BMJ Open

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Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-027931
Article Type:	Research
Date Submitted by the Author:	17-Nov-2018
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Keywords:	Chronic Kidney Disease, Psychosocial stressors, migrants, rodam study, Europe, Ghana

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Abstract

Objectives: The association between Psychosocial stressors (PS) and CKD within sub-Saharan African (SSA) populations is unknown. We examined the association between PS and CKD prevalence among rural and urban Ghanaians and their migrants living in three European cities. We also assessed if the influence of PS on CKD is partially mediated by primary risk factors (hypertension and diabetes) of CKD.

Methods: A multi-centred cross sectional baseline data from the Research on Obesity and Diabetes among African Migrants (RODAM) study. A random sample of 5,659 adults (Europe, 3167, rural, 1,043, Urban Ghana, 1,449, Ghana) aged 25 to 70 years. PS defined by negative life events, perceived discrimination, perceived stress at work/home and depressive symptoms. Three CKD outcomes were considered using the 2012 KDIGO (Kidney Disease: Improving Global Outcomes) severity of CKD classification. Comparisons between PS and CKD were made using logistic regression analyses across all sites.

Results: We observed higher proportion of Ghanaians living in SSA with negative life events (68.7%) and perceived permanent stress (15.9%). Depressive symptoms (7.5%) and perceived discrimination (29.7%) were more common among Ghanaians living in Europe. No association was observed between either one of the four constructs of PS and CKD across all the sites except for those with some level of stress at work/home in Berlin that had a higher risk of CKD (2.78, 95% C.I. 1.43-5.43).

Conclusion: Our study shows no convincing evidence for associations between stress as indicated by four PS constructs and prevalence of CKD. Further studies aimed at identifying potential factors driving the high prevalence of CKD among these populations are needed.

Index Words: Chronic kidney disease; psychosocial stressors; risk factor; migrants; RODAM study, Europe, Ghana

Strengths and limitations of the study

- This study used all three categories of CKD definitions (albuminuria, reduced eGFR and CKD risk) by KDIGO 2012 in assessing association of SS with CKD across all sites. This provided more detailed information on CKD outcomes.
- All sites in our study used well standardized study protocols and this eliminated intra protocol variability.

- The use of four constructs of psychosocial stressors (negative life events, perceived discrimination, perceived stress at work/home and depressive symptoms) provided a robust approach to assessing SS associations with CKD.

- The limitation of intra laboratory variability in earlier studies was eliminated using the same standard operating procedures in the same laboratory for running all samples for all sites.

- PS is captured and experienced in different magnitude across different populations. We were unable to ascertain if PS as defined in this study was adequately captured among Ghanaians living in rural and urban Ghana.

Introduction

Worldwide, Chronic Kidney Disease (CKD) is a leading cause of mortality and morbidity with several risk factors (diabetes mellitus, obesity, hypertension and cardiovascular disease) (1). The epidemiologic transition in low-and-middle income countries (LMICs) shows increased burden of these risk factors (2-4). CKD's high morbidity and mortality is mostly driven by uncontrolled comorbidities such as diabetes and hypertension (5, 6). CKD treatment and management cost is very high and not sustainable even in high-income countries and this underscores the need for prevention (7). Available literature has shown that both individual and community level economic factors influence CKD (8-10). However, after adjusting for both individual and community level socioeconomic position, differences in CKD risk among different populations remained (8, 10, 11). These findings seem to suggest other social environmental factors may be driving CKD prevalence and progression in high-risk populations. Recent studies have shown that whereas Ghanaians living in Europe have a higher CKD risk compared to their host nation populations, they have a lower CKD risk compared with their peers living in urban Ghana (12). The increased risk of CKD observed in urban Ghana was not fully explained by conventional risk factors (12) and socio-economic status (13). This underscores the need to identify other modifiable risk factors of CKD for prevention, optimum treatment and efficient management.

Evidence shows that where an individual works or stays influences his or her physiological wellbeing leading to an increased risk of chronic diseases (14, 15). Thus, migrants' physiological wellbeing are influenced by the environment (host nations) they move to stay. The association between PS and CKD as well as the biological pathways through which PS influences CKD progression is poorly understood and complex (5). Despite this, PS have been reported to be associated with alteration in the sympathetic/autonomic nervous system activity leading to higher rates of traditional risk factors of CKD including hypertension and diabetes (16, 17). A link between stress, hypertension, diabetes and CKD through innervation of all segments of the kidney by renal sympathetic nerves has been suggested (18). Also, environmental stressors have been reported to contribute to the development of insulin resistance, metabolic syndrome, obesity and diabetes which if uncontrolled leads to CKD incidence (19, 20). Thus, the above-mentioned risk factors of CKD may explain the link between PS and CKD.

However, studies linking psychosocial stressors (PS) to CKD prevalence and progression vary greatly among different geographical populations. (5, 21-26). Specifically, in the USA whereas no association was found between PS and CKD (26-28) another study reported lower prevalence of CKD was associated with greater life stressors at baseline (26). In contrast, in the Netherlands depressive and anxiety symptoms were observed to be common among CKD patients and such patients had increased risk of poor clinical outcomes (22). Similarly, a study conducted in Korea reported a positive relationship between depressive symptoms and CKD (21). These observations suggest differential impact of PS at different geographical locations. For

example, discrimination among migrants may differ greatly between host population and from their SSA compatriots. Specifically, some studies have reported differences in PS among rural and urban populations (29).

Current literature on the association between PS and CKD among sub-Saharan African populations and their migrants in Europe is scanty and uncertain. We therefore sought to determine the association between PS and CKD prevalence among Ghanaians in rural and urban Ghana and their migrants living in three European cities. Furthermore, we examined the influence of psychosocial stressors on risk factors (obesity, diabetes and hypertension) of CKD.

Methods

Study population and study design

For this study, data from the Research on Obesity & Diabetes among African Migrants (RODAM) study, a multi-centre cross sectional study, were used. The rationale, conceptual framework, design and methodology of the RODAM study have been described in detail elsewhere (12, 13, 30, 31). To summarize, the study was conducted from 2012 to 2015. Ghanaians aged 25-70 years living in rural and urban communities in Ghana as well as in three European cities (Amsterdam, Berlin and London) were included in this study. We standardized data collection across all sites. The ethics committees in Ghana, the Netherlands, Germany and the UK approved the study protocol prior to data collection. Informed consent was obtained from each participant prior to enrollment in the study. In Ghana, participants were randomly drawn

from a list of 30 enumeration areas in the Ashanti region based on the 2010 population census. These enumeration areas came from both rural areas and two purposively selected urban cities (Kumasi and Obuasi). For Ghanaians in Amsterdam, we randomly drew participants from the Municipal register. This register holds data on country of birth of citizens and their parents, thus allowing for sampling based on the Dutch standard indicator for ethnic origin. London lacked a population register for migrant groups. Thus, Ghanaian organizations served as sampling frame for the study. Lists of these organizations were obtained from the Ghanaian Embassy and the Association of Ghanaian Churches in the UK in the boroughs known to have the greatest concentration of Ghanaians. Members were selected from the lists of all members of these organizations. In Berlin, the registration office of the federal state of Berlin provided a list of Ghanaian individuals in Berlin but this resulted in low response rate. Because of this, a change was made to use lists of Ghanaian churches and organizations as the sampling frame. Across all sites in Europe, all selected participants were sent a written invitation combined with written information (information sheet) regarding the study and a response card. The participants were contacted by phone to schedule a date and location of the interview with a trained research assistant or opt for the self-administration of the paper questionnaire or digital online version depending on the preference of the participant. After the completion of the questionnaire, a date for physical examination was then scheduled after a positive response. The participants were instructed to fast from 10.00 p.m. the night before the physical examination. The response rate was 76% in rural Ghana and 74% in urban Ghana. In London, of those individuals who were registered in the various Ghanaian

organizations and were invited, 75% agreed and participated in the study, while in Berlin, this figure was 68%, and 53% in Amsterdam. For the current study, 5898 participants with data available on both questionnaire data and physical measurements were used. Individuals who were outside the age range of 25–70 years (n=239) were excluded because not all the study sites had individuals outside this age range resulting in 5659 individuals comprising of 2492 from rural and urban Ghana and 3167 from the three European cities. In the conduct of analysis, we further excluded individuals with no data on CKD and all other indicators (n=52), resulting in a data set of 5607 participants for analysis.

Measurements

Covariates

Demographic and lifestyle factors

For this study, we obtained information on demographics, educational level and lifestyle factors (smoking and physical activity) by questionnaire. Physical examinations were performed across all sites using validated devices per standardized operational procedures. Weight was measured in light clothing and without shoes with SECA 877 scales to the nearest 0.1 kg. Height was measured without shoes with a portable stadiometer (SECA 217) to the nearest 0.1 cm. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m2). Overweight was defined as BMI of 25 to < 30 kg/m^2 and obesity as BMI ≥30 kg/m^2. Waist circumference was measured in centimetres at the midpoint between the lower rib and the upper margin of the iliac

crest. We used the same assessor for each participant in measuring all anthropometrics and each was measured twice; the average of the two measurements was used for analyses.

Predictor: SS

For this study, four constructs of psychosocial stress (discrimination, perceived stress at work or at home, negative life events and depressive symptoms) were used as explanatory variables.

Perceived discrimination

Everyday discrimination as perceived by participants was reported as routinely experiencing instances of unfair treatment. We used the the Everyday Discrimination Scale (EDS). The EDS comprises of a 9-items which rates the frequency at which participants experience daily mistreatment and it focuses on being treated with less courtesy or less respect, receiving poorer service than other people or being called names or insulted. Participants had the option of rating each of the 9-items from "never" = 1 to "very often" = 5. The obtained scores were summed and an average of the scores was computed to obtain a final score of 1 to 5. This scale was used because it is commonly used for self-reported discrimination (32), with consistent high reliability among a variety of ethnicities (33), comprising African migrants in the Netherland (34).

Perceived stress at work or at home

We defined perceived stress at work or at home as "sense of irritation, filled with anxiety, or as having difficulties in sleeping because of circumstances at work or at

home". We used the psychological stress scale created by the INTERHEART study (35). Participants in the study were asked about their opinion on frequency of stress at work and at home, and could answer "never", "some periods", "several periods", or "continually". Both answers were then combined into a composite score and graded into four categories: never experienced to experienced permanent stress at home or at work (35). Due to the very small numbers in the permanent periods of stress group, we combined experienced several periods of stress at home or at work and permanent periods of stress at home or at work.

Negative life events

The presence of major negative life events among participants was perceived as any event that could cause acute stress to an individual. We therefore applied the well-validated and widely used List of Threatening Experiences (LTE) (36, 37). The scale comprised of 12 unpleasant events participants perceived to have experienced in the past 12 months. We used a slightly-altered version of LTE consisting of 9 unpleasant items. We dichotomized participants into two groups namely "no negative life events" and "one or more events" and participants in the second category were expected to have higher levels of stress (37).

Depressive symptoms

Depressive symptoms were measured by the 9-item Patient Health Questionnaire (PHQ-9). The PHQ-9 consists of nine items, with a response scales 0 'not at all', 1 'on several days', 2 'on more than half of the days' and 3 'nearly every day'. A participant was considered to be in a significant depressed mood (SDM) when one or

both of the items 1 (little interest or pleasure in doing things) and 2 (feeling down, depressed, or hopeless) were answered with at least 'on more than half of the days', and at least 5 of the 9 items were answered with at least 'on more than half of the days'(38).

Co-morbidity factors

Blood pressure (BP) was measured three times using a validated semi-automated device (The Microlife WatchBP home) with appropriate cuffs in a sitting position after at least 5min rest. The mean of the last two BP measurements was used in the analyses. Hypertension was defined as systolic BP 140mmHg and/or diastolic BP 90mmHg, and/or being on antihypertensive medication treatment, and/or self-reported hypertension. Trained research assistants in all sites collected fasting venous blood samples according to standard operation procedures, and then temporarily stored at the local research location. The stored blood samples from the local research centres were transported to Berlin, Germany, according to standardized procedures, for biochemical analyses. This was done to avoid intra-laboratory variability. Fasting plasma glucose concentration was measured using an enzymatic method (hexokinase). We defined Type 2 diabetes according to the World Health Organization diagnostic criteria (fasting glucose 7.0mmol/L, and/or current use of medication prescribed to treat diabetes, and/or self-reported diabetes) (39). We assessed concentration of total cholesterol using colorimetric test kits. All biochemical analyses were performed using an ABX Pentra 400 Chemistry Analyzer (ABX Pentra; Horiba 90 ABX, Germany). Hypercholesterolaemia was defined as total cholesterol level ≥6.22mmol/L. Serum creatinine concentration (in mol/L) was determined by a kinetic colorimetric

spectrophotometric isotope dilution mass spectrometry calibration method (Roche Diagnostics).

Outcome: CKD prevalence

We asked participants to bring an early morning urine sample for the analyses of albuminuria and creatinine levels. Urinary albumin concentration (in µmol/L) was measured by an immunochemical turbidimetric method (Roche Diagnostics). Urinary creatinine concentration (in l mol/L) was measured by a kinetic spectrophotometric method (Roche Diagnostics). Extensive quality checks were done inclusive of blinded serial measurements. Estimated glomerular filtration rate (eGFR) was calculated using the CKDEPI (CKD Epidemiology Collaboration) creatinine equation (40). Urinary albumin-creatinine ratio (ACR; expressed in mg/mmol) was calculated by taking the ratio between urinary albumin and urinary creatinine. eGFR and albuminuria were categorized according to the 2012 KDIGO classification (41). eGFR was categorized as follows: G1, 90mL/min/1.73m^2 (normal kidney function); G2, 60-89mL/min/1.73m^2 (mildly decreased); G3a, 45-59mL/min/1.73m^2 (mildly to moderatelydecreased); G3b, 30-44mL/min/1.73m^2 (moderately to severely decreased); G4, 15-29 mL/min/1.73 m^2 (severely decreased); and G5, <15mL/min/1.73m^2 (kidney failure). Albuminuria categories were derived from ACR and were as follows: A1, < 3mg/mmol (normal to mildly increased); A2, 3-30mg/mmol (moderately increased); and A3, > 30mg/mmol (severely increased). CKD status was categorized according to severity of kidney disease (green, low risk; yellow, moderately increased risk; orange, high risk; and red, very high risk) using the combination of eGFR (G1-G5) and albuminuria (A1-A3) levels

defined by the 2012 KDIGO guideline (42). Due to the small number of participants in the very high-risk category of CKD (n=27), the high and very high-risk groups were combined. Because of the small number of participants in the severely increased albuminuria category (A3, n=62), we defined albuminuria as ACR 3mg/ mmol by combining the moderately increased (A2) and severely increased (A3) categories.

Covariates assessed were age, sex, educational level and length of stay in Europe, hypertension and diabetes. Length of stay was assessed for Ghanaian migrants only. Length of stay was defined as the number of years lived in Europe at the time of data collection. Length of stay was controlled for due to evidence suggesting that it influences mental health (43). Other covariates were hypertension, obesity and diabetes.

Patient and Public Involvement

Community leaders were involved in the recruitment of patients. These comprised of religious communities (churches and mosques), endorsement from local key leaders and establishing relationships with healthcare organizations. We also provided information on the study by involving the local media (radio and television stations). We sent letters to all selected health and community authorities to notify participants of the study. Team members were sent to the various communities to stay among the community and organize mini clinics for a period of 1-2 weeks. Results of the study were disseminated through seminars, durbars and via radio and television stations.

Statistical methods

Characteristics of participants were expressed as absolute numbers and percentages for categorical variables and means and standard deviations for continuous variables. Odds ratios (ORs) and their corresponding 95% confidence intervals (CIs) and adjusted

CIs were estimated by means of binary logistic regression analyses to study odds of albuminuria (ACR>3 mg/mmol, A2-A3, moderately to severely increased albuminuria), reduced kidney function (eGFR< 60 mL/min/1.73m^2, G3-G5 moderately to severely decreased kidney function) and increased CKD risk (high and very high CKD risk), with adjustments for covariates (44). The Spearman's correlation test was used to test for associations between all four constructs of PS. Two models were used to examine the data. Model 1 was adjusted for age and sex, model 2 was adjusted for age and sex and educational level for Ghanaians living in SSA while age, sex, educational level and length of stay for Ghanaians living in Europe (45-47). Model 3 was adjusted for sex, age, educational level and conventional risk factors (hypertension, diabetes, hypercholesterolemia, BMI, physical activity and smoking status) of CKD. The analyses were performed for all 4 constructs of PS using individuals who have not experienced either of the PS per outcome as reference. All tests were stratified per sites, Ghanaians living in SSA and Europe; Ghanaians living in rural and urban Ghana and Ghanaians living in Amsterdam, Berlin and London due to an observed interaction between PS and site. Furthermore, the analysis were stratified for those with and without obesity, diaetes, hypertension across all sites. All analyses were performed using STATA, version 14.0 (StataCorp LP).

Results

Characteristics of the study population

Participants characteristics are shown in Table 1. Ghanaians living in Ghana were older than their peers living in Europe. There were more females compared with males

in both Ghana and Europe. Ghanaians living in Ghana were significantly less educated than those living in Europe. Higher proportion of Ghanaians living in Ghana had experienced negative life events in the last 12 months compared with their peers living in Europe. More than half of Ghanaians living in Ghana had experienced some stress at home or work whereas only a third of those living in Europe had experienced some stress at home or work. Permanent stress at home/work was fairly the same among Ghanaians living in SSA and Europe. Perceived discrimination was significantly higher among Ghanaians living in Europe compared with their peers living in Ghana. Depressive symptoms were more prevalent among Ghanaians living in Europe compared with their peers living in Ghana. Almost all Ghanaians living in Europe were first generation migrants. Ghanaians in Europe were more obese, more likely to smoke and less physically active compared with their peers living in Ghana. Prevalence of hypercholesterolemia was higher, but type 2 diabetes and hypertension were lower among Ghanaians living in Ghana compared with their peers living in Europe. Prevalence of albuminuria, reduced eGRF and CKD risk were higher in Ghanaians living in Ghana compared with those living in Europe.

Table 1: Baseline characteristics of respondents

	Ghanaians (SSA) n (%)	Ghanaians (Europe) n (%)	p-value
N	2,492 (44.1)	3,167 (55.9)	

			0.001*
Female sex	1672 (67.1)	1,851 (58.5)	0.001*
Age (years)	45.7±11.9	46.6±9.9	0.006*
Educational status			
Low	1169 (49.2)	635 (21.8)	0.001*
Middle	858 (36.1)	1111 (38.1)	0.122
High	347 (14.6)	1168 (40.1)	0.001*
Negative life events in the past 12 months			
No	739 (31.3)	1158 (41.0)	0.001*
Yes	1619 (68.7)	1667 (59.0)	0.001*
Perceived stress at home/work			
Never	692 (29.4)	1371 (48.8)	0.001*
Some periods	1290 (54.7)	1033 (36.8)	0.001*
Several/Permanent	375 (15.9)	407 (14.4)	0.117
Perceived discrimination			
No	2065 (95.2)	1960 (70.3)	0.001*
Yes	104 (4.8)	829 (29.7)	0.001*
Depressive symptoms			
No	2239 (94.9)	2582 (92.5)	0.001*
Yes	119 (5.1)	209 (7.5)	0.001*
Migration generation			
First	Not applicable	2868 (98.7)	Not applicable
Second	Not applicable	38 (1.3)	Not applicable

BMI			
Normal (<25kg/m2)	1373 (55.2)	643 (20.4)	0.001*
Overweight (25 ≤ 30kg/m2)	684 (27.5)	1,350 (42.8)	0.001*
Obese (>30kg/m2)	432 (17.3)	1163 (36.8)	0.001*
Currently smoking	36 (1.5)	121 (4.1)	0.001*
Physical activity	1255 (52.8)	1131 (44.0)	0.001*
Hypocholesteraemia	352 (14.2)	354 (11.3)	0.007*
Type 2 diabetes	206 (8.3)	444 (14.0)	0.001*
Hypertension	837 (33.6)	1801 (56.9)	0.001*
ACR			
A1 < 3mg/mmol	2215 (90.2)	2814 (91.8)	0.001*
A2-A ≥ 3mg/mmol	243 (9.8)	252 (8.2)	0.285
eGFR			
G1-G2 ≥ 60 mL/min/1.73 m2	2377 (96.3)	2936 (97.4)	0.018*
G3a-G5 < 60 mL/min/1.73 m2	85 (3.7)	78 (2.6)	0.018*
CKD Risk			
Low risk	2197 (89.6)	2705 (91.5)	0.015*
Moderate-very high risk	256 (10.4)	252 (8.5)	0.015*

Abbreviations: N, number of respondents; BMI, body mass index; eGFR, estimated glomerular filtration rate; G1-G2, normal to high kidney function to mildly decreased; G3a-G5, mildly to moderately decreased to Kidney failure; ACR, albumin creatinine ratio; A1, normal to mildly increased; A2-A3, moderately increased to severely increased; CKD, Chronic kidney disease; SSA, Sub-Saharan Africa; CI, confidence intervals.

