance, most individuals with albuminuria were unaware of the issue.[1] Studies show that healthy lifestyle choices, such as regular physical activity, eating healthy, and not smoking, are associated with lower incidence of albuminuria or kidney disease progression.[8,9] Additionally, angiotensin-blocking agents and controlling hyperglycemia and/or high blood pressure are important components for disease management.[10] Therefore, awareness of albuminuria can potentially help patients to engage in healthy lifestyle modifications and seek out early medication intervention. Concentrating efforts to expand albuminuria screening is a crucial step toward enhancing awareness of CKD and encouraging patients to pursue care.

The Kidney Disease Screening and Awareness Program (KDSAP) is an ongoing program run by college students, under the guidance of nephrologist faculty advisors. Since 2008, KDSAP has provided free screenings and education in communities across the country.[11] KDSAP aims for early detection and raising awareness of albuminuria in community settings, specifically underserved populations, who may experience language barriers and a lack of access to health care or health insurance. Using data collected through KDSAP, this study assessed the prevalence and awareness of albuminuria and identified associated risk factors among these unique populations in community settings.

METHODS

Study Design and Population

This cross-sectional study included participants in KDSAP screenings from October 2011 to May 2018 (n = 2443). Participants with age <18 years (n = 8), self-reported history of dialysis therapy (n = 1), kidney transplant (n = 2), and missing test results of albuminuria (n = 128) were excluded; there were 2304 remaining participants eligible for this study. The Committee on Human Research at Partners Healthcare approved the study protocol.

KDSAP has organized more than 100 screening events across the United States and Canada, mainly in underserved communities composed of various ethnic minority groups. Most of these events, more than 90%, were held in Massachusetts, New Jersey, Pennsylvania, New York, Michigan, California, and Ontario. KDSAP partners with volunteer physicians and community leaders to organize free screenings and health education on albuminuria and the risk factors of kidney disease. Partnering with local leaders improves community engagement by building on established relationships and trust. Health education lectures given by local physicians also help attract participants.[11]

Variables and Measurements

Data on demographics, comorbidities and risk factors, disease awareness, self-assessments of health, insurance coverage, volume and cost of prescribed medications, languages barriers, and impeded access to health care were obtained from the KDSAP questionnaire (Supplementary Item S1); participants completed the questionnaire during their KDSAP screening. The questionnaire was originally developed in English and subsequently translated into other languages, as approved by the Partners Healthcare Committee on Human Research. Bilingual college student volunteers and community collaborators assisted non–English-speaking participants with filling out the survey.

The screenings included a single random urine dipstick analysis to test for albuminuria and hematuria. Measuring albuminuria by dipstick urinalysis was semi-quantitative and performed using the Siemens Multistix 10 SG Reagent Strip and read by a Clinitek status analyzer (Siemens Healthcare Diagnostics, Deerfield, IL). Results from dipsticks were reported as negative, trace (15–30 mg/dl), 1+ (30–100 mg/dl), 2+ (100–300 mg/dl), or 3+ (300 mg/dl or higher).[12] Blood pressure was measured by a single automated reading using an aneroid sphygmomanometer as participants sat with their legs in an uncrossed position, following at least 5 minutes of rest. Participants' upper arm circumference determined the appropriate cuff size. Plasma glucose was checked by a OneTouch UltraMini meter and OneTouch Ultra Test Strips (LifeScan, Inc., Malvern, PA). Each device was calibrated on site before each screening. All KDSAP staff, largely college students, received training through workshops on screening modalities including measurements of blood pressure, plasma glucose, body mass index, and machine-run urine dipstick.

Definitions of Variables

A study showed that even small amount of albuminuria, less than 30 mg/d, was associated with CKD progression.[13] We, therefore, defined the results of trace or higher as positive albuminuria from urinary dipstick. We further categorized albuminuria of trace or 1+ as low degree and 2+ or more as high degree. Individuals with albuminuria who answered *yes* to either of the following 2 questions were defined as being aware: (i) Have you ever had protein in the urine? or (ii) Do you have kidney disease (do not include kidney stones, bladder infections, or incontinence)? A history of comorbidities or risk factors was defined by self-reported history of diabetes, hypertension, cardiovascular disease (including coronary artery disease, arrhythmia, heart failure, and stroke), hyperlipidemia, family history of kidney disease, and smoking status.