Association between PS and CKD

Figure 1-4 shows CKD prevalence by negative life events in the past 12 months among Ghanaians living in Ghana and Europe. In Europe, CKD prevalence was fairly the same among those who had experienced any negative life events compared with those who had not in the last 12 months. Prevalence of CKD was higher among Ghanaians who had not experienced any negative life events in the past 12 months compared with those who had experienced some negative life events and living in Ghana. CKD prevalence was higher among Ghanaians who had not experienced any form of discrimination than those who had not in Ghana as well as in Europe (Figure 2). CKD prevalence was higher among Ghanaians who had experienced several/permanent stress at work/home in the past 12 months and living in Ghana or Europe (Figure 3). Ghanaians who did not report any form of depressive symptoms

had a higher CKD prevalence than those who did and living in Ghana and Europe (Figure 4).

Table 2 shows the correlation matrix between the 4 constructs of PS among Ghanaians living in Ghana and those living in Europe. All four constructs of PS were positively correlated with each other among Ghanaians living in Europe and Ghanaians living in Ghana, except stress at work/home and discrimination among Ghanaians living in Ghana.

Table 2: Relationship between PS constructs (negative life events, discrimination, stress at work or home and depression) by Ghanaians (SSA) and Ghanaians (Europe)

Correlation matrix	Negative events	Discrimination	Stress at work/home	Depression
Europe				
Negative events	1.000			
Discrimination	0.152**	1.000		
Stress at work/home	0.297**	0.161**	1.000	
Depressive symptoms	0.143**	0.1366**	0.285**	1.000
Ghana				
Negative events	1.000			
Discrimination	0.079**	1.000		

Stress at work/home	0.101**	-0.032	1.000	
Depressive symptoms	0.091**	0.042	0.185**	1.000

**Significant at 1%, Spearman's correlation

Table 3 shows association between all 4 constructs of PS and CKD among Ghanaians living in Ghana and those living in Europe. There was no statistically significant association between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living in Ghana and those living in Europe except individuals living in Europe with some stress and lower risk of reduced eGFR. Table S1 shows further

adjustments for conventional risk factors of CKD. This did show any associations between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living in Ghana and Europe (S1). Table S2 shows further stratification based on obesity status. We did not find any association between PS and CKD for obese participants and those who were not obese for Ghanaians living in rural and urban Ghana and those living in Europe. However, we observed an inverse association between PS and CKD among migrants who were not obese but have experienced discrimination for the past 12 months (S2). In Table S3 we stratified our analysis based on diabetic status. We did not find any associations between PS and CKD for participants with and without diabetes for both Ghanaians living in rural and urban Ghana and their migrant peers in Europe (S3). Finally, Table S4 stratified analysis by hypertension status. No associations were observed between PS and CKD for individuals who had hypertension and those who did not have hypertension for both those living in rural and urban Ghana as well as their compatriots living in Europe. An inverse association was observed between PS and CKD among Ghanaians who have experienced discrimination in the last 12 months with no hypertension and living in Europe. Also, we observed that having experienced some stress at home/work was inversely associated with reduced eGFR among Ghanaians with hypertension and living in Europe (S4).

Table 3: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
	n (%)	OR (95% CI) Model 1	Model 2	n (%)	OR (95% CI) Model 1	Model 2	n cases (%)	OR (95% CI) Model 1	Model 2
Negative events									
Europe									
No	1128 (8.2)	1.00 (Reference)	1.00 (Reference)	1106 (2.6)	1.00 (Reference)	1.00 (Reference	1090 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	1615 (8.4)	1.03 (0.78-1.35)	1.07 (0.80-1.42)	1587 (2.5)	0.86 (0.53-1.42)	0.83 (0.49-1.39)	1557 (8.6)	0.97 (0.76-1.32)	0.99 (0.74-1.32)
Ghana									
No	732 (8.7)	1.00 (Reference)	1.00 (Reference)	736 (4.5)	1.00 (Reference)	1.00 (Reference)	732 (10.9)	1.00 (Reference)	1.00 (Reference)
Yes	1595 (3.8)	0.87 (0.65-1.16)	0.85 (0.63-1.14)	1601 (3.4)	0.69 (0.45-1.08)	0.67 (0.44-1.09)	1590 (9.9)	0.88 (0.66-1.17)	0.86 (0.64-1.15)
Discrimination									
Europe									
No	1899 (8.5)	1.00 (Reference)	1.00 (Reference)	1867 (2.6)	1.00 (Reference)	1.00 (Reference)	1832 (8.9)	1.00 (Reference)	1.00 (Reference)

Yes	810 (7.4)	0.87 (0.64-1.19)	0.92 (0.67-1.26)	791 (2.2)	0.83 (0.47-1.47)	0.84 (0.46-1.52)	782 (7.3)	0.82 (0.59-1.12)	0.84 (0.60-1.16)
Ghana									
No	2034 (10.0)	1.00 (Reference)	1.00 (Reference)	2047 (3.9)	1.00 (Reference)	1.00 (Reference)	2031 (10.6)	1.00 (Reference)	1.00 (Reference)
Yes	104 (7.7)	0.83 (0.39-1.73)	0.91 (0.67-1.24)	104 (1.9)	0.67 (0.15-2.85)	0.67 (0.16-2.84)	104 (6.7)	0.70 (0.32-1.55)	0.71 (0.32-1.55)
Stress at home/work									
Europe									
Never	1330 (8.2)	1.00 (Reference)	1.00 (Reference)	1305 (3.4)	1.00 (Reference)	1.00 (Reference)	1282 (8.5)	1.00 (Reference)	1.00 (Reference)
Some stress	1002 (7.9)	0.97 (0.72-1.31)	1.04 (0.76-1.42)	984 (1.4)	**0.47 (0.26-0.87)**	**0.46 (0.24-0.88)**	968 (8.6)	0.96 (0.71-1.30)	1.02 (0.74-1.39)
Several/Permanent stresses	397 (9.1)	1.11 (0.74-1.64)	1.153 (0.77-1.72)	390 (2.3)	0.73 (0.35-1.52)	0.76 (0.36-1.61)	383 (9.7)	1.13 (0.77-1.68)	1.19 (0.80-1.79)
Ghana									
Never	682 (10.3)	1.00 (Reference)	1.00 (Reference)	688 (3.3)	1.00 (Reference)	1.00 (Reference)	682 (9.9)	1.00 (Reference)	1.00 (Reference)
Some stress	1279 (9.5)	0.87 (0.64-1.19)	0.80 (0.59-1.11)	1279 (3.9)	1.06 (0.63-1.77)	1.11 (0.66-1.87)	1274 (10.3)	0.95 (0.69-1.30)	0.92 (0.67-1.26)
Several/Permanent stresses	365 (8.5)	0.75 (0.48-1.18)	0.68 (0.59-1.11)	369 (4.1)	1.13 (0.57-2.23)	1.22 (0.61-2.46)	365 (10.4)	0.96 (0.63-1.47)	0.92 (0.59-1.42)
Depressive symptoms									
Europe									
No	2505	1.00	1.00	2457	1.00	1.00	2416	1.00	1.00

	(8.5)	(Reference)	(Reference)	(2.7)	(Reference)	(Reference)	(8.7)	(Reference)	(Reference)
Yes	206 (6.3)	0.71 (0.39-1.27)	0.76 (0.43-1.36)	202 (1.5)	0.63 (0.19-2.03)	0.68 (0.21-2.23)	199 (7.1)	0.78 (0.44-1.37)	0.83 (0.47-1.46)
Ghana									
No	2212 (9.9)	1.00 (Reference)	1.00 (Reference)	2222 (3.8)	1.00 (Reference)	1.00 (Reference)	2207 (10.4)	1.00 (Reference)	1.00 (Reference)
Yes	114 (5.3)	0.45 (0.19-1.03)	0.45 (0.19-1.01)	114 (2.6)	0.52 (0.16-1.72)	0.53 (0.17-1.74)	114 (7.9)	0.62 (0.30-1.25)	0.61 (0.30-1.24)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe

Table 4 shows associations between all 4 constructs of PS and CKD stratified by Ghanaians living in urban and rural Ghana. There was no association between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living rural and urban Ghana.

Table 4: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depressive symptoms) with albuminuria, reduced eGFR and CKD risk among rural and urban Ghana

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
	n (%)	OR (95% CI) Model 1	Model 2	n (%)	OR (95% CI) Model 1	Model 2	n cases (%)	OR (95% CI) Model 1	Model 2
Negative events									
Urban Ghana									
No	477 (11.9)	1.00 (Reference)	1.00 (Reference)	477 (4.4)	1.00 (Reference)	1.00 (Reference)	477 (12.2)	1.00 (Reference)	1.00 (Reference)
Yes	912 (10.5)	0.87 (0.61-1.23)	0.87 (0.61-1.24)	911 (3.4)	0.73 (0.41-1.31)	0.72 (0.40-1.29)	910 (10.8)	0.87 (0.61-1.24)	0.87 (0.61-1.25)
Rural Ghana									
No	255 (7.5)	1.00 (Reference)	1.00 (Reference)	259 (4.6)	1.00 (Reference)	1.00 (Reference)	255 (8.6)	1.00 (Reference)	1.00 (Reference)
Yes	683 (7.6)	0.97 (0.56-1.69)	0.94 (0.54-1.64)	690 (3.5)	0.63 (0.31-1.31)	0.66 (0.32-1.37)	680 (8.8)	0.93 (0.55-1.58)	0.92 (0.54-1.56)
Discrimination									
Urban Ghana									
No	1326 (11.1)	1.00 (Reference)	1.00 (Reference)	1326 (3.9)	1.00 (Reference)	1.00 (Reference)	1325 (11.4)	1.00 (Reference)	1.00 (Reference)

Yes	71 (8.5)	0.85 (0.36-2.00)	0.89 (0.37-2.11)	71 (2.8)	1.17 (0.27-2.09)	1.16 (0.27-2.06)	71 (7.1)	0.69 (0.27-1.77)	0.72 (0.28-1.83)
Rural Ghana									
No	708 (8.1)	1.00 (Reference)	1.00 (Reference)	721 (3.9)	1.00 (Reference)	1.00 (Reference)	706 (9.2)	1.00 (Reference)	1.00 (Reference)
Yes	33 (6.1)	0.79 (0.18-3.47)	0.84 (0.19-2.65)	33 (0.0)	***	***	33 (6.1)	0.75 (0.17-2.89)	0.83 (0.19-2.65)
Stress at home/work									
Urban Ghana									
Never	460 (10.9)	1.00 (Reference)	1.00 (Reference)	460 (3.3)	1.00 (Reference)	1.00 (Reference)	460 (10.2)	1.00 (Reference)	1.00 (Reference)
Some stress	732 (11.5)	1.04 (0.71-1.51)	0.91 (0.62-1.37)	730 (4.1)	1.27 (0.66-2.43)	1.30 (0.67-2.51)	730 (11.8)	1.13 (0.77-1.65)	1.04 (0.71-1.53)
Several/Permanent stresses	197 (9.6)	0.87 (0.50-1.52)	0.74 (0.42-1.02)	198 (3.5)	1.17 (0.46-2.84)	1.20 (0.47-3.09)	197 (11.7)	1.15 (0.68-1.71)	1.05 (0.61-1.81)
Rural Ghana									
Never	222 (9.0)	1.00 (Reference)	1.00 (Reference)	228 (3.5)	1.00 (Reference)	1.00 (Reference)	222 (9.5)	1.00 (Reference)	1.00 (Reference)
Some stress	547 (6.9)	0.69 (0.39-1.23)	0.68 (0.38-1.22)	549 (3.6)	0.88 (0.38-2.07)	0.92 (0.39-2.18)	544 (8.3)	0.74 (0.42-1.30)	0.75 (0.42-1.31)
Several/Permanent stresses	168 (7.1)	0.63 (0.30-1.37)	0.60 (0.28-1.29)	171 (4.7)	1.07(0.38-3.03)	1.21(0.43-3.46)	168 (8.9)	0.71 (0.34-1.50)	0.73 (0.35-1.50)
Depressive symptoms									
Urban Ghana									
No	1336	1.00	1.00	1335	1.00	1.00	1334	1.00	1.00

	(11.3)	(Reference)	(Reference)	(3.8)	(Reference)	(Reference)	(11.5)	(Reference)	(Reference)
Yes	52 (3.9)	0.30 (0.07-1.25)	0.30 (0.07-1.27)	52 (1.9)	0.46 (0.06-2.50)	0.45 (0.06-2.13)	52 (5.8)	0.44 (0.14-1.45)	0.45 (0.14-1.48)
Rural Ghana									
No	876 (7.7)	1.00 (Reference)	1.00 (Reference)	887 (3.8)	1.00 (Reference)	1.00 (Reference)	873 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	62 (6.5)	0.67 (0.23-1.94)	0.67 (0.23-1.94)	62 (3.2)	0.58 (0.13-2.56)	0.61 (0.14-2.68)	62 (9.7)	0.82 (0.33-2.01)	0.85 (0.34-2.09)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in urban and rural Ghana among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in rural and urban Ghana. ***; no case of CKD and therefore odds ratios were not calculated

Table 5 shows associations between all 4 constructs of PS and CKD stratified by Ghanaians living in Amsterdam, Berlin and London. There was no association between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living Amsterdam, Berlin and London except for positive association between stress at work/home and albuminuria and CKD risk among Ghanaians living in Berlin.

Table 5: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depressive symptoms) with albuminuria, reduced eGFR and CKD risk among Ghanaians in three European cities.

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
	n (%)	OR (95% CI) Model 1	Model 2	n (%)	OR (95% CI) Model 1	Model 2	n (%)	OR (95% CI) Model 1	Model 2
Negative events									
Amsterdam									
No	548 (7.3)	1.00 (Reference)	1.00 (Reference)	534 (2.4)	1.00 (Reference)	1.00 (Reference))	521 (7.5)	1.00 (Reference)	1.00 (Reference)
Yes	784 (7.8)	1.08 (0.71-1.63)	1.18 (0.77-1.81)	764 (2.9)	1.11 (0.55-2.23)	1.15 (0.55-2.37)	742 (8.0)	1.06 (0.69-1.62)	1.08 (0.71-1.66)
Berlin									
No	213 (9.9)	1.00 (Reference)	1.00 (Reference)	213 (2.4)	1.00 (Reference)	1.00 (Reference)	213 (10.8)	1.00 (Reference)	1.00 (Reference)
Yes	329 (10.9)	1.12 (0.63-1.99)	1.19 (0.67-2.15)	330 (1.8)	0.64 (0.19-2.17)	0.61 (0.18-2.11)	329 (9.4)	0.86 (0.48-1.52)	0.91 (0.51-1.63)
London									
No	367 (8.7)	1.00 (Reference)	1.00 (Reference)	359 (3.1)	1.00 (Reference)	1.00 (Reference)	356 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	502 (7.8)	0.89 (0.55-	0.83 (0.49-	493	0.68 (0.28-	0.58 (0.22-	486 (9.1)	1.04 (0.64-	0.99 (0.58-1.68)

		1.46)	1.41)	(2.2)	1.65)	1.51)		1.68)	
Discrimination									
Amsterdam									
No	956 (8.3)	1.00 (Reference)	1.00 (Reference)	935 (2.9)	1.00 (Reference)	1.00 (Reference)	909 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	363 (5.0)	0.59 (0.34-1.00)	0.59 (0.35-1.02)	349 (2.1)	0.69 (0.30-1.62)	0.81 (0.34-1.91)	342 (5.9)	0.69 (0.41-1.14)	0.69 (0.41-1.16)
Berlin									
No	329(10.0)	1.00 (Reference)	1.00 (Reference)	329 (2.1)	1.00 (Reference)	1.00 (Reference)	329 (10.3)	1.00 (Reference)	1.00 (Reference)
Yes	209 (11.0)	1.11 (0.63-1.95)	1.16 (0.65-2.05)	210 (1.9)	0.83 (0.24-2.93)	0.82 (0.23-2.91)	209 (9.1)	0.86 (0.48-1.56)	0.89 (0.49-1.63)
London									
No	614 (7.9)	1.00 (Reference)	1.00 (Reference)	603 (2.5)	1.00 (Reference)	1.00 (Reference)	594 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	238 (7.9)	1.03 (0.59-1.81)	1.18 (0.65-2.15)	232 (2.6)	1.29 (0.46-3.59)	1.09 (0.35-3.43)	231 (7.8)	0.93 (0.53-1.63)	0.98 (0.52-1.82)
Stress at home/work									
Amsterdam									
Never	634 (8.4)	1.00 (Reference)	1.00 (Reference)	622 (3.2)	1.00 (Reference)	1.00 (Reference)	603 (8.0)	1.00 (Reference)	1.00 (Reference)
Some stress	478 (5.7)	0.68 (0.42-1.11)	0.69 (0.42-1.13)	462 (1.9)	0.64 (0.29-1.43)	0.68 (0.30-1.52)	452 (6.0)	0.74 (0.45-1.20)	0.74 (0.45-1.22)
Several/Permanent stresses	210 (9.1)	1.09 (0.63-1.91)	1.12 (0.64-1.95)	204 (2.5)	0.71 (0.26-1.95)	0.77 (0.28-2.14)	198 (10.1)	1.24 (0.71-2.14)	1.26 (0.73-2.20)

Berlin									
Never	250 (9.0)	1.00 (Reference)	1.00 (Reference)	250 (2.0)	1.00 (Reference)	1.00 (Reference)	250 (6.4)	1.00 (Reference)	1.00 (Reference)
Some stress	196 (15.3)	**2.50 (1.33-4.71)**	**2.81 (1.46-5.40)**	197 (1.5)	0.88 (0.20-3.79)	0.83 (0.19-3.62)	196 (14.8)	**2.57 (1.34-4.90)**	**2.78 (1.43-5.43)**
Several/Permanent stresses	96 (10.4)	1.64 (0.72-3.73)	1.69 (0.73-3.91)	197 (3.1)	2.10 (0.47-9.46)	2.04 (0.44-9.26)	76 (9.4)	1.52 (0.65-3.58)	1.58 (0.66-3.75)
London									
Never	446 (9.2)	1.00 (Reference)	1.00 (Reference)	433 (4.4)	1.00 (Reference)	1.00 (Reference)	429 (10.5)	1.00 (Reference)	1.00 (Reference)
Some stress	328 (7.0)	0.73 (0.43-1.25)	0.79 (0.44-1.40)	325 (0.6)	0.17 (0.04-0.73)	0.09 (0.01-0.67)	320 (6.9)	0.65 (0.38-1.10)	0.66 (0.37-1.19)
Several/permanent stresses	91 (7.7)	0.81 (0.35-1.87)	0.86 (0.35-2.14)	90 (1.1)	0.27 (0.03-2.12)	0.24 (0.03-2.05)	74 (8.9)	0.83 (0.38-1.83)	0.92 (0.39-2.16)
Depressive symptoms									
Amsterdam									
No	1199 (7.8)	1.00 (Reference)	1.00 (Reference)	1135 (2.8)	1.00 (Reference)	1.00 (Reference)	1135 (7.9)	1.00 (Reference)	1.00 (Reference)
Yes	121 (6.6)	0.81 (0.39-1.72)	0.83 (0.39-1.76)	118 (1.7)	0.65 (0.15-2.77)	0.71 (0.16-3.06)	116 (6.9)	0.83 (0.39-1.76)	0.82 (0.38-1.74)
Berlin									
No	503 (10.7)	1.00 (Reference)	1.00 (Reference)	504 (2.2)	1.00 (Reference)	1.00 (Reference)	503 (10.1)	1.00 (Reference)	1.00 (Reference)

Yes	34 (5.9)	0.53 (0.12-2.27)	0.49 (90.11-2.13)	34 (0.0)	***	***	34 (5.9)	0.55 (0.13-2.37)	0.52 (0.12-2.24)
London									
No	803 (8.3)	1.00 (Reference)	1.00 (Reference)	785 (2.6)	1.00 (Reference)	1.00 (Reference)	778 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	51 (5.9)	0.67 (0.20-2.21)	0.91 (0.27-3.07)	50 (2.0)	0.91 (0.11-7.43)	1.15 (0.14-9.54)	49 (8.2)	0.94 (0.33-2.69)	1.30 (0.44-3.81)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, educational level and length of stay; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Amsterdam, Berlin and London among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Europe ***; no case of CKD and therefore odds ratios were not calculated.

Discussion

Key findings

Whereas there was an association between those who have experienced some stress at home/work and reduced eGFR among Ghanaians living in Europe, we did not find any association between PS and CKD among Ghanaians living in rural and urban Ghana and their peers in Europe. Also, PS was not associated with CKD for those living in rural and urban Ghana and neither for those living in the three European cities. However, there was an association between stress at work/home and albuminuria and CKD risk among Ghanaians living in Berlin. Further adjustment for conventional risk factors of CKD yielded similar results.

Discussion of key findings

Association between PS and CKD in Ghana

Our study did not find any association between any of the four constructs of PS and prevalence of CKD (albuminuria, reduced eGFR and CKD risk) among Ghanaians living in rural and urban Ghana. Our findings are however in contrast with earlier studies which reported positive associations between PS and prevalent of CKD (22, 26, 48). Other studies have hypothesised that the influence of PS on CKD may be important in only those with hypertension and diabetes and that PS may mediate or moderate the association between renal functioning and lifestyle behaviours such as smoking and physical activity (28). For example, they argue that stress enhances

Sympathetic Nervous System (SNS) activity to increase glucocorticoid secretion and inflammatory cytokines, which heavily contribute to hypertension, diabetes and vascular disease which are major risk factors of CKD incidence and prevalence (49). We did not find any literature on the association between PS and CKD prevalence in rural and urban populations. Worth noting, however, is the presence of rich family support systems in the Ghanaian context especially in rural Ghana which may help individuals with CKD to cope with PS thereby minimizing its effect. For example, patients with limited social networks and low social support have been shown to have augmented risk of morbidity and mortality (50-52). Specifically, there is evidence that positive social support is a protective factor for persons dealing with long-term disease conditions (53). Other studies have reported a protective relationship between social networks, emotionally supportive relationship and threats to physiological and psychosocial health (54).

Association between PS and CKD Amsterdam, Berlin and London

Literature on the association between PS and CKD prevalence among migrants is scant and absent in most European populations. The lack of positive association between PS and CKD in our study is consistent with recent studies conducted among African Americans (26, 28) and other populations (27, 55). Specifically, a recent study using data from the Jackson Heart Study which comprised of extensive constructs of psychosocial variables reported that greater life stressors were associated with lower prevalence of CKD at baseline (26). Several studies in other parts of the world have

reported a positive relationship between higher prevalence of stressors and CKD risk (21, 22), although study findings have been inconsistent. Whereas some did not find any associations among African Americans (26) others found associations in other populations. Even among those who found some associations the directions differed (22). Reasons for the lack of association observed in our study among migrants are not fully understood but this lack of association may be a reflection of the real world. First, migrants from Ghana practice both nuclear and extended family support system as their peers living in rural and urban, this practice may mitigate the impact of stressors such as unemployment, death of a love one, discrimination, etc. They also belong to several religious organisations such as churches, which provide similar support systems against stressors. Moreover, there are several associations of the various ethnic groups (Akan, Ga and Ewe) providing such support when the need arises. These systems provide both instrumental and/or emotional social support (56). These assertions are supported by several studies. Specifically, these studies have shown that social support positively affect outcomes through mechanisms such as increased patient compliance with therapies, decreased levels of depressive affect, direct physiologic effects on the immune system and improved perception of quality of life (53, 54).

Strength and limitation

Our study is the first to use all four robust constructs of PS to determine association between PS and CKD. This gave our study a more robust definition of PS compared to other similar studies. The use of all three definitions of CKD per KDIGO guidelines

also provided a broader definition of CKD and allowed comparison between different geographical regions. The use of a homogenous population of Ghanaians and standardized protocols and diagnostic criteria in this study also provided a novel opportunity to compare Ghanaians living in rural and urban Ghana and their compatriots living in Europe. There are limitations to our study. First, the use of cross-sectional design prevented us from determining the longitudinal effect of repeated exposure to PS among the two populations. PS is captured and experienced in different magnitude across different populations. We were unable to ascertain if PS as defined in this study was adequately captured among Ghanaians living in rural and urban Ghana.

Conclusion

Generally, our study shows no associations between stress as indicated by four PS indicators and prevalence of CKD. Consequently, there is the need to explore other factors that may be responsible for the observed differences in the prevalence of CKD among Ghanaians living in rural and urban Ghana and their peers living in Europe.

Acknowledgement

The authors are very grateful to the research assistants, interviewers and other staff of the five research locations who took part in gathering the data and the Ghanaian volunteers in all the participating RODAM sites. We gratefully acknowledge the advisory board members for their valuable support in shaping the RODAM study methods and the Academic Medical Centre Biobank for their support in biobank management and high-quality storage of collected samples.

Contributors

My co-authors have all contributed substantially to this manuscript and approve of this submission. Research idea and study design: DNA, CA, KS, DA, EB, KM, JA; data acquisition and curation: DNA, CA, EB, KM, data analysis/interpretation: DNA, CA, KS, DA, EB, KM, LS, JA, EOD, KKG, FPM, ID, JS, SB, ADA; statistical analysis: DNA, CA, KS. DNA, CA, KS, DA, EB, KM, LS, JA, EOD, KKG, FPM, ID, JS, SB, ADA contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved. DNA and CA takes responsibility that this study has been reported honestly, accurately, and transparently; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Funding

This work was supported by the European Commission under the Framework Programme (Grant Number: 278901). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The

Wellcome Trust supported Professor Smeeth's contribution, grant number WT082178. Professor Joachim Spranger was supported by the DZHK (German Center for cardiovascular research) and the Berlin Institute of Health (BIH).

Competing interest: I have communicated with all my co-authors and obtained their full disclosures. My co-authors and I declare no conflicts of interest.

Patient Consent: None declared

Ethics approval: IRBs at each participating site.

Data sharing statement: Data are available from the RODAM research cohort, a third party. Dr. Eric Beune affiliated with the RODAM research cohort and a co-author of this paper in accordance with the RODAM requirements for collaboration. Dr. Beune is the Data Collection Coordinator of RODAM and may be contacted with further questions (e.j.beune@amc.uva.nl). Additionally, researchers interested in further collaboration with RODAM may see the following URL: http://www.rod-am.eu/

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Legend for figures

Figure 1: Prevalence of CKD risk among Ghanaians who have experienced negative life events and those who have not experienced any negative life events stratified by site. Definition per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 2: Prevalence of CKD risk among Ghanaians who have experienced discrimination and those who have not experienced any discrimination stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 3: Prevalence of CKD risk among Ghanaians who have experienced stress at home/work and those who have not experienced any stress at home/work in the past 12 months stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 4: Prevalence of CKD risk among Ghanaians who have depressive symptoms and those who do not have depressive symptoms stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

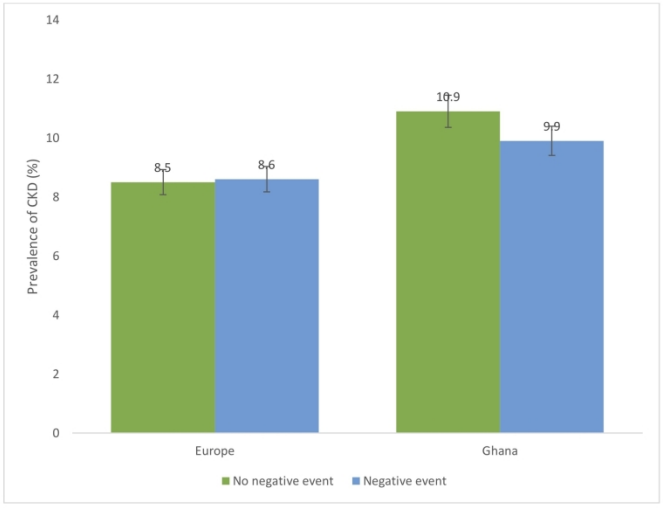

Figure 1: Prevalence of CKD risk among Ghanaians who have experienced negative life events and those who have not experienced any negative life events stratified by site. Definition per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 1: Prevalence of CKD risk among Ghanaians who have experienced negative life events and those who have not experienced any negative life events stratified by site. Definition per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

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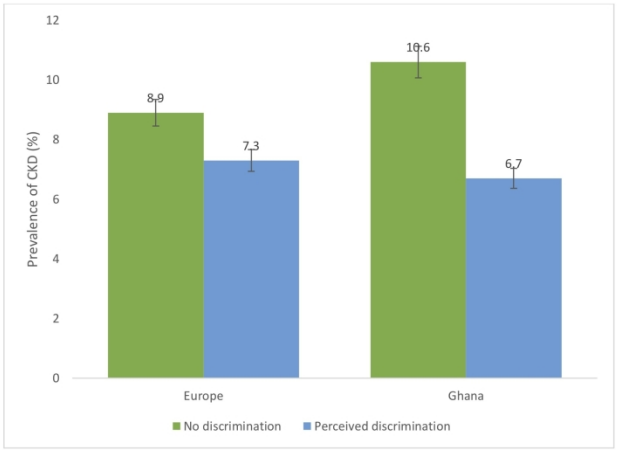

Figure 2: Prevalence of CKD risk among Ghanaians who have experienced discrimination and those who have not experienced any discrimination stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 2: Prevalence of CKD risk among Ghanaians who have experienced discrimination and those who have not experienced any discrimination stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

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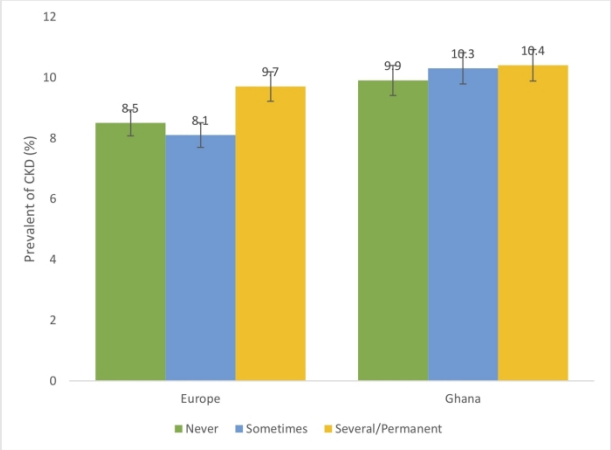

Figure 3: Prevalence of CKD risk among Ghanaians who have experienced stress at home/work and those who have not experienced any stress at home/work in the past 12 months stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 3: Prevalence of CKD risk among Ghanaians who have experienced stress at home/work and those who have not experienced any stress at home/work in the past 12 months stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

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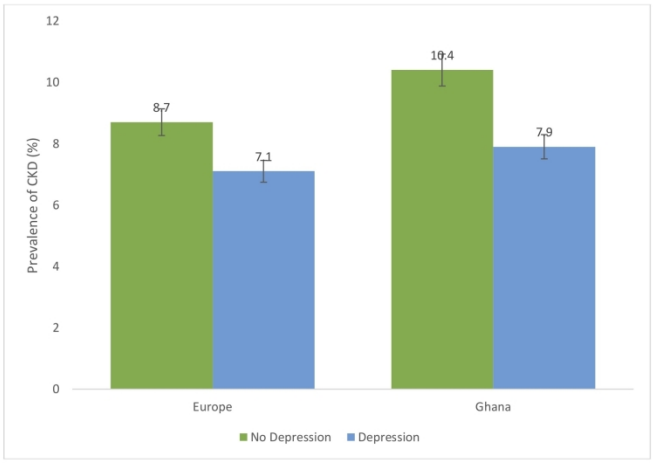

Figure 4: Prevalence of CKD risk among Ghanaians who have depressive symptoms and those who do not have depressive symptoms stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 4: Prevalence of CKD risk among Ghanaians who have depressive symptoms and those who do not have depressive symptoms stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines

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Supplementary Tables

S1: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe

	Albuminuria (ACR ≥ 3 mg/mmol)		eGFR < 60 mL/min/1.73 m2		High to very high CKD risk (KDIGO, 2012)	
	n (%)	OR (95% CI) Model 3	n (%)	OR (95% CI) Model 3	n cases (%)	OR (95% CI) Model 3
Negative events						
Europe						
No	1128 (8.2)	1.00 (Reference)	1106 (2.6)	1.00 (Reference)	1090 (8.5)	1.00 (Reference)
Yes	1615 (8.4)	0.95 (0.70-1.30)	1587 (2.5)	0.77 (0.44-1.37)	1557 (8.6)	0.92 (0.67-1.26)
Ghana						
No	732 (10.4)	1.00 (Reference)	736 (4.5)	1.00 (Reference)	732 (10.9)	1.00 (Reference)
Yes	1595 (9.2)	0.79 (0.58-1.07)	1601 (3.4)	0.69 (0.43-1.09)	1590 (9.9)	0.79 (0.58-1.06)
Discrimination						
Europe						
No	1899 (8.5)	1.00 (Reference)	1867 (2.6)	1.00 (Reference)	1832 (8.9)	1.00 (Reference)
Yes	810 (7.4)	0.87 (0.61-1.21)	791 (2.2)	0.87 (0.45-1.65)	782 (7.3)	0.79 (0.55-1.12)
Ghana						
No	2034 (10.0)	1.00 (Reference)	2047 (3.9)	1.00 (Reference)	2031 (10.6)	1.00 (Reference)
Yes	104 (7.7)	0.92 (0.43-1.98)	104 (1.9)	0.65 (0.15-2.79)	104 (6.7)	0.74 (0.33-1.66)
Stress at home/work						
Europe						
Never	1330 (8.2)	1.00 (Reference)	1305 (3.4)	1.00 (Reference)	1282 (8.5)	1.00 (Reference)
Some stress	1002 (7.9)	1.01 (0.72-1.41)	984 (1.4)	0.51 (0.25-1.04)	968 (8.1)	1.01 (0.72-1.42)
Several/Permanent stresses	397 (9.1)	1.00 (0.64-1.59)	390 (2.3)	0.91 (0.40-2.03)	383 (9.7)	1.15 (0.74-1.79)

Ghana						
Never	682 (10.3)	1.00 (Reference)	688 (3.3)	1.00 (Reference)	682 (9.9)	1.00 (Reference)
Some stress	1279 (9.5)	0.78 (0.56-1.09)	1279 (3.9)	1.14 (0.67-1.93)	1274 (10.3)	0.93 (0.67-1.29)
Several/Permanent stresses	365 (8.5)	0.70 (0.43-1.13)	369 (4.1)	1.32 (0.65-1.68)	365 (10.4)	0.97 (0.62-1.52)
Depressive symptoms						
Europe						
No	2505 (8.5)	1.00 (Reference)	2457 (2.7)	1.00 (Reference)	2416 (8.7)	1.00 (Reference)
Yes	206 (6.3)	0.65 (0.33-1.28)	202 (1.5)	0.94 (0.28-3.14)	199 (7.1)	0.78 (0.41-1.47)
Ghana						
No	2212 (9.9)	1.00 (Reference)	2222 (3.8)	1.00 (Reference)	2207 (10.4)	1.00 (Reference)
Yes	114 (5.3)	0.41 (0.16-1.04)	114 (2.6)	0.58 (0.17-1.95)	114 (7.9)	0.62 (0.28-1.31)

Model 3, adjusted for age, sex educational level, hypertension, diabetes, hypercholesterolemia, BMI, physical activity and smoking; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S2: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by obesity status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe/Not obese									
No	736 (7.4)	1.00 (Reference)	1.00 (Reference)	729 (2.5)	1.00 (Reference)	1.00 (Reference)	719 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	1003 (7.7)	0.98 (0.67-1.40)	0.99 (0.69-1.43)	992 (2.0)	0.77 (0.40-1.48)	0.71 (0.36-1.42)	971 (7.9)	0.91 (0.64-1.29)	0.89 (0.62-1.29)
Europe/Obese									
No	390 (9.2)	1.00 (Reference)	1.00 (Reference)	375 (2.9)	1.00 (Reference)	1.00 (Reference)	369 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	607 (9.6)	1.05 (0.67-1.63)	1.14 (0.72-1.82)	590 (3.2)	0.97 (0.44-2.11)	1.01 (0.44-2.26)	581 (9.6)	1.15 (0.73-1.82)	1.15 (0.71-1.85)
Ghana/Not obese									
No	588 (9.5)	1.00 (Reference)	1.00 (Reference)	592 (4.7)	1.00 (Reference)	1.00 (Reference)	588 (10.0)	1.00 (Reference)	1.00 (Reference)
Yes	1324 (8.5)	0.86 (0.61-1.21)	0.83 (0.59-1.17)	1331 (3.4)	0.64 (0.39-1.05)	0.65 (0.39-1.83)	1321 (9.0)	0.86 (0.61-1.20)	0.84 (0.60-1.18)
Ghana/Obese									
No	144 (13.9)	1.00 (Reference)	1.00 (Reference)	144 (3.5)	1.00 (Reference)	1.00 (Reference)	144 (14.6)	1.00 (Reference)	1.00 (Reference)
Yes	268 (13.1)	0.91 (0.50-1.64)	0.91 (0.49-1.65)	267 (3.8)	1.04 (0.34-3.16)	1.09 (0.35-3.37)	266 (14.3)	0.94 (0.52-1.68)	0.94 (0.52-1.67)
Discrimination									
Europe/Not obese									
No	1186 (8.4)	1.00 (Reference)	1.00 (Reference)	1172 (2.4)	1.00 (Reference)	1.00 (Reference)	1150 (9.4)	1.00 (Reference)	1.00 (Reference)
Yes	538 (5.9)	0.69 (0.46-1.05)	0.71 (0.46-1.11)	532 (1.5)	0.62 (0.28-1.37)	0.57 (0.24-1.34)	525 (5.9)	**0.63 (0.42-0.96)**	**0.63 (0.41-0.97)**
Europe/Obese									
No	709 (8.7)	1.00 (Reference)	1.00 (Reference)	691 (3.0)	1.00 (Reference)	1.00 (Reference)	678 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	269 (10.0)	1.14 (0.71-1.85)	1.29 (0.78-2.12)	256 (3.5)	1.15 (0.50-2.63)	1.27 (0.54-2.99)	254 (9.8)	1.13 (0.69-1.86)	1.22 (0.73-2.13)
Ghana/Not obese									
No	1648 (9.1)	1.00 (Reference)	1.00 (Reference)	1661 (3.9)	1.00 (Reference)	1.00 (Reference)	1646 (9.6)	1.00 (Reference)	1.00 (Reference)
Yes	81 (8.6)	1.06 (0.48-2.38)	1.04 (0.47-2.32)	81 (2.5)	1.04 (0.48-2.32)	0.86 (0.20-3.69)	81 (7.4)	0.90 (0.38-2.12)	0.89 (0.38-2.11)