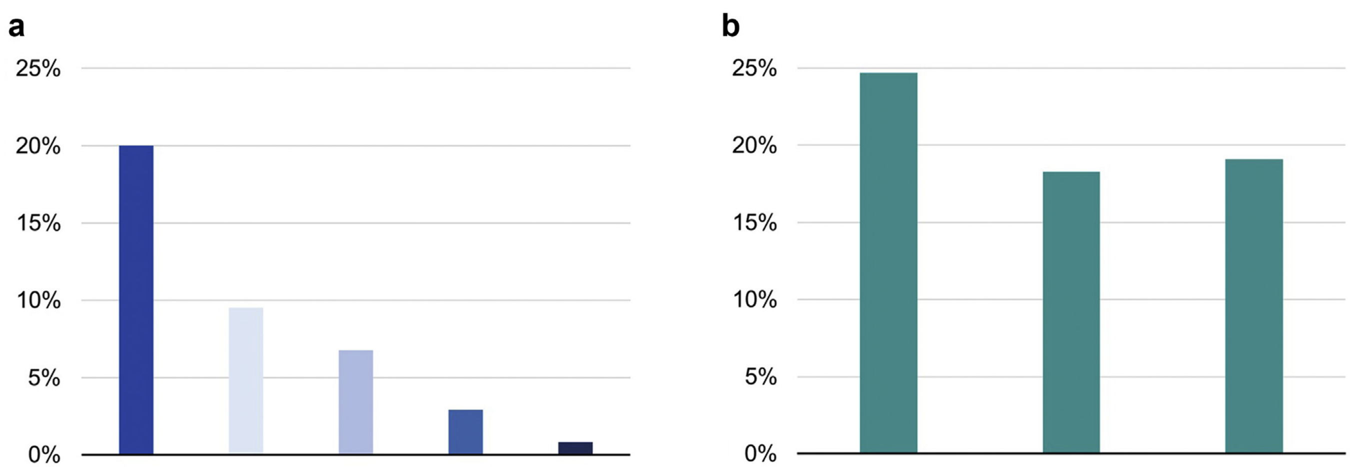
Statistical Analysis

Data were presented as mean $\pm$ SD for continuous variables and tested using Student *t* test. Categorical variables were presented as a number (percent) and tested by χ^2 tests. Tests were 2-tailed, with $P < 0.05$ considered significant. Logistic regression analysis was used to explore what factors were associated with awareness. A multivariable logistic regression model was constructed with the explanatory variables of race/ethnicity, self-reported history of diabetes, family history of kidney disease, self-assessments of health, dipstick hematuria, and degree of albuminuria. The variable selection was based on previously reported factors associated with awareness[3] and the software's backward stepwise selection method. Data were presented as odds ratio and 95% confidence intervals. Because missing data distribution were not uniform across measures, we performed complete-case analysis on a measure-to-measure basis to retain power. Based on the Little test,[14] we could not conclude that the data were missing completely at random ($\chi^2 = 9382.7$, degrees of freedom = 8369, $P < 0.001$). As data were not missing at random, we refrained from imputation or expectation maximization techniques to avoid further bias. Instead, we introduced a variable indicating missing data for every measure and conducted χ^2 tests between groups (Supplementary Table S1 with missing data analysis) to highlight distribution differences among missing data generally. Statistical analyses were performed with R, version 3.5.1, and SPSS, version 22.

RESULTS

High Prevalence of Albuminuria Among KDSAP Participants and the Associated Risk Factors

The overall prevalence of albuminuria among the 2304 eligible participants was 20.0% (461 individuals): 16.3% with trace or 1+ and 3.7% with 2+ or higher (Figure 1a). Our results further demonstrate that the highest prevalence was in the youngest age group, 24.7% in 18–39 years of age; the prevalence fell to 18.3% in ages 40–59 years and 19.1% in ages 60 years or older ($P = 0.01$) (Figure 1b). Although the mean age of the KDSAP population was 54.1 $\pm$ 17.3 years old, our results show that the population with albuminuria was younger than the nonalbuminuric population (52.5 vs. 54.5 years, $P < 0.05$). Our data also show that male sex, African American descent, and English-speaking all correlated to albuminuria. Among our cohort, data on insurance coverage, paying out-of-



Overall	Trace	1+	2+	3+
461 (20.0%)	219 (9.5%)	156 (6.8%)	67 (2.9%)	19 (0.8%)

18–39 years	40–59 years	≥60 years
125/506 (24.7%)	159/870 (18.3%)	177/928 (19.1%)

Figure 1. High prevalence of albuminuria among Kidney Disease Screening and Awareness Program (KDSAP) population and particularly in the youngest age group. (a) Among 2304 participants, 461 (20.0%) were found to have albuminuria: 219 (9.5%) with trace, 156 (6.8%) with 1+, 67 (2.9%) with 2+, and 19 (0.8%) with 3+. (b) The prevalence of albuminuria was highest in the youngest age group: 24.7% in 18–39 years old, 18.3% in 40–59 years old, and 19.1% in ≥60 years old, $P = 0.01$.