Ghana/Obese									
No	383 (13.8)	1.00 (Reference)	1.00 (Reference)	383 (3.7)	1.00 (Reference)	1.00 (Reference)	382 (14.9)	1.00 (Reference)	1.00 (Reference)
Yes	23 (4.4)	0.31 (0.04-2.36)	0.40 (0.05-3.11)	23 (0.0)	**** (***-***)	**** (***-***)	23 (4.4)	0.29 (0.04-2.22)	0.34 (0.04-2.66)
Stress at home/work									
Europe/Not obese									
Never	855 (7.4)	1.00 (Reference)	1.00 (Reference)	847 (3.4)	1.00 (Reference)	1.00 (Reference)	831 (8.2)	1.00 (Reference)	1.00 (Reference)
Some stress	629 (8.3)	1.16 (0.79-1.70)	1.20 (0.81-1.79)	627 (1.4)	0.52 (0.24-1.12)	0.47 (0.21-1.07)	615 (7.9)	0.98 (0.66-1.43)	0.98 (0.65-1.46)
Several/Permanent stresses	247 (6.9)	0.93 (0.53-1.62)	1.15 (0.77-1.72)	239 (2.3)	0.45 (0.13-1.52)	0.49 (0.15-1.67)	236 (9.1)	0.97 (0.57-1.65)	1.04 (0.61-1.78)
Europe/Obese									
Never	472 (9.8)	1.00 (Reference)	1.00 (Reference)	455 (3.9)	1.00 (Reference)	1.00 (Reference)	448 (10.3)	1.00 (Reference)	1.00 (Reference)
Some stress	372 (7.5)	0.72 (0.44-1.18)	0.79 (0.47-1.32)	356 (1.4)	0.41 (0.15-1.16)	0.43 (0.15-1.21)	352 (9.5)	0.94 (0.57-1.53)	1.05 (0.62-1.76)
Several/Permanent stresses	147 (12.2)	1.32 (0.74-2.38)	1.31 (0.72-2.42)	148 (4.1)	1.05 (0.40-2.79)	1.09 (0.40-2.91)	144 (8.5)	1.36 (0.74-2.49)	1.41 (0.75-2.64)
Ghana/Not obese									
Never	537 (9.7)	1.00 (Reference)	1.00 (Reference)	542 (3.1)	1.00 (Reference)	1.00 (Reference)	537 (8.9)	1.00 (Reference)	1.00 (Reference)
Some stress	1055 (8.3)	0.79 (0.56-1.15)	0.74 (0.52-1.07)	1057 (3.9)	1.16 (0.65-2.09)	1.21 (0.67-2.18)	1052 (9.0)	0.92 (0.64-1.35)	0.90 (0.62-1.32)
Several/permanent stresses	319 (8.5)	0.81 (0.49-1.32)	0.73 (0.44-1.20)	323 (4.3)	1.34 (0.64-2.83)	1.43 (0.67-3.04)	319 (10.7)	1.12 (0.69-1.79)	1.09 (0.68-1.76)
Ghana/Obese									
Never	145 (12.4)	1.00 (Reference)	1.00 (Reference)	146 (4.1)	1.00 (Reference)	1.00 (Reference)	145 (13.8)	1.00 (Reference)	1.00 (Reference)
Some stress	221 (14.9)	1.21 (0.64-2.26)	1.05 (0.55-1.99)	219 (3.7)	0.74 (0.25-2.22)	0.83 (0.26-2.06)	219 (15.9)	1.13 (0.62-2.07)	1.02 (0.55-1.89)
Several/Permanent stresses	46 (8.7)	0.64 (0.20-2.01)	0.52 (0.16-1.65)	46 (2.2)	0.41 (0.05-3.61)	0.45 (0.05-4.01)	46 (8.8)	0.55 (0.17-1.71)	0.47 (0.14-1.50)
Depressive symptoms									
Europe/Not obese									
No	1601 (7.9)	1.00 (Reference)	1.00 (Reference)	1586 (2.2)	1.00 (Reference)	1.00 (Reference)	1558 (8.3)	1.00 (Reference)	1.00 (Reference)
Yes	121 (4.9)	0.59 (0.25-1.36)	0.65 (0.27-1.48)	117 (1.7)	0.79 (0.18-2.35)	0.86 (0.21-3.80)	115 (5.22)	0.58 (0.25-1.35)	0.64 (0.27-1.49)
Europe/Obese									
No	899 (9.7)	1.00 (Reference)	1.00 (Reference)	866 (3.4)	1.00 (Reference)	1.00 (Reference)	853 (9.4)	1.00 (Reference)	1.00 (Reference)

Yes	83 (7.2)	0.71 (0.29-1.67)	0.72 (0.30-1.74)	83 (1.2)	0.46 (0.06-3.52)	0.46 (0.06-3.57)	82 (8.5)	0.89 (0.40-2.01)	0.90 (0.40-2.04)
Ghana/Not obese									
No	1811 (8.9)	1.00 (Reference)	1.00 (Reference)	1822 (3.9)	1.00 (Reference)	1.00 (Reference)	1808 (9.4)	1.00 (Reference)	1.00 (Reference)
Yes	100 (6.0)	0.57 (0.24-1.33)	0.56 (0.24-1.32)	100 (2.0)	0.38 (0.09-1.63)	0.38 (0.09-1.63)	100 (8.0)	0.69 (0.32-1.46)	0.69 (0.32-1.47)
Ghana/Obese									
No	398 (13.8)	1.00 (Reference)	1.00 (Reference)	397 (3.5)	1.00 (Reference)	1.00 (Reference)	396 (14.7)	1.00 (Reference)	1.00 (Reference)
Yes	14 (0.0)	*** (****-****)	*** (****-****)	14 (7.1)	1.76 (0.21-14.89)	2.14 (0.25-8.78)	14 (7.1)	0.42 (0.05-3.32)	0.38 (0.05-3.07)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S3: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by diabetes status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe/No diabetes									
No	986 (8.0)	1.00 (Reference)	1.00 (Reference)	971 (2.1)	1.00 (Reference)	1.00 (Reference)	957 (7.9)	1.00 (Reference)	1.00 (Reference)
Yes	1359 (7.7)	0.95 (0.70-1.29)	0.97 (0.71-1.34)	1340 (2.0)	0.90 (0.50-1.63)	0.90 (0.48-1.68)	1315 (8.1)	1.01 (0.75-1.37)	0.99 (0.72-1.36)
Europe/Diabetes									
No	142 (9.9)	1.00 (Reference)	1.00 (Reference)	135 (6.7)	1.00 (Reference)	1.00 (Reference)	133 (12.8)	1.00 (Reference)	1.00 (Reference)
Yes	256 (12.5)	1.28 (0.66-2.50)	1.41 (0.71-2.82)	247 (4.9)	0.75 (0.29-1.89)	10.68 (0.27-1.77)	242 (11.2)	0.87 (0.46-1.69)	0.96 (0.49-1.88)
Ghana/No diabetes									
No	683 (9.1)	1.00 (Reference)	1.00 (Reference)	687 (4.1)	1.00 (Reference)	1.00 (Reference)	683 (9.8)	1.00 (Reference)	1.00 (Reference)
Yes	1447 (7.7)	0.84 (0.60-1.16)	0.82 (0.59-1.14)	1451 (3.1)	0.69 (0.42-1.13)	0.69 (0.42-1.13)	1442 (8.3)	0.82 (0.59-1.12)	0.80 (0.58-1.10)
Ghana/Diabetes									
No	49 (28.3)	1.00 (Reference)	1.00 (Reference)	49 (10.2)	1.00 (Reference)	1.00 (Reference)	49 (26.4)	1.00 (Reference)	1.00 (Reference)
Yes	148 (24.3)	0.78 (0.37-1.61)	0.72 (0.34-1.52)	150 (7.3)	0.55 (0.16-1.81)	0.57 (0.17-1.88)	148 (26.4)	0.93 (0.45-1.97)	0.90 (0.43-1.92)
Discrimination									
Europe/No diabetes									
No	1629 (7.9)	1.00 (Reference)	1.00 (Reference)	1609 (2.2)	1.00 (Reference)	1.00 (Reference)	1580 (8.3)	1.00 (Reference)	1.00 (Reference)
Yes	684 (6.7)	0.85 (0.60-1.21)	0.89 (0.62-1.28)	669 (1.5)	0.68 (0.33-1.40)	0.69 (0.32-1.47)	661 (7.0)	0.84 (0.59-1.20)	0.86 (0.59-1.25)
Europe/Diabetes									

No	270 (11.9)	1.00 (Reference)	1.00 (Reference)	258 (5.4)	1.00 (Reference)	1.00 (Reference)	252 (13.1)	1.00 (Reference)	1.00 (Reference)
Yes	126 (11.1)	0.87 (0.44-1.71)	0.89 (0.45-1.76)	122 (5.7)	1.29 (0.48-3.45)	1.25 (0.46-3.37)	121 (9.1)	0.68 (0.32-1.40)	0.69 (0.33-1.42)
Ghana/No diabetes									
No	1854 (8.4)	1.00 (Reference)	1.00 (Reference)	1865 (3.5)	1.00 (Reference)	1.00 (Reference)	1851 (9.0)	1.00 (Reference)	1.00 (Reference)
Yes	99 (8.1)	1.03 (0.49-2.17)	1.04 (0.49-2.19)	99 (2.0)	0.79 (0.19-3.33)	0.78 (0.18-3.29)	99 (7.1)	0.87 (0.39-1.93)	0.88 (0.39-1.95)
Ghana/Diabetes									
No	180 (26.7)	1.00 (Reference)	1.00 (Reference)	182 (7.7)	1.00 (Reference)	1.00 (Reference)	180 (27.2)	1.00 (Reference)	1.00 (Reference)
Yes	5 (0.0)	**** (***-***)	0.40 (0.05-3.11)	5 (0.0)	**** (***-***)	**** (***-***)	5 (0.0)	**** (***-***)	**** (***-***)
Stress at home/work									
Europe/No diabetes									
Never	1137 (7.9)	1.00 (Reference)	1.00 (Reference)	1127 (2.3)	1.00 (Reference)	1.00 (Reference)	1102 (8.0)	1.00 (Reference)	1.00 (Reference)
Some stress	860 (7.2)	0.90 (0.65-1.27)	0.96 (0.68-1.36)	850 (1.2)	0.49 (0.24-1.02)	0.49 (0.22-1.07)	835 (7.4)	0.94 (0.67-1.31)	0.99 (0.69-1.41)
Several/Permanent stresses	335 (8.4)	1.04 (0.67-1.62)	1.07 (0.68-1.70)	327 (2.1)	0.84 (0.36-1.95)	0.92 (0.39-2.17)	322 (9.6)	1.20 (0.77-1.85)	1.28 (0.82-1.99)
Europe/Diabetes									
Never	193 (9.8)	1.00 (Reference)	1.00 (Reference)	184 (8.2)	1.00 (Reference)	1.00 (Reference)	180 (11.7)	1.00 (Reference)	1.00 (Reference)
Some stress	142 (12.7)	1.22 (0.61-2.45)	1.38 (0.67-2.81)	134 (3.0)	0.43 (0.13-1.39)	0.40 (0.12-1.29)	133 (12.0)	1.04 (0.52-2.09)	1.13 (0.56-2.32)
Several/Permanent stresses	62 (12.9)	1.31 (0.54-3.16)	1.38 (0.56-3.41)	63 (3.2)	0.49 (0.10-2.29)	0.46 (0.10-2.23)	61 (9.8)	0.82 (0.31-2.13)	0.89 (0.34-2.35)
Ghana/No diabetes									
Never	628 (7.8)	1.00 (Reference)	1.00 (Reference)	634 (2.7)	1.00 (Reference)	1.00 (Reference)	628 (7.6)	1.00 (Reference)	1.00 (Reference)
Some stress	1163 (8.6)	1.06 (0.74-1.51)	0.97 (0.67-1.39)	1163 (3.7)	1.27 (0.71-2.27)	1.32 (0.74-2.34)	1158 (9.3)	1.15 (0.80-1.65)	1.10 (0.77-1.58)
Several/permanent stresses	339 (7.4)	0.88 (0.53-1.46)	0.76 (0.46-1.27)	341 (3.5)	1.24 (0.58-2.67)	1.35 (0.62-2.95)	339 (8.9)	1.07 (0.66-1.73)	1.00 (0.61-1.64)
Ghana/Diabetes									
Never	54 (38.9)	1.00 (Reference)	1.00 (Reference)	54 (11.1)	1.00 (Reference)	1.00 (Reference)	54 (37.0)	1.00 (Reference)	1.00 (Reference)
Some stress	116 (18.9)	**0.37 (0.37-0.77)**	**0.35 (0.17-0.75)**	116 (6.0)	0.47 (0.14-1.60)	0.45 (0.12-1.55)	116 (19.8)	**0.43 (0.21-0.89)**	**0.40 (0.19-0.86)**
Several/Permanent stresses	26 (25.0)	0.44 (0.44-1.29)	0.39 (0.13-1.19)	28 (10.7)	0.65 (0.13-3.21)	0.62 (0.12-3.23)	26 (30.8)	0.69 (0.25-1.93)	0.64 (0.22-1.87)

Depressive symptoms									
Europe/No diabetes									
No	2154 (8.0)	1.00 (Reference)	1.00 (Reference)	2122 (2.1)	1.00 (Reference)	1.00 (Reference)	2087 (8.1)	1.00 (Reference)	1.00 (Reference)
Yes	167 (5.4)	0.63 (0.32-1.25)	0.69 (0.34-1.38)	163 (2.0)	0.65 (0.15-2.72)	0.72 (0.17-3.04)	161 (6.8)	0.58 (0.25-1.35)	0.86 (0.46-1.64)
Europe/Diabetes									
No	351 (12.0)	1.00 (Reference)	1.00 (Reference)	335 (35.9)	1.00 (Reference)	1.00 (Reference)	329 (12.5)	1.00 (Reference)	1.00 (Reference)
Yes	39 (10.3)	0.79 (0.26-1.35)	0.73 (0.24-2.19)	39 (2.6)	0.49 (0.06-3.97)	0.49 (0.06-3.99)	38 (7.9)	0.89 (0.40-2.01)	0.60 (0.17-2.08)
Ghana/No diabetes									
No	2027 (8.3)	1.00 (Reference)	1.00 (Reference)	2035 (3.4)	1.00 (Reference)	1.00 (Reference)	2022 (8.8)	1.00 (Reference)	1.00 (Reference)
Yes	102 (4.9)	0.50 (0.20-1.25)	0.48 (0.19-1.19)	102 (2.9)	0.64 (0.19-2.13)	0.67 (0.20-2.21)	102 (7.8)	0.69 (0.32-1.46)	0.71 (0.34-1.51)
Ghana/Diabetes									
No	185 (26.5)	1.00 (Reference)	1.00 (Reference)	187 (8.7)	1.00 (Reference)	1.00 (Reference)	185 27.6)	1.00 (Reference)	1.00 (Reference)
Yes	12 (8.3)	0.27 (0.03-2.13)	0.25 (0.03-2.01)	12 (0.0)	*** (****-****)	*** (***-***)	12 (8.3)	0.42 (0.05-3.32)	0.27 (0.03-2.19)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S4: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by hypertensive status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
	n (%)	OR (95% CI) Model 1	Model 2	n (%)	OR (95% CI) Model 1	Model 2	n cases (%)	OR (95% CI) Model 1	Model 2
Negative events									
Europe/No hypertension									
No	568 (6.9)	1.00 (Reference)	1.00 (Reference)	562 (1.3)	1.00 (Reference)	1.00 (Reference)	551 (7.1)	1.00 (Reference)	1.00 (Reference)
Yes	743 (5.0)	0.72 (0.45-1.15)	0.78 (0.48-1.27)	740 (0.8)	0.59 (0.19-1.77)	0.60 (0.20-1.83)	724 (5.1)	0.71 (0.44-1.13)	0.75 (0.46-1.22)
Europe/Hypertension									
No	560 (9.6)	1.00 (Reference)	1.00 (Reference)	544 (4.0)	1.00 (Reference)	1.00 (Reference)	539 (10.0)	1.00 (Reference)	1.00 (Reference)
Yes	872 (11.4)	1.22 (0.86-1.73)	1.20 (0.83-1.73)	847 (3.9)	0.95 (0.54-1.67)	0.89 (0.49-1.62)	833 (11.6)	1.19 (0.83-1.69)	1.13 (0.78-1.62)
Ghana/No Hypertension									
No	540 (6.3)	1.00 (Reference)	1.00 (Reference)	543 (2.2)	1.00 (Reference)	1.00 (Reference)	540 (6.9)	1.00 (Reference)	1.00 (Reference)
Yes	1118 (5.6)	0.88 (0.57-1.36)	0.84 (0.54-1.31)	1124 (1.9)	0.82 (0.39-1.69)	0.86 (0.41-1.79)	1115 (6.4)	0.93 (0.61-1.40)	0.90 (0.59-1.36)
Ghana/Hypertension									
No	192 (21.9)	1.00 (Reference)	1.00 (Reference)	193 (10.9)	1.00 (Reference)	1.00 (Reference)	192 (22.4)	1.00 (Reference)	1.00 (Reference)
Yes	476 (18.1)	0.78 (0.52-1.18)	0.79 (0.52-1.20)	476 (6.9)	0.58 (0.32-1.04)	0.58 (0.33-1.05)	474 (18.4)	0.77 (0.50-1.16)	0.76 (0.51-1.16)

Discrimination									
Europe/No hypertension									
No	916 (6.3)	1.00 (Reference)	1.00 (Reference)	907 (0.8)	1.00 (Reference)	1.00 (Reference)	885 (6.8)	1.00 (Reference)	1.00 (Reference)
Yes	379 (3.7)	0.60 (0.33-1.09)	0.65 (0.36-1.21)	378 (1.1)	1.35 (0.39-4.74)	1.37 (0.38-4.89)	374 (3.2)	**0.47 (0.25-0.89)**	**0.51 (0.27-0.97)**
Europe/Hypertension									
No	983 (10.5)	1.00 (Reference)	1.00 (Reference)	960 (4.4)	1.00 (Reference)	1.00 (Reference)	947 (10.9)	1.00 (Reference)	1.00 (Reference)
Yes	431 (10.7)	1.03 (0.71-1.49)	1.05 (0.72-1.54)	413 (3.2)	0.73 (0.38-1.39)	0.75 (0.38-1.48)	408 (11.0)	1.03 (0.71-1.49)	1.04 (0.71-1.53)
Ghana/No hypertension									
No	1427 (5.7)	1.00 (Reference)	1.00 (Reference)	1437 (2.2)	1.00 (Reference)	1.00 (Reference)	1424 (6.5)	1.00 (Reference)	1.00 (Reference)
Yes	81 (7.4)	1.30 (0.55-3.09)	1.30 (0.55-3.10)	81 (0.0)	**** (***-***)	**** (***-***)	81 (7.4)	1.21 (0.51-2.88)	1.22 (0.51-2.89)
Ghana/Hypertension									
No	606 (20.3)	1.00 (Reference)	1.00 (Reference)	609 (7.9)	1.00 (Reference)	1.00 (Reference)	606 (20.3)	1.00 (Reference)	1.00 (Reference)
Yes	23 (8.7)	0.38 (0.09-1.68)	0.40 (0.09-1.74)	23 (8.7)	1.27 (0.28-5.70)	1.20 (0.26-5.44)	23 (4.4)	0.19 (0.03-1.44)	0.19 (0.03-1.45)
Stress at home/work									
Europe/No hypertension									
Never	644 (6.1)	1.00 (Reference)	1.00 (Reference)	640 (1.3)	1.00 (Reference)	1.00 (Reference)	625 (5.8)	1.00 (Reference)	1.00 (Reference)
Some stress	468 (4.5)	0.74 (0.43-1.27)	0.81 (0.46-1.43)	464 (0.4)	0.37 (0.07-1.74)	0.41 (0.09-2.01)	457 (4.8)	0.84 (0.49-1.45)	0.91 (0.52-1.60)
Several/Permanent stresses	192 (6.8)	1.07 (0.56-2.05)	1.19 (0.61-2.29)	191 (1.6)	1.49 (0.38-5.78)	1.52 (0.39-5.98)	186 (8.1)	1.38 (0.74-2.60)	1.49 (0.79-2.84)
Europe/Hypertension									
Never	686 (10.2)	1.00 (Reference)	1.00 (Reference)	665 (5.4)	1.00 (Reference)	1.00 (Reference)	657 (11.1)	1.00 (Reference)	1.00 (Reference)
Some stress	534 (11.1)	1.03 (0.71-1.49)	1.05 (0.72-1.54)	520 (2.3)	**0.49 (0.25-0.96)**	**0.47 (0.23-0.95)**	511 (10.9)	0.97 (0.67-1.41)	0.99 (0.67-0.47)
Several/Permanent stresses	205 (11.2)	1.11 (0.67-1.82)	1.12 (0.67-1.87)	199 (3.0)	0.56 (0.23-1.37)	0.58 (0.24-1.43)	197 (11.2)	0.99 (0.59-1.64)	1.03 (0.61-1.74)
Ghana/No hypertension									
Never	495 (5.5)	1.00 (Reference)	1.00 (Reference)	498 (1.4)	1.00 (Reference)	1.00 (Reference)	495 (5.9)	1.00 (Reference)	1.00 (Reference)
Some stress	899 (5.9)	1.07 (0.66-1.73)	0.99 (0.61-1.60)	901 (2.2)	1.30 (0.54-3.15)	1.39 (0.57-3.37)	896 (6.5)	1.04 (0.65-1.65)	1.00 (0.63-1.59)