Table 1. Demographics of the study population and risk factors for presence of albuminuria

Variable	Total (N = 2304)	Albuminuric (n = 461, 20.0%)	Nonalbuminuric (n = 1843, 80.0%)	*P*[a]
Age, yr	54.1 ± 17.3	52.5 ± 18.4	54.5 ± 17.0	0.027
Male	958 (41.6)	231 (50.1)	727 (39.4)	<0.001
Race/ethnicity				<0.001
Asian	1241 (53.9)	164 (35.6)	1077 (58.4)	
African American	420 (18.2)	144 (31.2)	276 (15.0)	
Non–Hispanic white	319 (13.8)	79 (17.1)	240 (13.0)	
Hispanic	211 (9.2)	46 (10.0)	165 (9.0)	
Miscellaneous[b]	113 (4.9)	28 (6.1)	85 (4.6)	
English-speaking	1286 (55.8)	310 (67.2)	976 (53.0)	<0.001
Highest education				0.189
Primary or high school	727 (34.9)	137 (32.3)	590 (35.6)	
College or postgraduate	1355 (65.1)	287 (67.7)	1068 (64.4)	
Self-reported comorbidities/risk factors				
Diabetes	389 (18.9)	98 (23.6)	291 (17.7)	0.014
Hypertension	641 (31.1)	161 (38.2)	480 (29.3)	0.002
Hyperlipidemia	580 (13.8)	109 (26.5)	471 (29.1)	0.534
Cardiovascular disease	301 (15.5)	64 (16.2)	237 (15.3)	0.660
Family history of kidney disease	209 (13.6)	56 (18.5)	153 (12.4)	0.005
Current or prior smoker	498 (24.4)	121 (29.3)	377 (23.1)	0.016
At least 1 of above	1372 (59.5)	293 (63.6)	1079 (58.5)	0.050
Health insurance coverage				0.753
Yes	1609 (69.8)	332 (72.0)	1277 (69.3)	
No	362 (15.7)	78 (16.9)	284 (15.4)	
Missing	333 (14.5)	51 (11.1)	282 (15.3)	0.025
Medication insurance coverage				0.296
Yes	1536 (66.7)	311 (67.5)	1225 (66.5)	
No	404 (17.5)	92 (20.0)	312 (16.9)	
Missing	364 (15.8)	58 (12.6)	306 (16.6)	0.041
Number of prescribed medications				0.045
0–3	1574 (83.0)	310 (79.5)	1264 (83.9)	
≥4	322 (17.0)	80 (20.5)	242 (16.1)	
Monthly self-pay for medications				0.066
<$20	1236 (71.9)	243 (68.1)	933 (71.6)	
≥$20	484 (28.1)	114 (31.9)	370 (28.4)	
Self-assessment of health				0.659
Poor or fair	616 (29.5)	131 (30.7)	485 (29.2)	
Good	819 (39.2)	170 (39.8)	649 (39.1)	
Very good or excellent	653 (31.3)	126 (29.5)	527 (31.7)	
Last physician visit				0.535
≤1 year	1554 (76.7)	321 (78.5)	1233 (76.3)	
>1 year ago	472 (23.3)	88 (21.5)	384 (23.7)	
Difficulty obtaining care				0.214
Difficult	482 (24.6)	86 (21.6)	396 (25.3)	
Not difficult	1479 (75.4)	312 (78.4)	1167 (74.7)	

[a]*P* value between albuminuric and nonalbuminuric groups.
[b]Other, mixed race/ethnicity, or declining to answer.
Albuminuria was defined by trace or higher in dipstick urinalysis. Data are presented as mean ± SD for continuous variables and as number (percentage) for categorical variables. Missing data were similarly distributed between the nonalbuminuric and albuminuric groups, except health insurance coverage and prescribed medication coverage as listed above and in Supplementary Table S1. Missing data were excluded from percentage calculation.

pocket for medications, or access to health care were similar between the albuminuric and nonalbuminuric groups. However, the number of prescribed medications appeared to be an associated factor; the albuminuric group had a higher proportion with more than 4 prescribed medications. Furthermore, individuals who self-reported having diabetes, hypertension, or a family history of kidney disease or identified as smokers had a higher tendency to test positive for albuminuria (Table 1). We equally demonstrate that among the KDSAP participants, higher mean systolic and diastolic blood pressure (SBP and DBP) obtained during the screenings was linked to albuminuria. Additionally, body mass index was also significantly higher in the albuminuric group, but plasma glucose levels showed no difference between the albuminuric and nonalbuminuric groups (Figure 2).