Several/permanent stresses	263 (5.7)	1.01 (0.53-1.95)	0.89 (0.46-1.72)	267 (2.6)	1.69 (0.58-5.01)	1.89 (0.63-5.65)	263 (7.6)	1.21 (0.67-2.20)	1.15 (0.63-2.11)
Ghana/Hypertension									
Never	187 (22.9)	1.00 (Reference)	1.00 (Reference)	190 (8.4)	1.00 (Reference)	1.00 (Reference)	187 (20.9)	1.00 (Reference)	1.00 (Reference)
Some stress	379 (18.2)	0.74 (0.48-1.14)	0.68 (0.43-1.05)	377 (7.9)	0.95 (0.50-1.80)	0.99 (0.51-1.91)	377 (19.4)	0.90 (0.58-1.40)	0.87 (0.55-1.36)
Several/Permanent stresses	102 (15.7)	0.62 (0.33-1.17)	0.54 (0.28-1.04)	102 (7.8)	0.92 (0.37-2.26)	0.97 (0.39-2.43)	102 (17.7)	0.79 (0.42-1.49)	0.76 (0.40-1.43)
Depressive symptoms									
Europe/No hypertension									
No	1195 (5.9)	1.00 (Reference)	1.00 (Reference)	1187 (1.1)	1.00 (Reference)	1.00 (Reference)	1162 (6.0)	1.00 (Reference)	1.00 (Reference)
Yes	101 (3.9)	0.59 (0.21-1.65)	0.64 (0.23-1.82)	99 (1.0)	1.18 (0.15-2.72)	1.27 (0.16-10.17)	98 (5.1)	0.77 (0.30-1.97)	0.84 (0.33-2.17)
Europe/Hypertension									
No	1310(10.9)	1.00 (Reference)	1.00 (Reference)	1270 (4.1)	1.00 (Reference)	1.00 (Reference)	1254 (11.2)	1.00 (Reference)	1.00 (Reference)
Yes	105 (8.6)	0.76 (0.37-1.53)	0.75 (0.37-1.55)	103 (1.9)	0.52 (0.12-2.18)	0.56 (0.13-2.38)	101 (8.9)	0.77 (0.38-1.58)	0.80 (0.39-1.63)
Ghana/No hypertension									
No	1575 (5.9)	1.00 (Reference)	1.00 (Reference)	1584 (2.1)	1.00 (Reference)	1.00 (Reference)	1572 (6.7)	1.00 (Reference)	1.00 (Reference)
Yes	82 (2.4)	0.36 (0.09-1.51)	0.35 (0.08-1.44)	82 (1.2)	0.39 (0059-2.95)	0.39 (0.05-2.97)	82 (3.7)	0.44 (0.13-1.42)	0.43 (0.13-1.40)
Ghana/Hypertension									
No	636 (19.5)	1.00 (Reference)	1.00 (Reference)	637 (8.2)	1.00 (Reference)	1.00 (Reference)	634 (19.6)	1.00 (Reference)	1.00 (Reference)
Yes	32 (12.5)	0.59 (0.20-1.72)	0.59 (0.20-1.74)	32 (6.3)	0.74 (0.17-3.25)	0.76 (0.17-3.33)	32 (18.8)	0.94 (0.0.37-2.37)	0.94 (0.38-2.37)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1,2	We have included a commonly used term in the title and abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	2	Our study shows no convincing evidence for associations between stress as indicated by four PS constructs and prevalence of CKD. Further studies aimed at identifying potential factors driving the high prevalence of CKD among these populations are needed.
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	4	The theoretical and scientific background as well as the rationale for conducting the study have been provided in the introduction section.
Objectives	3	State specific objectives, including any prespecified hypotheses	4	We examined the

				association between PS and CKD prevalence among rural and urban Ghanaians and their migrants living in three European cities. We also assessed if the influence of PS on CKD is partially mediated by primary risk factors (hypertension and diabetes) of CKD.
Methods				
Study design	4	Present key elements of study design early in the paper	5-6	Details given in the methods
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	5-6	Rural or urban Ghana and three (Amsterdam, Berlin, London) European cities (migrants)
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	6-8	A multi-centred cross sectional baseline data from the Research on Obesity and Diabetes among African Migrants (RODAM) study. A random sample of

				5,659 adults (Europe, 3167, rural, 1,043, Urban Ghana, 1,449, Ghana) aged 25 to 70 years.
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	6-8	The main outcomes have been clearly defined.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	*6-8*	We defined each variable of interest in the methods accordingly
Bias	9	Describe any efforts to address potential sources of bias	18	Potential sources of bias have discussed in the discussion section
Study size	10	Explain how the study size was arrived at	5	Given in the methods section and we have also referred to the RODAM study methods paper

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	8-9	Please see methods
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	8-9	Please see methods
		(*b*) Describe any methods used to examine subgroups and interactions	8-9	Please see methods
		(*c*) Explain how missing data were addressed	8-9	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NA	We have reported non-response across sites
		(*e*) Describe any sensitivity analyses	NA	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	5	Non-response analysis was done to shed light on the differential response rates across sites
		(b) Give reasons for non-participation at each stage	5	
		(c) Consider use of a flow diagram	5	We have also referred to RODAM methods paper
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	5	We have also referred to RODAM methods paper
		(b) Indicate number of participants with missing data for each variable of interest	5	We have also referred to RODAM methods paper
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*NA*	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*NA*	
		Cross-sectional study—Report numbers of outcome events or summary measures	*9-10*	Summary measures are given in the results section and in tables and figures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	*12-16*	Unadjusted and adjusted estimates are given in the results section and in figures
		(*b*) Report category boundaries when continuous variables were categorized	12-16	We have provided mean and corresponding standard deviations for the continuous variables.

		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time	NA	

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	
Discussion				
Key results	18	Summarise key results with reference to study objectives	8	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	18	Key limitations regarding study methods including differential response rates and sampling methods in the various study sites have been provided
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	17-18	Cautious overall interpretation of the key findings have been provided.
Generalisability	21	Discuss the generalisability (external validity) of the study results	17-18	
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	19	The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

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A CROSS SECTIONAL STUDY OF ASSOCIATION BETWEEN PSYCHOSOCIAL STRESSORS WITH CHRONIC KIDNEY DISEASE AMONG MIGRANT AND NON-MIGRANT GHANAIANS LIVING IN EUROPE AND GHANA: THE RODAM STUDY

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-027931.R1
Article Type:	Research
Date Submitted by the Author:	12-Mar-2019
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Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Public health, Renal medicine
Keywords:	Chronic Kidney Disease, Psychosocial stressors, migrants, rodam study, Europe, Ghana

A CROSS SECTIONAL STUDY OF ASSOCIATION BETWEEN PSYCHOSOCIAL STRESSORS WITH CHRONIC KIDNEY DISEASE AMONG MIGRANT AND NON-MIGRANT GHANAIANS LIVING IN EUROPE AND GHANA: THE RODAM STUDY

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Abstract

Objectives: The association between Psychosocial stressors (PS) and CKD among sub-Saharan African (SSA) populations is unknown. We examined the association between PS and CKD prevalence among rural and urban Ghanaians and Ghanaian migrants living in three European cities. We also assessed if the influence of PS on CKD is partially mediated by primary risk factors (hypertension and diabetes) of CKD.

Design: A multi-centred cross sectional data from the Research on Obesity and Diabetes among African Migrants (RODAM) study.

Setting: Rural and urban Ghana and three European cities (Amsterdam, Berlin and London).

Participants: A random sample of 5,659 adults (Europe 3167, rural Ghana 1,043, and Urban Ghana 1,449) aged 25 to 70 years.

Explanatory and outcome measures: PS was defined by negative life events, perceived discrimination, perceived stress at work/home and depressive symptoms. Three CKD outcomes were considered using the 2012 KDIGO (Kidney Disease: Improving Global Outcomes) severity of CKD classification. Comparisons between PS and CKD outcomes were made using logistic regression analyses across all sites.

Results: We observed higher proportion of negative life events (68.7%) and perceived permanent stress (15.9%) among Ghanaians living in Ghana than Ghanaians living in Europe. Depressive symptoms (7.5%) and perceived discrimination (29.7%) were more common among Ghanaians living in Europe than Ghanaians living in Ghana. No significant association was observed between any of the PS constructs and CKD outcomes across sites except for positive association between stress at work/home and albuminuria (2.81, 95% C.I. 1.46-5.40) and CKD risk (2.78, 95% C.I. 1.43-5.43) among Ghanaians living in Berlin.

Conclusion: Our study shows no convincing evidence of associations between PS constructs and the prevalence of CKD outcomes. Further studies are needed to identify potential factors driving the high prevalence of CKD among these populations.

Index Words: Chronic kidney disease; psychosocial stressors; risk factor; migrants; RODAM study, Europe, Ghana

Strengths and limitations of the study

- This study used all three categories of CKD definitions (albuminuria, reduced eGFR and CKD risk) by KDIGO 2012 in assessing association of SS with CKD across all sites. This provided more detailed information on CKD outcomes.
- All sites in our study used well standardized study protocols and this eliminated intra protocol variability.
- The use of four constructs of psychosocial stressors (negative life events, perceived discrimination, perceived stress at work/home and depressive symptoms) provided a robust approach to assessing SS associations with CKD.
- The limitation of intra laboratory variability in earlier studies was eliminated using the same standard operating procedures in the same laboratory for running all samples for all sites.
- PS is captured and experienced in different magnitude across different populations. We were unable to ascertain if PS as defined in this study was adequately captured among Ghanaians living in rural and urban Ghana.

Introduction

Worldwide, Chronic Kidney Disease (CKD) is a leading cause of mortality and morbidity with several risk factors (diabetes mellitus, obesity, hypertension and cardiovascular disease) [1]. The epidemiologic transition in low-and-middle income countries (LMICs) shows increased burden of these risk factors [2-4]. CKD's high morbidity and mortality is mostly driven by uncontrolled comorbidities such as diabetes and hypertension [5 6]. CKD treatment and management cost is very high and not sustainable even in high-income countries and this underscores the need for prevention [7]. Available literature has shown that both individual and community level economic factors influence CKD [8-10]. However, after adjusting for both individual and community level socioeconomic position, differences in CKD risk among different populations remained [8 10 11]. These findings seem to suggest that other social environmental factors may be driving CKD prevalence and progression in high-risk populations. Recent studies have shown that whereas Ghanaians living in Europe have a higher CKD risk compared to their host nation populations, they have a lower CKD risk compared with their peers living in urban Ghana [12]. The increased risk of CKD observed in urban Ghana was not fully explained by conventional risk factors [12] and socio-economic status [13]. This underscores the need to identify other modifiable risk factors of CKD for prevention, optimum treatment and efficient management.

Evidence shows that where an individual works or stays influences his or her physiological wellbeing leading to an increased risk of chronic diseases [14 15]. Thus, migrants' physiological wellbeing is influenced by the environment (host nations) they move to stay. The association between PS and CKD as well as the biological pathways through which PS influences CKD progression is poorly understood and complex [5] although several pathways have been suggested [16 17]. Specifically, PS have been reported to be associated with alteration in the sympathetic/autonomic nervous system activity leading to higher rates of traditional risk factors of CKD including hypertension and diabetes [18-20]. Environmental stressors have been reported to contribute to the development of insulin resistance, metabolic syndrome, obesity and diabetes which if uncontrolled leads to CKD incidence [21 22]. Other studies [23 24] have suggested that stress attributable to social and/or economic disadvantage is associated with CKD development and progression through an interaction between other psychosocial factors and comorbid behaviors such as alcohol, tobacco and drug use [25]. In addition, undernutrition due to stress adversely impact on fetal environment by impeding fetal growth leading to low birth weight, which has been shown to be associated with CKD in adult life [25 26].

However, studies linking psychosocial stressors (PS) to CKD prevalence and progression vary greatly among different geographical populations. [5 16 27-31]. Specifically, in the USA whereas no association was found between PS and CKD [31-33] another study reported lower prevalence of CKD was associated with

greater life stressors at baseline [31]. In contrast, in the Netherlands depressive and anxiety symptoms were observed to be common among CKD patients and such patients had increased risk of poor clinical outcomes [28]. Similarly, a study conducted in Korea reported a positive relationship between depressive symptoms and CKD [27]. These observations suggest differential impact of PS at different geographical locations. For example, discrimination among migrants may differ greatly between host population and from their SSA compatriots. Specifically, some studies have reported differences in PS among rural and urban populations [34].

Current literature on the association between PS and CKD among sub-Saharan African populations and their migrants in Europe is scanty and uncertain. We therefore sought to determine the association between PS and CKD prevalence among Ghanaians in rural and urban Ghana and their migrants living in three European cities. Furthermore, we examined the influence of psychosocial stressors on risk factors (obesity, diabetes and hypertension) of CKD.

Methods

Study population and study design

For this study, data from the Research on Obesity & Diabetes among African Migrants (RODAM) study, a multi-centre cross sectional study, were used. The rationale, conceptual framework, design and methodology of the RODAM study have been described in detail elsewhere [12 13 35 36]. To summarize, the study was conducted from 2012 to 2015. Ghanaians aged 25–70 years living in rural and urban communities in Ghana as well as in three European cities (Amsterdam, Berlin and London) were included in this study. We standardized data collection across all sites. The ethics committees in Ghana, the Netherlands, Germany and the UK approved the study protocol prior to data collection. Informed consent was obtained from each participant prior to enrollment in the study. In Ghana, participants were randomly drawn from a list of 30 enumeration areas in the Ashanti region based on the 2010 population census. These enumeration areas came from both rural areas and two purposively selected urban cities (Kumasi and Obuasi). For Ghanaians in Amsterdam, we randomly drew participants from the Municipal register. This register holds data on country of birth of citizens and their parents, thus allowing for sampling based on the Dutch standard indicator for ethnic origin. London lacked a population register for migrant groups. Thus, Ghanaian organizations served as sampling frame for the study. Lists of these organizations were obtained from the Ghanaian Embassy and the Association of Ghanaian Churches in the UK in the boroughs known to have the greatest concentration of Ghanaians. Members were selected from the lists of all members of these organizations. In Berlin, the registration office of the federal state of Berlin provided a list of Ghanaian individuals in Berlin but this resulted in low response rate. Because of this, a change was made to use lists

of Ghanaian churches and organizations as the sampling frame. Across all sites in Europe, all selected participants were sent a written invitation combined with written information (information sheet) regarding the study and a response card. The participants were contacted by phone to schedule a date and location of the interview with a trained research assistant or opt for the self-administration of the paper questionnaire or digital online version depending on the preference of the participant. After the completion of the questionnaire, a date for physical examination was then scheduled after a positive response. The participants were instructed to fast from 10.00 p.m. the night before the physical examination. The response rate was 76% in rural Ghana and 74% in urban Ghana. In London, of those individuals who were registered in the various Ghanaian organizations and were invited, 75% agreed and participated in the study, while in Berlin, this figure was 68%, and 53% in Amsterdam. For the current study, 5898 participants with data available on both questionnaire data and physical measurements were used. Individuals who were outside the age range of 25–70 years (n=239) were excluded because not all the study sites had individuals outside this age range resulting in 5659 individuals comprising of 2492 from rural and urban Ghana and 3167 from the three European cities. In the conduct of analysis, we further excluded individuals with no data on CKD and all other indicators (n=52), resulting in a data set of 5607 participants for analysis.

Measurements

Covariates

Demographic and lifestyle factors

For this study, we obtained information on demographics, educational level and lifestyle factors (smoking and physical activity) by questionnaire. Physical examinations were performed across all sites using validated devices per standardized operational procedures. Weight was measured in light clothing and without shoes with SECA 877 scales to the nearest 0.1 kg. Height was measured without shoes with a portable stadiometer (SECA 217) to the nearest 0.1 cm. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m2). Overweight was defined as BMI of 25 to < 30 kg/m^2 and obesity as BMI ≥30 kg/m^2. Waist circumference was measured in centimetres at the midpoint between the lower rib and the upper margin of the iliac crest. We used the same assessor for each participant in measuring all anthropometrics and each was measured twice; the average of the two measurements was used for analyses.

Predictor: SS

For this study, four constructs of psychosocial stress (discrimination, perceived stress at work or at home, negative life events and depressive symptoms) were used as explanatory variables.

Perceived discrimination

Everyday discrimination as perceived by participants was reported as routinely experiencing instances of unfair treatment. We used the the Everyday Discrimination Scale (EDS). The EDS comprises of a 9-items which rates the frequency at which participants experience daily mistreatment and it focuses on being treated with less courtesy or less respect, receiving poorer service than other people or being called names or insulted. Participants had the option of rating each of the 9-items from "never" = 1 to "very often" = 5. The obtained scores were summed and an average of the scores was computed to obtain a final score of 1 to 5. This scale was used because it is commonly used for self-reported discrimination [37], with consistent high reliability among a variety of ethnicities [38], comprising African migrants in the Netherland [39].

Perceived stress at work or at home

We defined perceived stress at work or at home as "sense of irritation, filled with anxiety, or as having difficulties in sleeping because of circumstances at work or at home". We used the psychological stress scale created by the INTERHEART study [40]. Participants in the study were asked about their opinion on frequency of stress at work and at home, and could answer "never", "some periods", "several periods", or "continually". Both answers were then combined into a composite score and graded into four categories: never experienced to experienced permanent stress at home or at work [40]. Due to the very small numbers in the permanent periods of stress group, we combined experienced several periods of stress at home or at work and permanent periods of stress at home or at work.

Negative life events

The presence of major negative life events among participants was perceived as any event that could cause acute stress to an individual. We therefore applied the well-validated and widely used List of Threatening Experiences (LTE) [41 42]. The scale comprised of 12 unpleasant events participants perceived to have experienced in the past 12 months. We used a slightly-altered version of LTE consisting of 9 unpleasant items. We dichotomized participants into two groups namely "no negative life events" and "one or more events" and participants in the second category were expected to have higher levels of stress [42].

Depressive symptoms

Depressive symptoms were measured by the 9-item Patient Health Questionnaire (PHQ-9). The PHQ-9 consists of nine items, with a response scales 0 'not at all', 1 'on several days', 2 'on more than half of the days' and 3 'nearly every day'. A participant was considered to be in a significant depressed mood (SDM) when one or both of the items 1 (little interest or pleasure in doing things) and 2 (feeling down, depressed, or hopeless) were answered with at least 'on more than half of the days', and at least 5 of the 9 items were answered with at least 'on more than half of the days'[43].