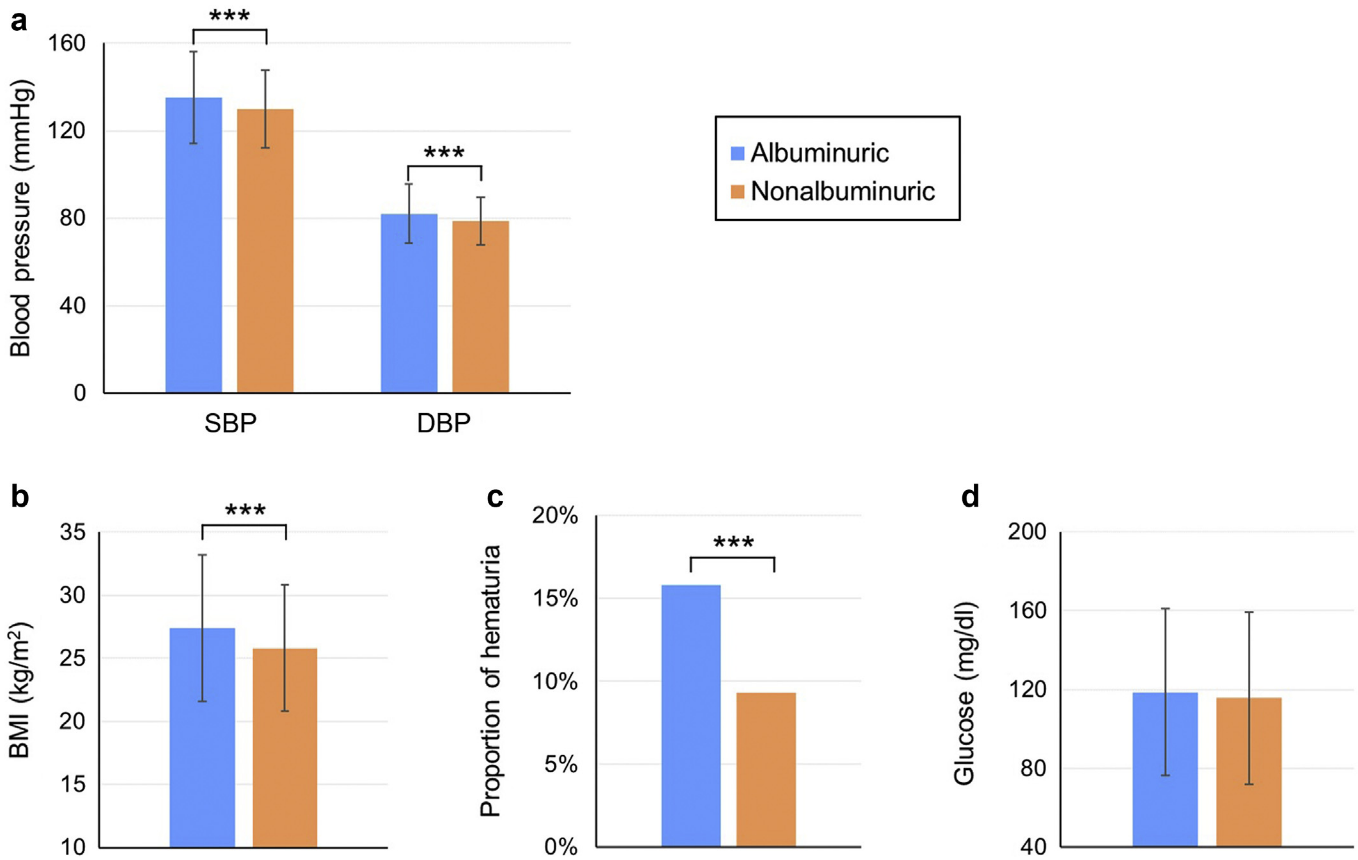


Figure 2. Higher blood pressure, body mass index (BMI), and proportion of hematuria were detected among the albuminuric group during the screenings. Results collected during the screenings showed that (a) mean systolic blood pressure (SBP; 135.2 $\pm$ 21.1 vs. 130.0 $\pm$ 17.8, $P < 0.001$), diastolic blood pressure (DBP; 82.1 $\pm$ 13.6 vs. 78.8 $\pm$ 10.9, $P<0.001$), (b) BMI (27.4 $\pm$ 5.8 vs. 25.8 $\pm$ 5.0, $P < 0.001$), and (c) proportion of hematuria by urine dipstick (15.8% vs. 9.3%, $P < 0.001$) were higher in the albuminuric group than in the nonalbuminuric group, whereas the (d) mean plasma glucose showed no significant difference (118.7 $\pm$ 42.5 vs. 115.6 $\pm$ 43.6, $P = 0.172$). ***$P < 0.001$.

Low Awareness of Albuminuria Among KDSAP Participants and the Associated Risk Factors

After excluding 38 participants with albuminuria, because of missing awareness data, our results show a low awareness of albuminuria overall, 15.8% (67 of 423); low awareness was particularly prominent among the younger age group (7.0% in the age group of 18–39 years, 13.5% in 40–59 years, and 24.0% in 60 years or older; $P < 0.001$) (Figure 3). Our results also reveal that low awareness was associated with the African American population, English speakers, better self-assessments of health, lower monthly out-of-pocket medication costs, and lower numbers of prescribed medications. Furthermore, higher awareness was identified among the populations with morbidities such as diabetes, hypertension, hyperlipidemia, cardiovascular disease, and family history of kidney disease (Table 2 and Supplementary Table S2); these conditions were validated through the results collected during screenings with higher SBP and plasma glucose levels. Our results also demonstrate that a high degree of albuminuria and concurrent presence of hematuria by urine dipstick were linked to higher levels of awareness (Table 2 and Supplementary Table S2). Using multivariable logistic regression analysis, we demonstrate that race/ethnicity, presence of hematuria, degree of albuminuria, family history of kidney disease, and self-assessments of health were the most relevant

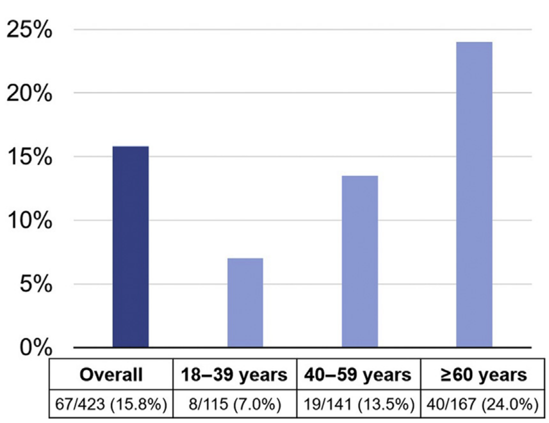


Figure 3. Low awareness among Kidney Disease Screening and Awareness Program (KDSAP) participants with albuminuria and particularly in the younger age groups. Overall, 67 of 423 (15.8%) individuals were aware of having albuminuria: 7.0% in 18–39 years old, 13.5% in 40–59 years old, and 24.0% in $\geq$60 years old; $P < 0.001$.

Table 2. Characteristics of albuminuric participants who were aware and unaware of having albuminuria