Co-morbidity factors

Blood pressure (BP) was measured three times using a validated semi-automated device (The Microlife WatchBP home) with appropriate cuffs in a sitting position after at least 5min rest. The mean of the last two BP measurements was used in the analyses. Hypertension was defined as systolic BP 140mmHg and/or diastolic BP 90mmHg, and/or being on antihypertensive medication treatment, and/or self-reported hypertension. Trained research assistants in all sites collected fasting venous blood samples according to standard operation procedures, and then temporarily stored at the local research location. The stored blood samples from the local research centres were transported to Berlin, Germany, according to standardized procedures, for biochemical analyses. This was done to avoid intra-laboratory variability. Fasting plasma glucose concentration was measured using an enzymatic method (hexokinase). We defined Type 2 diabetes according to the World Health Organization diagnostic criteria (fasting glucose 7.0mmol/L, and/or current use of medication prescribed to treat diabetes, and/or self-reported diabetes) [44]. We assessed concentration of total cholesterol using colorimetric test kits. All biochemical analyses were performed using an ABX Pentra 400 Chemistry Analyzer (ABX Pentra; Horiba 90 ABX, Germany). Hypercholesterolaemia was defined as total cholesterol level ≥6.22mmol/L. Serum creatinine concentration (in mol/L) was determined by a kinetic colorimetric spectrophotometric isotope dilution mass spectrometry calibration method (Roche Diagnostics).

Outcome: CKD prevalence

We asked participants to bring an early morning urine sample for the analyses of albuminuria and creatinine levels. Urinary albumin concentration (in μmol/L) was measured by an immunochemical turbidimetric method (Roche Diagnostics). Urinary creatinine concentration (in l mol/L) was measured by a kinetic spectrophotometric method (Roche Diagnostics). Extensive quality checks were done inclusive of blinded serial measurements. Estimated glomerular filtration rate (eGFR) was calculated using the CKDEPI (CKD Epidemiology Collaboration) creatinine equation [45]. Urinary albumin–creatinine ratio (ACR; expressed in mg/mmol) was calculated by taking the ratio between urinary albumin and urinary creatinine. eGFR and albuminuria were categorized according to the 2012 KDIGO classification [46]. eGFR was categorized as follows: G1, 90mL/min/1.73m^2 (normal kidney function); G2, 60–89mL/min/1.73m^2 (mildly decreased); G3a, 45–59mL/min/1.73m^2 (mildly to moderatelydecreased); G3b, 30–44mL/min/1.73m^2 (moderately to severely decreased); G4, 15–29 mL/min/1.73 m^2 (severely decreased); and G5, <15mL/min/1.73m^2 (kidney failure). Albuminuria categories were derived from ACR and were as follows: A1, < 3mg/mmol (normal to mildly increased); A2, 3–30mg/mmol (moderately increased); and A3, > 30mg/mmol (severely increased). CKD status was categorized according to severity of kidney disease (green, low risk; yellow, moderately increased risk; orange, high risk; and red, very high risk) using the combination of eGFR (G1–

G5) and albuminuria (A1–A3) levels defined by the 2012 KDIGO guideline [47]. Due to the small number of participants in the very high-risk category of CKD (n=27), the high and very high-risk groups were combined. Because of the small number of participants in the severely increased albuminuria category (A3, n=62), we defined albuminuria as ACR 3mg/ mmol by combining the moderately increased (A2) and severely increased (A3) categories.

Covariates assessed were age, sex, educational level and length of stay in Europe, hypertension and diabetes. Length of stay was assessed for Ghanaian migrants only. Length of stay was defined as the number of years lived in Europe at the time of data collection. Length of stay was controlled for due to evidence suggesting that it influences mental health [48]. Other covariates were hypertension, obesity and diabetes.

Patient and Public Involvement

Community leaders were involved in the recruitment of patients. These comprised of religious communities (churches and mosques), endorsement from local key leaders and establishing relationships with healthcare organizations. We also provided information on the study by involving the local media (radio and television stations). We sent letters to all selected health and community authorities to notify participants of the study. Team members were sent to the various communities to stay among the community and organize mini clinics for a period of 1-2 weeks. Results of the study were disseminated through seminars, durbars and via radio and television stations.

Statistical methods

Characteristics of participants were expressed as absolute numbers and percentages for categorical variables and means and standard deviations for continuous variables. The z-test was used to compare proportions of demographic and clinical variables among the various sites and the independent t-test was also used to test for mean differences between the two sites. Odds Ratios (ORs) and their corresponding 95% confidence intervals (CIs) were estimated by means of binary logistic regression analyses to study the associations of albuminuria (ACR>3 mg/mmol, A2-A3, moderately to severely increased albuminuria), reduced kidney function (eGFR< 60 mL/min/1.73m^2, G3-G5 moderately to severely decreased kidney function) and increased CKD risk (high and very high CKD risk), with adjustments for covariates [49]. The Spearman's correlation test was used to test for associations between all four constructs of PS. Three models were used to examine the data. Model 1 was adjusted for age and sex, model 2 was adjusted for age and sex and educational level for Ghanaians living in SSA while age, sex, educational level and length of stay for Ghanaians living in Europe [50-52]. Model 3 was adjusted for sex, age, educational level and conventional risk factors (hypertension, diabetes, hypercholesterolemia, BMI, physical activity and smoking status) of CKD.

The analyses were performed for all 4 constructs of PS using individuals who have not experienced either of the PS per outcome as reference. All tests were stratified per sites due to interactions, Ghanaians living in SSA and Europe; Ghanaians living in rural and urban Ghana and Ghanaians living in Amsterdam, Berlin and London due to an observed interaction between PS and site. Furthermore, the analyses were stratified for those with and without obesity, diabetes, hypertension across all sites. P-values less than 0.05 were interpreted as statistically significant. All analyses were performed using STATA, version 14.0 (StataCorp LP).

Results

Characteristics of the study population

Participants characteristics are shown in Table 1. Ghanaians living in Ghana were significantly older than their peers living in Europe (47.7±11.9 versus 46.6±9.9, p=0.006). There were more female participants in the Ghana sample compared with European sample (67.1% versus 58.5%, p=0.001). Ghanaians living in Ghana were significantly less educated than those living in Europe. Higher proportion of Ghanaians living in Ghana had experienced negative life events in the last 12 months compared with their peers living in Europe (68.7% versus 59.0%, p=0.001). More than half of Ghanaians living in Ghana had experienced some stress at home or work whereas only a third of those living in Europe had experienced some stress at home or work (p=0.001). Permanent stress at home/work was fairly the same among Ghanaians living in SSA and Europe. Perceived discrimination was significantly higher among Ghanaians living in Europe compared with their peers living in Ghana (29.7% versus 4.8%, p=0.001). Depressive symptoms were more prevalent among Ghanaians living in Europe 7.5% compared with their peers living in Ghana 5.1%. Almost all Ghanaians living in Europe were first generation migrants. Ghanaians in Europe were significantly more obese, more likely to smoke and less physically active compared with their peers living in Ghana. Prevalence of hypercholesterolemia was significantly higher, but type 2 diabetes and hypertension were significantly lower among Ghanaians living in Ghana compared with their peers living in Europe (p=0.001). Prevalence of albuminuria, reduced eGRF and CKD risk were higher in Ghanaians living in Ghana compared with those living in Europe.

413 **Table 1: Baseline characteristics of respondents**

	Ghanaians (SSA) n (%)	Ghanaians (Europe) n (%)	p-value
N	2,492 (44.1)	3,167 (55.9)	0.001
Female sex	1672 (67.1)	1,851 (58.5)	0.001
Age (years)	47.7±11.9	46.6±9.9	0.006
Educational status			
Low	1169 (49.2)	635 (21.8)	0.001
Middle	858 (36.1)	1111 (38.1)	
High	347 (14.6)	1168 (40.1)	
Negative life events in the past 12 months			
No	739 (31.3)	1158 (41.0)	0.001
Yes	1619 (68.7)	1667 (59.0)	
Perceived stress at home/work			
Never	692 (29.4)	1371 (48.8)	0.001
Some periods	1290 (54.7)	1033 (36.8)	
Several/Permanent	375 (15.9)	407 (14.4)	
Perceived discrimination			
No	2065 (95.2)	1960 (70.3)	0.001
Yes	104 (4.8)	829 (29.7)	
Depressive symptoms			
No	2239 (94.9)	2582 (92.5)	0.001
Yes	119 (5.1)	209 (7.5)	
Migration generation			
First	Not applicable	2868 (98.7)	Not applicable
Second	Not applicable	38 (1.3)	Not applicable
BMI			
Normal (<25kg/m2)	1373 (55.2)	643 (20.4)	0.001
Overweight (25 ≤ 30kg/m2)	684 (27.5)	1,350 (42.8)	

Obese (>30kg/m2)	432 (17.3)	1163 (36.8)	
Currently smoking	36 (1.5)	121 (4.1)	0.001
Physical activity	1255 (52.8)	1131 (44.0)	0.001
Hypocholesteraemia	352 (14.2)	354 (11.3)	0.007
Type 2 diabetes	206 (8.3)	444 (14.0)	0.001
Hypertension	837 (33.6)	1801 (56.9)	0.001
ACR			
A1 < 3mg/mmol	2215 (90.2)	2814 (91.8)	0.001
A2-A ≥ 3mg/mmol	243 (9.8)	252 (8.2)	
eGFR			
G1-G2 ≥ 60 mL/min/1.73 m2	2377 (96.3)	2936 (97.4)	0.018
G3a-G5 < 60 mL/min/1.73 m2	85 (3.7)	78 (2.6)	
CKD Risk			
Low risk	2197 (89.6)	2705 (91.5)	0.015
Moderate-very high risk	256 (10.4)	252 (8.5)	

Abbreviations: N, number of respondents; BMI, body mass index; eGFR, estimated glomerular filtration rate; G1-G2, normal to high kidney function to mildly decreased; G3a-G5, mildly to moderately decreased to Kidney failure; ACR, albumin creatinine ratio; A1, normal to mildly increased; A2-A3, moderately increased to severely increased; CKD, Chronic kidney disease; SSA, Sub-Saharan Africa; CI, confidence intervals.

Association between PS and CKD

Figure 1-4 shows CKD prevalence by negative life events in the past 12 months among Ghanaians living in Ghana and Europe. In Europe, CKD prevalence was fairly the same among those who had experienced any negative life events compared with those who had not in the last 12 months. Prevalence of CKD was higher among Ghanaians who had not experienced any negative life events in the past 12 months (10.9%) compared with those who had experienced some negative life events (9.9%) and living in Ghana. CKD prevalence was higher among Ghanaians who had not experienced any form of discrimination (10.6%) than those who had (6.7%) in Ghana as well as in Europe (Figure 2). CKD prevalence was slightly higher among Ghanaians who had experienced several/permanent stress at work/home in the past 12 months and living in Ghana (10.4%) or Europe (9.7%) (Figure 3). Ghanaians who did not report any form of depressive symptoms had a significantly higher CKD prevalence than those who did and living in Ghana (10.4%) and Europe (8.7**%)** (Figure 4).

Table 2 shows the correlation matrix between the 4 constructs of PS among Ghanaians living in Ghana and those living in Europe. All four constructs of PS were positively correlated with each other among Ghanaians living in Europe and Ghanaians living in Ghana ($p<0.001$), except stress at work/home and discrimination among Ghanaians living in Ghana.

Table 2: Relationship between PS constructs (negative life events, discrimination, stress at work or home and depression) by Ghanaians (SSA) and Ghanaians (Europe)

Correlation matrix	Negative events	Discrimination	Stress at work/home	Depression
Europe				
Negative events	1.000			
Discrimination	0.152**	1.000		
Stress at work/home	0.297**	0.161**	1.000	
Depressive symptoms	0.143**	0.136**	0.285**	1.000
Ghana				
Negative events	1.000			
Discrimination	0.079**	1.000		
Stress at work/home	0.101**	-0.032	1.000	
Depressive symptoms	0.091**	0.042	0.185**	1.000

****Significant at 1%, Spearman's correlation**

Table 3 shows association between all 4 constructs of PS and CKD among Ghanaians living in Ghana and those living in Europe. There was no statistically significant association between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living in Ghana and those living in Europe except individuals living in Europe with some stress and lower risk of reduced eGFR (0.46, 95% C.I. 0.24-0.88). Table S1 shows further adjustments for conventional risk factors of CKD. This did not show any statistically significant associations between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living in Ghana and Europe (Table S1). Table S2 shows further stratification based on obesity status. We did not find any association between PS and CKD for obese participants and those who were not obese for Ghanaians living in rural and urban Ghana and those living in Europe. However, we observed an inverse association between PS and CKD among migrants who were not obese but have experienced discrimination for the past 12 months (0.63 95% C.I. 0.41-0.97) (Table S2). In Table S3 we stratified our analysis based on diabetic status. We did not find any associations between PS and

CKD for participants with and without diabetes for both Ghanaians living in rural and urban Ghana and their migrant peers in Europe (Table S3). Finally, Table S4 stratified analysis by hypertension status. No associations were observed between PS and CKD for individuals who had hypertension and those who did not have hypertension for both those living in rural and urban Ghana as well as their compatriots living in Europe. An inverse association was observed between PS and CKD among Ghanaians who have experienced discrimination in the last 12 months with no hypertension and living in Europe (0.51, 95% C.I. 0.27-0.97). Also, we observed that having experienced some stress at home/work was inversely associated with reduced eGFR among Ghanaians with hypertension and living in Europe (0.47, 95% C.I. 0. 0.23-0.95) (Table S4).

Table 3: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe									
No	1128 (8.2)	1.00 (Reference)	1.00 (Reference)	1106 (2.6)	1.00 (Reference)	1.00 (Reference	1090 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	1615 (8.4)	1.03 (0.78-1.35)	1.07 (0.80-1.42)	1587 (2.5)	0.86 (0.53-1.42)	0.83 (0.49-1.39)	1557 (8.6)	0.97 (0.76-1.32)	0.99 (0.74-1.32)
Ghana									
No	732 (8.7)	1.00 (Reference)	1.00 (Reference)	736 (4.5)	1.00 (Reference)	1.00 (Reference)	732 (10.9)	1.00 (Reference)	1.00 (Reference)
Yes	1595 (3.8)	0.87 (0.65-1.16)	0.85 (0.63-1.14)	1601 (3.4)	0.69 (0.45-1.08)	0.67 (0.44-1.09)	1590 (9.9)	0.88 (0.66-1.17)	0.86 (0.64-1.15)
Discrimination									
Europe									
No	1899 (8.5)	1.00 (Reference)	1.00 (Reference)	1867 (2.6)	1.00 (Reference)	1.00 (Reference)	1832 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	810 (7.4)	0.87 (0.64-1.19)	0.92 (0.67-1.26)	791 (2.2)	0.83 (0.47-1.47)	0.84 (0.46-1.52)	782 (7.3)	0.82 (0.59-1.12)	0.84 (0.60-1.16)
Ghana									
No	2034 (10.0)	1.00 (Reference)	1.00 (Reference)	2047 (3.9)	1.00 (Reference)	1.00 (Reference)	2031 (10.6)	1.00 (Reference)	1.00 (Reference)
Yes	104 (7.7)	0.83 (0.39-1.73)	0.91 (0.67-1.24)	104 (1.9)	0.67 (0.15-2.85)	0.67 (0.16-2.84)	104 (6.7)	0.70 (0.32-1.55)	0.71 (0.32-1.55)
Stress at home/work									
Europe									
Never	1330 (8.2)	1.00 (Reference)	1.00 (Reference)	1305 (3.4)	1.00 (Reference)	1.00 (Reference)	1282 (8.5)	1.00 (Reference)	1.00 (Reference)
Some stress	1002 (7.9)	0.97 (0.72-1.31)	1.04 (0.76-1.42)	984 (1.4)	**0.47 (0.26-0.87)**	**0.46 (0.24-0.88)**	968 (8.6)	0.96 (0.71-1.30)	1.02 (0.74-1.39)
Several/Permanent stresses	397 (9.1)	1.11 (0.74-1.64)	1.153 (0.77-1.72)	390 (2.3)	0.73 (0.35-1.52)	0.76 (0.36-1.61)	383 (9.7)	1.13 (0.77-1.68)	1.19 (0.80-1.79)
Ghana									
Never	682 (10.3)	1.00 (Reference)	1.00 (Reference)	688 (3.3)	1.00 (Reference)	1.00 (Reference)	682 (9.9)	1.00 (Reference)	1.00 (Reference)

Some stress	1279 (9.5)	0.87 (0.64-1.19)	0.80 (0.59-1.11)	1279 (3.9)	1.06 (0.63-1.77)	1.11 (0.66-1.87)	1274 (10.3)	0.95 (0.69-1.30)	0.92 (0.67-1.26)
Several/Permanent stresses	365 (8.5)	0.75 (0.48-1.18)	0.68 (0.59-1.11)	369 (4.1)	1.13 (0.57-2.23)	1.22 (0.61-2.46)	365 (10.4)	0.96 (0.63-1.47)	0.92 (0.59-1.42)
Depressive symptoms									
Europe									
No	2505 (8.5)	1.00 (Reference)	1.00 (Reference)	2457 (2.7)	1.00 (Reference)	1.00 (Reference)	2416 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	206 (6.3)	0.71 (0.39-1.27)	0.76 (0.43-1.36)	202 (1.5)	0.63 (0.19-2.03)	0.68 (0.21-2.23)	199 (7.1)	0.78 (0.44-1.37)	0.83 (0.47-1.46)
Ghana									
No	2212 (9.9)	1.00 (Reference)	1.00 (Reference)	2222 (3.8)	1.00 (Reference)	1.00 (Reference)	2207 (10.4)	1.00 (Reference)	1.00 (Reference)
Yes	114 (5.3)	0.45 (0.19-1.03)	0.45 (0.19-1.01)	114 (2.6)	0.52 (0.16-1.72)	0.53 (0.17-1.74)	114 (7.9)	0.62 (0.30-1.25)	0.61 (0.30-1.24)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe

Table 4 shows associations between all 4 constructs of PS and CKD stratified by Ghanaians living in urban and rural Ghana. There was no association between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living rural and urban Ghana.