Variable	Unaware (n = 356, 84.2%)	Aware (n = 67, 15.8%)	*P*
Age, yr	51.1 ± 18.6	60.9 ± 16.0	<0.001
Male	184 (51.7)	33 (49.3)	0.816
Race/ethnicity			0.004
Asian	111 (31.2)	34 (50.7)	
African American	126 (35.4)	9 (13.4)	
Non–Hispanic white	66 (18.5)	12 (17.9)	
Hispanic	38 (10.7)	8 (11.9)	
Miscellaneous	15 (4.2)	4 (6.0)	
English-speaking	259 (72.8)	38 (56.7)	0.013
Highest education			0.809
Primary or high school	109 (31.4)	22 (33.8)	
College or Postgraduate	238 (68.6)	43 (66.2)	
Self-reported comorbidities/risk factors			
Diabetes	66 (19.2)	30 (47.6)	<0.001
Hypertension	113 (32.2)	43 (66.2)	<0.001
Hyperlipidemia	84 (24.6)	24 (37.5)	0.018
Cardiovascular disease	43 (13.0)	19 (31.1)	0.002
Family history of kidney disease	41 (16.1)	15 (30.6)	0.013
Current or prior smoker	99 (28.8)	19 (30.1)	0.647
Health insurance coverage	273 (81.2)	52 (80.0)	0.950
Medication insurance coverage	253 (76.4)	52 (81.2)	0.498
Number of prescribed medications			<0.001
0–3	268 (84.0)	36 (58.1)	
≥4	51 (16.0)	26 (41.9)	
Monthly self-pay for medications			0.030
<$20	208 (71.0)	31 (55.4)	
≥$20	85 (29.0)	25 (44.6)	
Self-assessment of health			<0.001
Poor or fair	92 (26.4)	35 (53.8)	
Good	146 (41.8)	19 (29.2)	
Very good or excellent	111 (31.8)	11 (16.9)	
Language barriers with physicians	41 (12.5)	17 (28.3)	0.002
Measurements			
Systolic blood pressure, mmHg	134.2 ± 21.2	143.2 ± 20.4	0.002
Diastolic blood pressure, mmHg	82.0 ± 14.0	83.0 ± 11.3	0.605
Body mass index	26.9 ± 5.9	27.4 ± 4.9	0.516
Plasma glucose, mg/dl	114.8 ± 36.8	137.5 ± 56.5	<0.001
Dipstick hematuria	126 (36.1)	45 (67.2)	<0.001
Albuminuria			<0.001
Trace	183 (51.4)	16 (23.9)	
1+	124 (34.8)	19 (28.4)	
2+	39 (11.0)	25 (37.3)	
3+	10 (2.8)	7 (10.4)	

Data were presented as mean ± SD for continuous variables and as number (percentage) for categorical variables. Missing data were excluded from percentage calculation.

factors relating to awareness. Compared with the African American population, non–Hispanic white and Asian populations in our cohort had a better awareness of albuminuria. Individuals without concurrent hematuria and family history of kidney disease, as well as individuals with low-degree albuminuria (trace or 1+), also had lower awareness. Furthermore, the data demonstrate that lower albuminuria awareness was associated with better self-assessments of health (Figure 4).

DISCUSSION

Albuminuria is the cardinal manifestation of CKD and an independent risk factor for adverse consequences.[4,7] Even small amounts of albuminuria are associated with CKD progression and all-cause mortality.[7,15] A meta-analysis of 21 studies, including 9 from North America, 6 from Europe, 5 from Asia, and 1 from Australia, showed that in a general population, individuals with an albumin-to-creatinine ratio greater than 10 mg/g and 30 mg/g had 20% and 63% increased risk for all-cause mortality, respectively, as compared to individuals with an albumin-to-creatinine ratio of 5 mg/g.[7] Similar findings were observed for cardiovascular mortality.[7] However, albuminuria is usually asymptomatic and must be detected by laboratory testing. The albumin-to-creatinine ratio is a more sensitive test for albuminuria, but dipstick urinalysis is widely used as an initial screening tool due to its low cost, wide availability, and capacity to provide rapid point-of-care information to clinicians and patients.[16] Given that even small amounts of albuminuria are associated with significant adverse outcomes,[7,15] it is crucial to timely identify albuminuria and raise awareness on the importance of detection and early intervention.

Using the KDSAP participant data, largely from underserved communities, we found a high prevalence of albuminuria, yet low awareness. Our study suggests that male sex, race/ethnicity, and high comorbidities might be associated with this high prevalence. Additionally, the data collected during screenings also reveal higher mean SBP, DBP and body mass index in the albuminuric group, indicating that hypertension and obesity are likely associated with albuminuria. Furthermore, a higher level of awareness correlated with self-reported comorbidities such as diabetes, hypertension, hyperlipidemia, and cardiovascular disease; this finding is validated by results collected during screenings that showed higher SBP and plasma glucose levels. Younger age, African American descent, and better self-assessments of health were risk factors for low awareness among our participants. On the other hand, family history of kidney disease, higher degrees of albuminuria, and concurrent positive dipstick hematuria were associated with greater awareness.

Among the general population in Korea, 9.1% of adults over 20 years old had trace albuminuria or higher when dipstick urinalysis was used.[17] Similarly, a community-based cohort study in Canada, with a predominantly white population, showed that the prevalence of albuminuria, as measured by dipstick, was 9.2%.[4] Our study shows a much higher prevalence of albuminuria among the KDSAP participants, overall a prevalence of 20.0%. Within this percentage, 16.3%

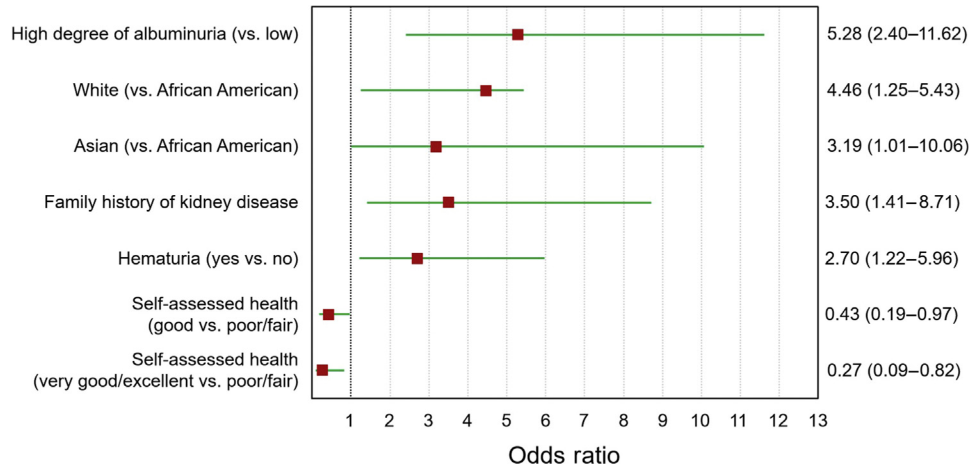


Figure 4. Factors associated with awareness of albuminuria by multivariable logistic regression analysis. The explanatory variables in this model included race/ethnicity, self-reported history of diabetes, family history of kidney disease, self-assessments of health, dipstick hematuria, and degree of albuminuria. The data was shown as forest plot of odds ratios with 95% confidence intervals. Note: Albuminuria was dichotomized into high degree (2+ or more) or low degree (trace or 1+). Self-assessments of health were categorized into poor or fair, good, and very good or excellent.

were trace or 1+ albuminuria and 3.7% were 2+ or more, compared to 7.8% and 1.4%, respectively, in the Canadian cohort.[4] We speculate that the higher number of risk factors for developing kidney disease found among the KDSAP participants explains our findings (Table 1). When compared to the Korean[17] and the Canadian[4] cohorts, the KDSAP population had a higher prevalence of hypertension (26.3% vs. 22.3% vs. 31.1%) and diabetes (9.2% vs. 7.0% vs. 18.9%). Here, our data demonstrate that KDSAP was a potentially useful modality for detecting albuminuria among high-risk populations in the community settings.

Kidney disease awareness among the general population is alarmingly low.[2,18] According to the NKF-KEEP study (National Kidney Foundation, Kidney Early Evaluation Program), awareness was at only 9%.[19] Approximately 10% of the National Health and Nutrition Examination Survey participants with CKD, stages 1–4, were aware they had a kidney disease; assessment was based on single question: "Have you ever been told by a health care provider you have weak or failing kidneys?"[1] While many studies have addressed CKD awareness, there are limited studies on albuminuria awareness. Using data collected from Italy's general population, including high school students, on World Kidney Day in 2012 and 2013, Esposito *et.al*. reported that albuminuria awareness was at about 20%.[20] In contrast to these studies, we used 2 questions ("Have you ever had protein in the urine?" and "Do you have kidney disease?"), which we expected would improve assessment sensitivity for albuminuria awareness (results from assessing awareness through each question, individually, are provided in Supplementary Table S3). Nevertheless, overall awareness among KDSAP participants remained as low as 15.8%. Similar to previous studies, individuals who had more severe albuminuria were more likely to be aware of the problem.[21] However, even in participants with albuminuria 2+ or more, only 39.5% were aware of their condition (Table 2).

We found that African American participants were associated with lower albuminuria awareness when compared to non–Hispanic Whites and Asians; this finding is consistent with prior studies.[18,19,22] Previous studies demonstrated that African Americans were less likely to take advantage of screening programs due to feelings of denial, limited knowledge of kidney disease, low perceived susceptibility, and frequent use of religion as a coping mechanism.[23,24] However, as a community-based program, KDSAP had the advantage of enrolling African American participants by partnering with community leaders, selecting convenient locations, and tailoring advertisement.

We also found that self-assessments of health were inversely associated with albuminuria awareness. We speculated that individuals who thought they were healthy were less likely to be cognizant of the insidious albuminuria health problem or feel the need to seek medical attention; additional studies on this hypothesis are needed in the future. KDSAP could potentially be a successful modality of outreach to this particular population to raise their awareness of albuminuria.