Table 4: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depressive symptoms) with albuminuria, reduced eGFR and CKD risk among rural and urban Ghana

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Urban Ghana									
No	477 (11.9)	1.00 (Reference)	1.00 (Reference)	477 (4.4)	1.00 (Reference)	1.00 (Reference	477 (12.2)	1.00 (Reference)	1.00 (Reference)
Yes	912 (10.5)	0.87 (0.61-1.23)	0.87 (0.61-1.24)	911 (3.4)	0.73 (0.41-1.31)	0.72 (0.40-1.29)	910 (10.8)	0.87 (0.61-1.24)	0.87 (0.61-1.25)
Rural Ghana									
No	255 (7.5)	1.00 (Reference)	1.00 (Reference)	259 (4.6)	1.00 (Reference)	1.00 (Reference)	255 (8.6)	1.00 (Reference)	1.00 (Reference)
Yes	683 (7.6)	0.97 (0.56-1.69)	0.94 (0.54-1.64)	690 (3.5)	0.63 (0.31-1.31)	0.66 (0.32-1.37)	680 (8.8)	0.93 (0.55-1.58)	0.92 (0.54-1.56)
Discrimination									
Urban Ghana									
No	1326 (11.1)	1.00 (Reference)	1.00 (Reference)	1326 (3.9)	1.00 (Reference)	1.00 (Reference)	1325 (11.4)	1.00 (Reference)	1.00 (Reference)
Yes	71 (8.5)	0.85 (0.36-2.00)	0.89 (0.37-2.11)	71 (2.8)	1.17 (0.27-2.09)	1.16 (0.27-2.06)	71 (7.1)	0.69 (0.27-1.77)	0.72 (0.28-1.83)
Rural Ghana									
No	708 (8.1)	1.00 (Reference)	1.00 (Reference)	721 (3.9)	1.00 (Reference)	1.00 (Reference)	706 (9.2)	1.00 (Reference)	1.00 (Reference)
Yes	33 (6.1)	0.79 (0.18-3.47)	0.84 (0.19-2.65)	33 (0.0)	***	***	33 (6.1)	0.75 (0.17-2.89)	0.83 (0.19-2.65)
Stress at home/work									
Urban Ghana									
Never	460 (10.9)	1.00 (Reference)	1.00 (Reference)	460 (3.3)	1.00 (Reference)	1.00 (Reference)	460 (10.2)	1.00 (Reference)	1.00 (Reference)
Some stress	732 (11.5)	1.04 (0.71-1.51)	0.91 (0.62-1.37)	730 (4.1)	1.27 (0.66-2.43)	1.30 (0.67-2.51)	730 (11.8)	1.13 (0.77-1.65)	1.04 (0.71-1.53)
Several/Permanent stresses	197 (9.6)	0.87 (0.50-1.52)	0.74 (0.42-1.02)	198 (3.5)	1.17 (0.46-2.84)	1.20 (0.47-3.09)	197 (11.7)	1.15 (0.68-1.71)	1.05 (0.61-1.81)

Rural Ghana									
Never	222 (9.0)	1.00 (Reference)	1.00 (Reference)	228 (3.5)	1.00 (Reference)	1.00 (Reference)	222 (9.5)	1.00 (Reference)	1.00 (Reference)
Some stress	547 (6.9)	0.69 (0.39-1.23)	0.68 (0.38-1.22)	549 (3.6)	0.88 (0.38-2.07)	0.92 (0.39-2.18)	544 (8.3)	0.74 (0.42-1.30)	0.75 (0.42-1.31)
Several/Permanent stresses	168 (7.1)	0.63 (0.30-1.37)	0.60 (0.28-1.29)	171 (4.7)	1.07(0.38-3.03)	1.21(0.43-3.46)	168 (8.9)	0.71 (0.34-1.50)	0.73 (0.35-1.50)
Depressive symptoms									
Urban Ghana									
No	1336 (11.3)	1.00 (Reference)	1.00 (Reference)	1335 (3.8)	1.00 (Reference)	1.00 (Reference)	1334 (11.5)	1.00 (Reference)	1.00 (Reference)
Yes	52 (3.9)	0.30 (0.07-1.25)	0.30 (0.07-1.27)	52 (1.9)	0.46 (0.06-2.50)	0.45 (0.06-2.13)	52 (5.8)	0.44 (0.14-1.45)	0.45 (0.14-1.48)
Rural Ghana									
No	876 (7.7)	1.00 (Reference)	1.00 (Reference)	887 (3.8)	1.00 (Reference)	1.00 (Reference)	873 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	62 (6.5)	0.67 (0.23-1.94)	0.67 (0.23-1.94)	62 (3.2)	0.58 (0.13-2.56)	0.61 (0.14-2.68)	62 (9.7)	0.82 (0.33-2.01)	0.85 (0.34-2.09)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in urban and rural Ghana among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in rural and urban Ghana. ***; no case of CKD and therefore odds ratios were not calculated

Table 5 shows associations between all 4 constructs of PS and CKD stratified by Ghanaians living in Amsterdam, Berlin and London. There were no associations between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living in Europe except for positive association between stress at work/home and albuminuria (2.81, 95% C.I. 1.46-5.40) and CKD risk (2.78, 95% C.I. 1.43-5.43) among Ghanaians living in Berlin.

Table 5: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depressive symptoms) with albuminuria, reduced eGFR and CKD risk among Ghanaians in three European cities.

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2
Negative events									
Amsterdam									
No	548 (7.3)	1.00 (Reference)	1.00 (Reference)	534 (2.4)	1.00 (Reference)	1.00 (Reference))	521 (7.5)	1.00 (Reference)	1.00 (Reference)
Yes	784 (7.8)	1.08 (0.71-1.63)	1.18 (0.77-1.81)	764 (2.9)	1.11 (0.55-2.23)	1.15 (0.55-2.37)	742 (8.0)	1.06 (0.69-1.62)	1.08 (0.71-1.66)
Berlin									
No	213 (9.9)	1.00 (Reference)	1.00 (Reference)	213 (2.4)	1.00 (Reference)	1.00 (Reference)	213 (10.8)	1.00 (Reference)	1.00 (Reference)
Yes	329 (10.9)	1.12 (0.63-1.99)	1.19 (0.67-2.15)	330 (1.8)	0.64 (0.19-2.17)	0.61 (0.18-2.11)	329 (9.4)	0.86 (0.48-1.52)	0.91 (0.51-1.63)
London									
No	367 (8.7)	1.00 (Reference)	1.00 (Reference)	359 (3.1)	1.00 (Reference)	1.00 (Reference)	356 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	502 (7.8)	0.89 (0.55-1.46)	0.83 (0.49-1.41)	493 (2.2)	0.68 (0.28-1.65)	0.58 (0.22-1.51)	486 (9.1)	1.04 (0.64-1.68)	0.99 (0.58-1.68)
Discrimination									
Amsterdam									
No	956 (8.3)	1.00 (Reference)	1.00 (Reference)	935 (2.9)	1.00 (Reference)	1.00 (Reference)	909 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	363 (5.0)	0.59 (0.34-1.00)	0.59 (0.35-1.02)	349 (2.1)	0.69 (0.30-1.62)	0.81 (0.34-1.91)	342 (5.9)	0.69 (0.41-1.14)	0.69 (0.41-1.16)
Berlin									
No	329(10.0)	1.00 (Reference)	1.00 (Reference)	329 (2.1)	1.00 (Reference)	1.00 (Reference)	329 (10.3)	1.00 (Reference)	1.00 (Reference)
Yes	209 (11.0)	1.11 (0.63-1.95)	1.16 (0.65-2.05)	210 (1.9)	0.83 (0.24-2.93)	0.82 (0.23-2.91)	209 (9.1)	0.86 (0.48-1.56)	0.89 (0.49-1.63)
London									
No	614 (7.9)	1.00 (Reference)	1.00 (Reference)	603 (2.5)	1.00 (Reference)	1.00 (Reference)	594 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	238 (7.9)	1.03 (0.59-1.81)	1.18 (0.65-2.15)	232 (2.6)	1.29 (0.46-3.59)	1.09 (0.35-3.43)	231 (7.8)	0.93 (0.53-1.63)	0.98 (0.52-1.82)
Stress at home/work									

Amsterdam									
Never	634 (8.4)	1.00 (Reference)	1.00 (Reference)	622 (3.2)	1.00 (Reference)	1.00 (Reference)	603 (8.0)	1.00 (Reference)	1.00 (Reference)
Some stress	478 (5.7)	0.68 (0.42-1.11)	0.69 (0.42-1.13)	462 (1.9)	0.64 (0.29-1.43)	0.68 (0.30-1.52)	452 (6.0)	0.74 (0.45-1.20)	0.74 (0.45-1.22)
Several/Permanent stresses	210 (9.1)	1.09 (0.63-1.91)	1.12 (0.64-1.95)	204 (2.5)	0.71 (0.26-1.95)	0.77 (0.28-2.14)	198 (10.1)	1.24 (0.71-2.14)	1.26 (0.73-2.20)
Berlin									
Never	250 (9.0)	1.00 (Reference)	1.00 (Reference)	250 (2.0)	1.00 (Reference)	1.00 (Reference)	250 (6.4)	1.00 (Reference)	1.00 (Reference)
Some stress	196 (15.3)	**2.50 (1.33-4.71)**	**2.81 (1.46-5.40)**	197 (1.5)	0.88 (0.20-3.79)	0.83 (0.19-3.62)	196 (14.8)	**2.57 (1.34-4.90)**	**2.78 (1.43-5.43)**
Several/Permanent stresses	96 (10.4)	1.64 (0.72-3.73)	1.69 (0.73-3.91)	197 (3.1)	2.10 (0.47-9.46)	2.04 (0.44-9.26)	76 (9.4)	1.52 (0.65-3.58)	1.58 (0.66-3.75)
London									
Never	446 (9.2)	1.00 (Reference)	1.00 (Reference)	433 (4.4)	1.00 (Reference)	1.00 (Reference)	429 (10.5)	1.00 (Reference)	1.00 (Reference)
Some stress	328 (7.0)	0.73 (0.43-1.25)	0.79 (0.44-1.40)	325 (0.6)	0.17 (0.04-0.73)	0.09 (0.01-0.67)	320 (6.9)	0.65 (0.38-1.10)	0.66 (0.37-1.19)
Several/permanent stresses	91 (7.7)	0.81 (0.35-1.87)	0.86 (0.35-2.14)	90 (1.1)	0.27 (0.03-2.12)	0.24 (0.03-2.05)	74 (8.9)	0.83 (0.38-1.83)	0.92 (0.39-2.16)
Depressive symptoms									
Amsterdam									
No	1199 (7.8)	1.00 (Reference)	1.00 (Reference)	1135 (2.8)	1.00 (Reference)	1.00 (Reference)	1135 (7.9)	1.00 (Reference)	1.00 (Reference)
Yes	121 (6.6)	0.81 (0.39-1.72)	0.83 (0.39-1.76)	118 (1.7)	0.65 (0.15-2.77)	0.71 (0.16-3.06)	116 (6.9)	0.83 (0.39-1.76)	0.82 (0.38-1.74)
Berlin									
No	503 (10.7)	1.00 (Reference)	1.00 (Reference)	504 (2.2)	1.00 (Reference)	1.00 (Reference)	503 (10.1)	1.00 (Reference)	1.00 (Reference)
Yes	34 (5.9)	0.53 (0.12-2.27)	0.49 (90.11-2.13)	34 (0.0)	***	***	34 (5.9)	0.55 (0.13-2.37)	0.52 (0.12-2.24)
London									
No	803 (8.3)	1.00 (Reference)	1.00 (Reference)	785 (2.6)	1.00 (Reference)	1.00 (Reference)	778 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	51 (5.9)	0.67 (0.20-2.21)	0.91 (0.27-3.07)	50 (2.0)	0.91 (0.11-7.43)	1.15 (0.14-9.54)	49 (8.2)	0.94 (0.33-2.69)	1.30 (0.44-3.81)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, educational level and length of stay; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Amsterdam, Berlin and London among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Europe ***; no case of CKD and therefore odds ratios were not calculated.

Discussion

Key findings

Whereas there was an association between those who have experienced some stress at home/work and reduced eGFR among Ghanaians living in Europe, we did not find any association between PS and CKD among Ghanaians living in rural and urban Ghana and their peers in Europe. Also, PS was not associated with CKD for those living in rural and urban Ghana and neither for those living in the three European cities. However, there was an association between stress at work/home and albuminuria and CKD risk among Ghanaians living in Berlin. Further adjustment for conventional risk factors of CKD yielded similar results.

Discussion of key findings

Association between PS and CKD in Ghana

Our study did not find any association between any of the four constructs of PS and prevalence of CKD (albuminuria, reduced eGFR and CKD risk) among Ghanaians living in rural and urban Ghana. Our findings are however in contrast with earlier studies which reported positive associations between PS and prevalent of CKD [28 31 53]. Other studies have hypothesised that the influence of PS on CKD may be important in only those with hypertension and diabetes and that PS may mediate or moderate the association between renal functioning and lifestyle behaviours such as smoking and physical activity [33]. For example, they argue that stress enhances Sympathetic Nervous System (SNS) activity to increase glucocorticoid secretion and inflammatory cytokines, which heavily contribute to hypertension, diabetes and vascular disease, which are major risk factors of CKD incidence and prevalence [54]. The lack of association between PS and CKD in this present study is unclear due to lack of literature on the association between PS and CKD prevalence particularly in rural and urban populations. Worth noting, however, is the presence of rich family support systems in the Ghanaian context especially in rural Ghana, which may help individuals with CKD to cope with PS thereby minimizing its effect. For example, patients with limited social networks and low social support have been shown to have augmented risk of morbidity and mortality [55-57]. Specifically, there is evidence that positive social support is a protective factor for persons dealing with long-term disease conditions [58]. Other studies have reported a protective relationship between social networks, emotionally supportive relationship and threats to physiological and psychosocial health [59].

Association between PS and CKD Amsterdam, Berlin and London

Literature on the association between PS and CKD prevalence among migrants is scant and absent in most European populations. The lack of positive association between PS and CKD in our study is consistent with

recent studies conducted among African Americans [31 33] and other populations [32 60]. Specifically, a recent study using data from the Jackson Heart Study, which comprised of extensive constructs of psychosocial variables reported that greater life stressors were associated with lower prevalence of CKD at baseline [31]. Several studies in other parts of the world have reported a positive relationship between higher prevalence of stressors and CKD risk [27 28], although the study findings have been inconsistent. Whereas some did not find any associations among African Americans [31] others found associations in other populations. Even among those who found some associations the directions differed [28]. Reasons for the lack of association observed in our study among migrants are not fully understood but may reflect the real world situation. First, migrants from Ghana practice both nuclear and extended family support system as their peers living in rural and urban, this practice may mitigate the impact of stressors such as unemployment, death of a love one, discrimination, etc. They also belong to several religious organisations such as churches, which provide similar support systems against stressors. Moreover, there are several associations of the various ethnic groups (Akan, Ga and Ewe) providing such support when the need arises. These systems provide both instrumental and/or emotional social support [61]. These assertions are supported by several studies. Specifically, these studies have shown that social support positively affect health outcomes through mechanisms such as increased patient compliance with therapies, decreased levels of depressive affect, direct physiologic effects on the immune system and improved perception of quality of life [58 59]. The lack of association observed in this study may also be attributed to other mechanisms, which influence the associations between PS and CKD. Another reason for the lack of association between PS and CKD in this study could be the cross-sectional analysis of our study. The association between PS and CKD has been shown to be cumulative and builds over substantial period of time[62]. To effectively evaluate this, longitudinal study design is required. This suggests the needs for more longitudinal studies in future research in assessing the associations between PS and CKD outcomes [62 63].

Strength and limitation

Our study is the first to use all four robust constructs of PS to determine association between PS and CKD. This gave our study a more robust definition of PS compared to other similar studies. The use of all three definitions of CKD per KDIGO guidelines also provided a broader definition of CKD and allowed comparison between different geographical regions. The use of a homogenous population of Ghanaians and standardized protocols and diagnostic criteria in this study also provided a novel opportunity to compare Ghanaians living in rural and urban Ghana and their compatriots living in Europe. There are limitations to our study. The effect of PS on CKD has been reported to be cumulative and takes a long period of time, therefore the use of cross-sectional design prevented us from determining the longitudinal and cumulative

effect of repeated exposure to PS among the two populations. PS is captured and experienced in different magnitude across different populations. We were unable to ascertain if PS as defined in this study was adequately captured among Ghanaians living in rural and urban Ghana.

Conclusion

Generally, our study shows no associations between stress as indicated by four PS indicators and prevalence of CKD. Consequently, there is the need to explore other factors that may be responsible for the observed differences in the prevalence of CKD among Ghanaians living in rural and urban Ghana and their peers living in Europe.

Acknowledgement

The authors are very grateful to the research assistants, interviewers and other staff of the five research locations who took part in gathering the data and the Ghanaian volunteers in all the participating RODAM sites. We gratefully acknowledge the advisory board members for their valuable support in shaping the RODAM study methods and the Academic Medical Centre Biobank for their support in biobank management and high-quality storage of collected samples.

Contributors

My co-authors have all contributed substantially to this manuscript and approve of this submission. Research idea and study design: DNA, CA, KS, DA, EB, KM, JA; data acquisition and curation: DNA, CA, EB, KM, data analysis/interpretation: DNA, CA, KS, DA, EB, KM, LS, JA, EOD, KKG, FPM, MBS, ID, JS, SB; statistical analysis: DNA, CA, KS. DNA, CA, KS, DA, EB, KM, LS, JA, EOD, KKG, FPM, MBS, ID, JS, SB; contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved. DNA and CA takes responsibility that this study has been reported honestly, accurately, and transparently; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Funding

This work was supported by the European Commission under the Framework Programme (Grant Number: 278901). The funders had no role in study design, data collection and analysis, decision to publish, or

preparation of the manuscript. The Wellcome Trust supported Professor Smeeth's contribution, grant number WT082178. Professor Joachim Spranger was supported by the DZHK (German Center for cardiovascular research) and the Berlin Institute of Health (BIH).

Competing interest: I have communicated with all my co-authors and obtained their full disclosures. My co-authors and I declare no conflicts of interest.

Patient Consent: None declared

Ethics approval: IRBs at each participating site.

Data sharing statement: Data are available from the RODAM research cohort, a third party. Dr. Eric Beune affiliated with the RODAM research cohort and a co-author of this paper in accordance with the RODAM requirements for collaboration. Dr. Beune is the Data Collection Coordinator of RODAM and may be contacted with further questions (e.j.beune@amc.uva.nl). Additionally, researchers interested in further collaboration with RODAM may see the following URL: http://www.rod-am.eu/

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Legend for figures

Figure 1: Prevalence of CKD risk among Ghanaians who have experienced negative life events and those who have not experienced any negative life events stratified by site. Definition per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 2: Prevalence of CKD risk among Ghanaians who have experienced discrimination and those who have not experienced any discrimination stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 3: Prevalence of CKD risk among Ghanaians who have experienced stress at home/work and those who have not experienced any stress at home/work in the past 12 months stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 4: Prevalence of CKD risk among Ghanaians who have depressive symptoms and those who do not have depressive symptoms stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Legend for Supplementary Tables

S1: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe.

S2: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by obesity status.

S3: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by diabetes status.

S4: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by hypertensive status.