KDSAP screening is unique because the volunteer nephrologists/physicians reviewed the questionnaire with the participants, discussed results, and referred participants to primary care physicians or nephrologists when necessary. In addition, each KDSAP screening concluded by providing participants with the summary page of objective data and a health education flyer (Supplementary Item S2). By screening for albuminuria and educational efforts in the community setting, KDSAP may be a potentially useful avenue for raising albuminuria awareness. Therefore, KDSAP screenings may also potentially facilitate early referrals and medical interventions.

Prior studies show that a single question regarding awareness of kidney disease has lower sensitivity, ranging from 26.4% to 40.1%, but using 2 questions can yield a higher sensitivity of 53.1%.[25] One of our study's strengths was using 2 questions to assess albuminuria awareness, something not previously done. Additional strength of this study was establishing the measurement to validate the risk factors for both prevalence and albuminuria awareness (Figure 2).

However, our study experienced several constraints. First, the albuminuria diagnosis was based on a single random urinalysis dipstick measurement, which could lead to overestimating the prevalence of albuminuria by misclassifying individuals with physiologic albuminuria. Saydah *et al*. found that a single random albuminuria measurement tended to overestimate prevalence.[26] However, the urine albumin-to-creatinine ratio test is more sensitive to detecting albuminuria[4] and thus our study may have underestimated the prevalence of albuminuria by only using the urine dipstick. Second, as a cross-sectional screening program, our data do not include long-term follow-up information. Third, while both albuminuria and decreased eGFR independently predict progression of kidney disease to ESRD, low eGFR and albuminuria do not always coexist.[27] Our screening modalities did not measure eGFR and were, there, not able to detect nonalbuminuric kidney disease; adding point-of-care creatinine measurement could improve CKD detection. Fourth, KDSAP participants may not generally represent community populations because individuals with risk factors such as a family history of kidney disease, concurrent hypertension or diabetes, and self-awareness of kidney problems may be more likely to participate in KDSAP's screenings; this could potentially contribute to overestimating albuminuria prevalence and general awareness. Finally, we excluded some individuals from the analysis because of missing data, which could contribute to selection bias.

Missing data are common in survey-based research[28]; our investigation was no exception. Missing data were similarly distributed between our nonalbuminuric and albuminuric groups, except for data regarding health insurance coverage and medication insurance coverage (Supplementary Table S1). Additionally, we did not perform sensitivity analysis, such as imputations, because there was compelling evidence that data were not missing at random. Notably, the survey item "Family History of Kidney Disease" (n = 769, 33.4%) had the most missing data, which further underscores our investigation's relevance.

There has been lack of consensus regarding clinical practice guidelines for albuminuria screening using urine dipstick from professional societies representing, or made up of, primary care clinicians. This is largely because awareness of the need to screen for albuminuria is equally low among health care professionals.[29] Our results indicate that concurrent hematuria is associated with a higher awareness of albuminuria. Therefore, routine dipstick urinalysis can be a useful tool to assess concurrent albuminuria and hematuria.

In conclusion, our study provides important observations regarding the high prevalence, and low awareness, of albuminuria in the community setting. However, a large portion of the KDSAP participants were Asian, because of substantial interest among various Asian organizations and communities to collaborate with KDSAP, and therefore the data may not necessarily represent the general population. Regardless, we suggest that KDSAP can serve as a model to detect albuminuria and raise awareness.

DISCLOSURE

All the authors declared no competing interests.

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AUTHOR CONTRIBUTIONS

Research concept and study design was carried out by MZ, M-YJ, and L-LH. Data acquisition was carried out by LCP, MZ, RS, and JL. Data analysis/interpretation was carried out by MZ, M-YJ, RS, SSM, SB, JL, and AC. Statistical analysis was carried out by MZ, M-YJ, and SSM. L-LH supervised. Each author contributed intellectual content during the manuscript drafting/revision process and accepts accountability for the overall work and ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved.

MZ, M-YJ, and L-LH had full access to all study data and take responsibility for data integrity and data analysis accuracy.

SUPPLEMENTARY MATERIAL

Supplementary File (PDF)

File S1. Questionnaire of Kidney Disease Screening and Awareness Program (KDSAP) used during the screenings.

File S2. Summary page of objective data and health education flyer given to the participants after KDSAP screening.

Table S1. Missing data among individuals with and without albuminuria.

Table S2. Factors associated with awareness of albuminuria by unadjusted and age- and sex-adjusted logistic regression analysis.

Table S3. Awareness of albuminuria assessed by each question individually.

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