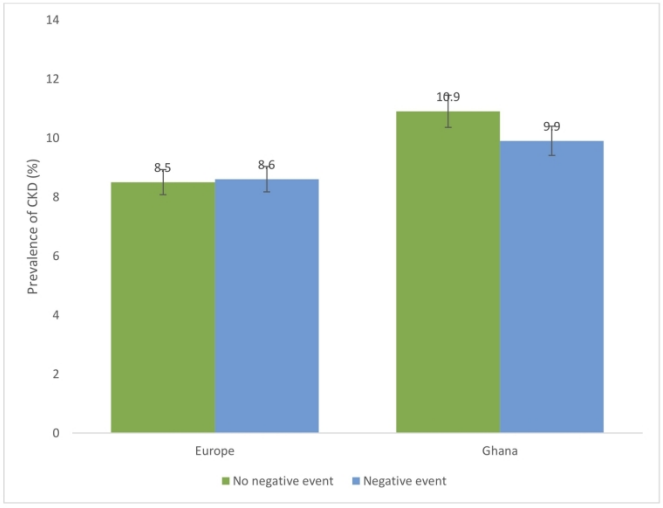

Figure 1: Prevalence of CKD risk among Ghanaians who have experienced negative life events and those who have not experienced any negative life events stratified by site. Definition per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 1: Prevalence of CKD risk among Ghanaians who have experienced negative life events and those who have not experienced any negative life events stratified by site. Definition per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

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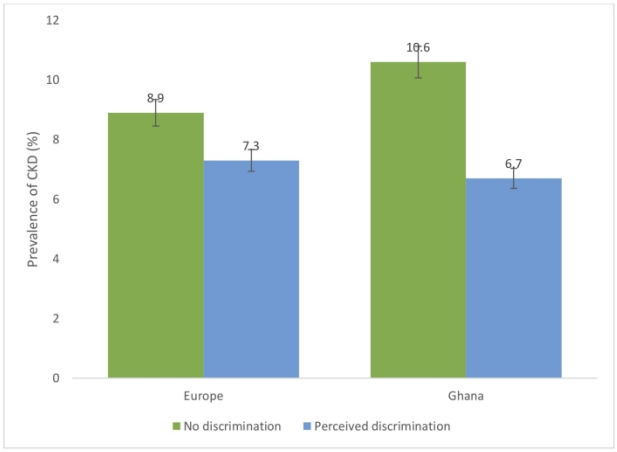

Figure 2: Prevalence of CKD risk among Ghanaians who have experienced discrimination and those who have not experienced any discrimination stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 2: Prevalence of CKD risk among Ghanaians who have experienced discrimination and those who have not experienced any discrimination stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

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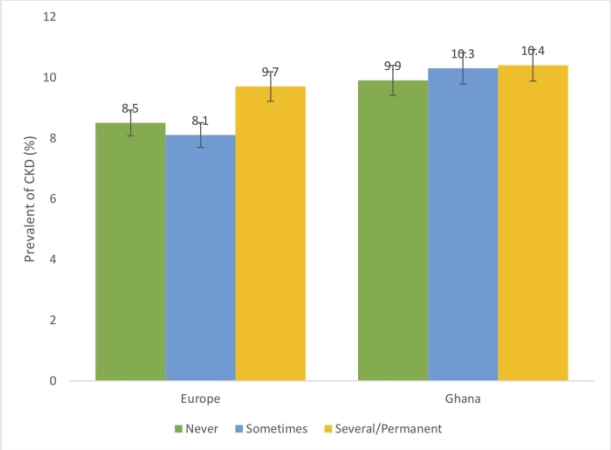

Figure 3: Prevalence of CKD risk among Ghanaians who have experienced stress at home/work and those who have not experienced any stress at home/work in the past 12 months stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 3: Prevalence of CKD risk among Ghanaians who have experienced stress at home/work and those who have not experienced any stress at home/work in the past 12 months stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

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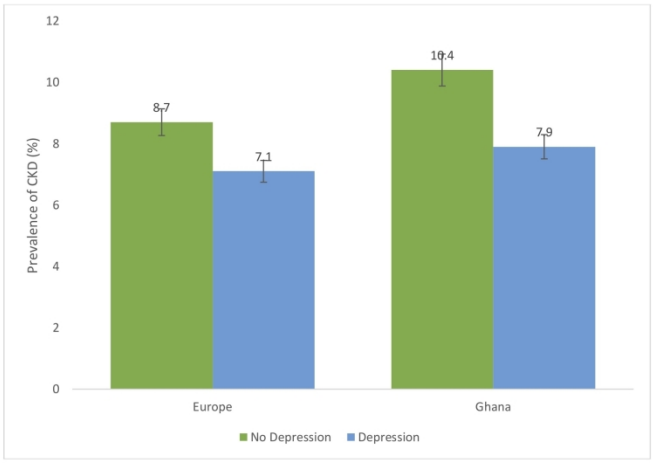

Figure 4: Prevalence of CKD risk among Ghanaians who have depressive symptoms and those who do not have depressive symptoms stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 4: Prevalence of CKD risk among Ghanaians who have depressive symptoms and those who do not have depressive symptoms stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines

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Supplementary Tables

S1: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe

	Albuminuria (ACR ≥ 3 mg/mmol)		eGFR < 60 mL/min/1.73 m2		High to very high CKD risk (KDIGO, 2012)	
	n (%)	OR (95% CI) Model 3	n (%)	OR (95% CI) Model 3	n cases (%)	OR (95% CI) Model 3
Negative events						
Europe						
No	1128 (8.2)	1.00 (Reference)	1106 (2.6)	1.00 (Reference)	1090 (8.5)	1.00 (Reference)
Yes	1615 (8.4)	0.95 (0.70-1.30)	1587 (2.5)	0.77 (0.44-1.37)	1557 (8.6)	0.92 (0.67-1.26)
Ghana						
No	732 (10.4)	1.00 (Reference)	736 (4.5)	1.00 (Reference)	732 (10.9)	1.00 (Reference)
Yes	1595 (9.2)	0.79 (0.58-1.07)	1601 (3.4)	0.69 (0.43-1.09)	1590 (9.9)	0.79 (0.58-1.06)
Discrimination						
Europe						
No	1899 (8.5)	1.00 (Reference)	1867 (2.6)	1.00 (Reference)	1832 (8.9)	1.00 (Reference)
Yes	810 (7.4)	0.87 (0.61-1.21)	791 (2.2)	0.87 (0.45-1.65)	782 (7.3)	0.79 (0.55-1.12)
Ghana						
No	2034 (10.0)	1.00 (Reference)	2047 (3.9)	1.00 (Reference)	2031 (10.6)	1.00 (Reference)
Yes	104 (7.7)	0.92 (0.43-1.98)	104 (1.9)	0.65 (0.15-2.79)	104 (6.7)	0.74 (0.33-1.66)
Stress at home/work						
Europe						
Never	1330 (8.2)	1.00 (Reference)	1305 (3.4)	1.00 (Reference)	1282 (8.5)	1.00 (Reference)
Some stress	1002 (7.9)	1.01 (0.72-1.41)	984 (1.4)	0.51 (0.25-1.04)	968 (8.1)	1.01 (0.72-1.42)
Several/Permanent stresses	397 (9.1)	1.00 (0.64-1.59)	390 (2.3)	0.91 (0.40-2.03)	383 (9.7)	1.15 (0.74-1.79)
Ghana						

Never	682 (10.3)	1.00 (Reference)	688 (3.3)	1.00 (Reference)	682 (9.9)	1.00 (Reference)
Some stress	1279 (9.5)	0.78 (0.56-1.09)	1279 (3.9)	1.14 (0.67-1.93)	1274 (10.3)	0.93 (0.67-1.29)
Several/Permanent stresses	365 (8.5)	0.70 (0.43-1.13)	369 (4.1)	1.32 (0.65-1.68)	365 (10.4)	0.97 (0.62-1.52)
Depressive symptoms						
Europe						
No	2505 (8.5)	1.00 (Reference)	2457 (2.7)	1.00 (Reference)	2416 (8.7)	1.00 (Reference)
Yes	206 (6.3)	0.65 (0.33-1.28)	202 (1.5)	0.94 (0.28-3.14)	199 (7.1)	0.78 (0.41-1.47)
Ghana						
No	2212 (9.9)	1.00 (Reference)	2222 (3.8)	1.00 (Reference)	2207 (10.4)	1.00 (Reference)
Yes	114 (5.3)	0.41 (0.16-1.04)	114 (2.6)	0.58 (0.17-1.95)	114 (7.9)	0.62 (0.28-1.31)

Model 3, adjusted for age, sex educational level, hypertension, diabetes, hypercholesterolemia, BMI, physical activity and smoking; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S2: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by obesity status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe/Not obese									
No	736 (7.4)	1.00 (Reference)	1.00 (Reference)	729 (2.5)	1.00 (Reference)	1.00 (Reference)	719 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	1003 (7.7)	0.98 (0.67-1.40)	0.99 (0.69-1.43)	992 (2.0)	0.77 (0.40-1.48)	0.71 (0.36-1.42)	971 (7.9)	0.91 (0.64-1.29)	0.89 (0.62-1.29)
Europe/Obese									
No	390 (9.2)	1.00 (Reference)	1.00 (Reference)	375 (2.9)	1.00 (Reference)	1.00 (Reference)	369 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	607 (9.6)	1.05 (0.67-1.63)	1.14 (0.72-1.82)	590 (3.2)	0.97 (0.44-2.11)	1.01 (0.44-2.26)	581 (9.6)	1.15 (0.73-1.82)	1.15 (0.71-1.85)
Ghana/Not obese									
No	588 (9.5)	1.00 (Reference)	1.00 (Reference)	592 (4.7)	1.00 (Reference)	1.00 (Reference)	588 (10.0)	1.00 (Reference)	1.00 (Reference)
Yes	1324 (8.5)	0.86 (0.61-1.21)	0.83 (0.59-1.17)	1331 (3.4)	0.64 (0.39-1.05)	0.65 (0.39-1.83)	1321 (9.0)	0.86 (0.61-1.20)	0.84 (0.60-1.18)
Ghana/Obese									
No	144 (13.9)	1.00 (Reference)	1.00 (Reference)	144 (3.5)	1.00 (Reference)	1.00 (Reference)	144 (14.6)	1.00 (Reference)	1.00 (Reference)
Yes	268 (13.1)	0.91 (0.50-1.64)	0.91 (0.49-1.65)	267 (3.8)	1.04 (0.34-3.16)	1.09 (0.35-3.37)	266 (14.3)	0.94 (0.52-1.68)	0.94 (0.52-1.67)
Discrimination									
Europe/Not obese									
No	1186 (8.4)	1.00 (Reference)	1.00 (Reference)	1172 (2.4)	1.00 (Reference)	1.00 (Reference)	1150 (9.4)	1.00 (Reference)	1.00 (Reference)
Yes	538 (5.9)	0.69 (0.46-1.05)	0.71 (0.46-1.11)	532 (1.5)	0.62 (0.28-1.37)	0.57 (0.24-1.34)	525 (5.9)	**0.63 (0.42-0.96)**	**0.63 (0.41-0.97)**
Europe/Obese									
No	709 (8.7)	1.00 (Reference)	1.00 (Reference)	691 (3.0)	1.00 (Reference)	1.00 (Reference)	678 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	269 (10.0)	1.14 (0.71-1.85)	1.29 (0.78-2.12)	256 (3.5)	1.15 (0.50-2.63)	1.27 (0.54-2.99)	254 (9.8)	1.13 (0.69-1.86)	1.22 (0.73-2.13)
Ghana/Not obese									
No	1648 (9.1)	1.00 (Reference)	1.00 (Reference)	1661 (3.9)	1.00 (Reference)	1.00 (Reference)	1646 (9.6)	1.00 (Reference)	1.00 (Reference)
Yes	81 (8.6)	1.06 (0.48-2.38)	1.04 (0.47-2.32)	81 (2.5)	1.04 (0.48-2.32)	0.86 (0.20-3.69)	81 (7.4)	0.90 (0.38-2.12)	0.89 (0.38-2.11)
Ghana/Obese									

No	383 (13.8)	1.00 (Reference)	1.00 (Reference)	383 (3.7)	1.00 (Reference)	1.00 (Reference)	382 (14.9)	1.00 (Reference)	1.00 (Reference)
Yes	23 (4.4)	0.31 (0.04-2.36)	0.40 (0.05-3.11)	23 (0.0)	**** (***-***)	**** (***-***)	23 (4.4)	0.29 (0.04-2.22)	0.34 (0.04-2.66)
Stress at home/work									
Europe/Not obese									
Never	855 (7.4)	1.00 (Reference)	1.00 (Reference)	847 (3.4)	1.00 (Reference)	1.00 (Reference)	831 (8.2)	1.00 (Reference)	1.00 (Reference)
Some stress	629 (8.3)	1.16 (0.79-1.70)	1.20 (0.81-1.79)	627 (1.4)	0.52 (0.24-1.12)	0.47 (0.21-1.07)	615 (7.9)	0.98 (0.66-1.43)	0.98 (0.65-1.46)
Several/Permanent stresses	247 (6.9)	0.93 (0.53-1.62)	1.15 (0.77-1.72)	239 (2.3)	0.45 (0.13-1.52)	0.49 (0.15-1.67)	236 (9.1)	0.97 (0.57-1.65)	1.04 (0.61-1.78)
Europe/Obese									
Never	472 (9.8)	1.00 (Reference)	1.00 (Reference)	455 (3.9)	1.00 (Reference)	1.00 (Reference)	448 (10.3)	1.00 (Reference)	1.00 (Reference)
Some stress	372 (7.5)	0.72 (0.44-1.18)	0.79 (0.47-1.32)	356 (1.4)	0.41 (0.15-1.16)	0.43 (0.15-1.21)	352 (9.5)	0.94 (0.57-1.53)	1.05 (0.62-1.76)
Several/Permanent stresses	147 (12.2)	1.32 (0.74-2.38)	1.31 (0.72-2.42)	148 (4.1)	1.05 (0.40-2.79)	1.09 (0.40-2.91)	144 (8.5)	1.36 (0.74-2.49)	1.41 (0.75-2.64)
Ghana/Not obese									
Never	537 (9.7)	1.00 (Reference)	1.00 (Reference)	542 (3.1)	1.00 (Reference)	1.00 (Reference)	537 (8.9)	1.00 (Reference)	1.00 (Reference)
Some stress	1055 (8.3)	0.79 (0.56-1.15)	0.74 (0.52-1.07)	1057 (3.9)	1.16 (0.65-2.09)	1.21 (0.67-2.18)	1052 (9.0)	0.92 (0.64-1.35)	0.90 (0.62-1.32)
Several/permanent stresses	319 (8.5)	0.81 (0.49-1.32)	0.73 (0.44-1.20)	323 (4.3)	1.34 (0.64-2.83)	1.43 (0.67-3.04)	319 (10.7)	1.12 (0.69-1.79)	1.09 (0.68-1.76)
Ghana/Obese									
Never	145 (12.4)	1.00 (Reference)	1.00 (Reference)	146 (4.1)	1.00 (Reference)	1.00 (Reference)	145 (13.8)	1.00 (Reference)	1.00 (Reference)
Some stress	221 (14.9)	1.21 (0.64-2.26)	1.05 (0.55-1.99)	219 (3.7)	0.74 (0.25-2.22)	0.83 (0.26-2.06)	219 (15.9)	1.13 (0.62-2.07)	1.02 (0.55-1.89)
Several/Permanent stresses	46 (8.7)	0.64 (0.20-2.01)	0.52 (0.16-1.65)	46 (2.2)	0.41 (0.05-3.61)	0.45 (0.05-4.01)	46 (8.8)	0.55 (0.17-1.71)	0.47 (0.14-1.50)
Depressive symptoms									
Europe/Not obese									
No	1601 (7.9)	1.00 (Reference)	1.00 (Reference)	1586 (2.2)	1.00 (Reference)	1.00 (Reference)	1558 (8.3)	1.00 (Reference)	1.00 (Reference)
Yes	121 (4.9)	0.59 (0.25-1.36)	0.65 (0.27-1.48)	117 (1.7)	0.79 (0.18-2.35)	0.86 (0.21-3.80)	115 (5.22)	0.58 (0.25-1.35)	0.64 (0.27-1.49)
Europe/Obese									
No	899 (9.7)	1.00 (Reference)	1.00 (Reference)	866 (3.4)	1.00 (Reference)	1.00 (Reference)	853 (9.4)	1.00 (Reference)	1.00 (Reference)
Yes	83 (7.2)	0.71 (0.29-1.67)	0.72 (0.30-1.74)	83 (1.2)	0.46 (0.06-3.52)	0.46 (0.06-3.57)	82 (8.5)	0.89 (0.40-2.01)	0.90 (0.40-2.04)

Ghana/Not obese									
No	1811 (8.9)	1.00 (Reference)	1.00 (Reference)	1822 (3.9)	1.00 (Reference)	1.00 (Reference)	1808 (9.4)	1.00 (Reference)	1.00 (Reference)
Yes	100 (6.0)	0.57 (0.24-1.33)	0.56 (0.24-1.32)	100 (2.0)	0.38 (0.09-1.63)	0.38 (0.09-1.63)	100 (8.0)	0.69 (0.32-1.46)	0.69 (0.32-1.47)
Ghana/Obese									
No	398 (13.8)	1.00 (Reference)	1.00 (Reference)	397 (3.5)	1.00 (Reference)	1.00 (Reference)	396 (14.7)	1.00 (Reference)	1.00 (Reference)
Yes	14 (0.0)	*** (****-****)	*** (****-****)	14 (7.1)	1.76 (0.21-14.89)	2.14 (0.25-8.78)	14 (7.1)	0.42 (0.05-3.32)	0.38 (0.05-3.07)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S3: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by diabetes status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe/No diabetes									
No	986 (8.0)	1.00 (Reference)	1.00 (Reference)	971 (2.1)	1.00 (Reference)	1.00 (Reference)	957 (7.9)	1.00 (Reference)	1.00 (Reference)
Yes	1359 (7.7)	0.95 (0.70-1.29)	0.97 (0.71-1.34)	1340 (2.0)	0.90 (0.50-1.63)	0.90 (0.48-1.68)	1315 (8.1)	1.01 (0.75-1.37)	0.99 (0.72-1.36)
Europe/Diabetes									
No	142 (9.9)	1.00 (Reference)	1.00 (Reference)	135 (6.7)	1.00 (Reference)	1.00 (Reference)	133 (12.8)	1.00 (Reference)	1.00 (Reference)
Yes	256 (12.5)	1.28 (0.66-2.50)	1.41 (0.71-2.82)	247 (4.9)	0.75 (0.29-1.89)	10.68 (0.27-1.77)	242 (11.2)	0.87 (0.46-1.69)	0.96 (0.49-1.88)
Ghana/No diabetes									
No	683 (9.1)	1.00 (Reference)	1.00 (Reference)	687 (4.1)	1.00 (Reference)	1.00 (Reference)	683 (9.8)	1.00 (Reference)	1.00 (Reference)
Yes	1447 (7.7)	0.84 (0.60-1.16)	0.82 (0.59-1.14)	1451 (3.1)	0.69 (0.42-1.13)	0.69 (0.42-1.13)	1442 (8.3)	0.82 (0.59-1.12)	0.80 (0.58-1.10)
Ghana/Diabetes									
No	49 (28.3)	1.00 (Reference)	1.00 (Reference)	49 (10.2)	1.00 (Reference)	1.00 (Reference)	49 (26.4)	1.00 (Reference)	1.00 (Reference)
Yes	148 (24.3)	0.78 (0.37-1.61)	0.72 (0.34-1.52)	150 (7.3)	0.55 (0.16-1.81)	0.57 (0.17-1.88)	148 (26.4)	0.93 (0.45-1.97)	0.90 (0.43-1.92)
Discrimination									
Europe/No diabetes									
No	1629 (7.9)	1.00 (Reference)	1.00 (Reference)	1609 (2.2)	1.00 (Reference)	1.00 (Reference)	1580 (8.3)	1.00 (Reference)	1.00 (Reference)
Yes	684 (6.7)	0.85 (0.60-1.21)	0.89 (0.62-1.28)	669 (1.5)	0.68 (0.33-1.40)	0.69 (0.32-1.47)	661 (7.0)	0.84 (0.59-1.20)	0.86 (0.59-1.25)
Europe/Diabetes									
No	270 (11.9)	1.00 (Reference)	1.00 (Reference)	258 (5.4)	1.00 (Reference)	1.00 (Reference)	252 (13.1)	1.00 (Reference)	1.00 (Reference)
Yes	126 (11.1)	0.87 (0.44-1.71)	0.89 (0.45-1.76)	122 (5.7)	1.29 (0.48-3.45)	1.25 (0.46-3.37)	121 (9.1)	0.68 (0.32-1.40)	0.69 (0.33-1.42)
Ghana/No diabetes									
No	1854 (8.4)	1.00 (Reference)	1.00 (Reference)	1865 (3.5)	1.00 (Reference)	1.00 (Reference)	1851 (9.0)	1.00 (Reference)	1.00 (Reference)
Yes	99 (8.1)	1.03 (0.49-2.17)	1.04 (0.49-2.19)	99 (2.0)	0.79 (0.19-3.33)	0.78 (0.18-3.29)	99 (7.1)	0.87 (0.39-1.93)	0.88 (0.39-1.95)

Ghana/Diabetes									
No	180 (26.7)	1.00 (Reference)	1.00 (Reference)	182 (7.7)	1.00 (Reference)	1.00 (Reference)	180 (27.2)	1.00 (Reference)	1.00 (Reference)
Yes	5 (0.0)	**** (***-***)	0.40 (0.05-3.11)	5 (0.0)	**** (***-***)	**** (***-***)	5 (0.0)	**** (***-***)	**** (***-***)
Stress at home/work									
Europe/No diabetes									
Never	1137 (7.9)	1.00 (Reference)	1.00 (Reference)	1127 (2.3)	1.00 (Reference)	1.00 (Reference)	1102 (8.0)	1.00 (Reference)	1.00 (Reference)
Some stress	860 (7.2)	0.90 (0.65-1.27)	0.96 (0.68-1.36)	850 (1.2)	0.49 (0.24-1.02)	0.49 (0.22-1.07)	835 (7.4)	0.94 (0.67-1.31)	0.99 (0.69-1.41)
Several/Permanent stresses	335 (8.4)	1.04 (0.67-1.62)	1.07 (0.68-1.70)	327 (2.1)	0.84 (0.36-1.95)	0.92 (0.39-2.17)	322 (9.6)	1.20 (0.77-1.85)	1.28 (0.82-1.99)
Europe/Diabetes									
Never	193 (9.8)	1.00 (Reference)	1.00 (Reference)	184 (8.2)	1.00 (Reference)	1.00 (Reference)	180 (11.7)	1.00 (Reference)	1.00 (Reference)
Some stress	142 (12.7)	1.22 (0.61-2.45)	1.38 (0.67-2.81)	134 (3.0)	0.43 (0.13-1.39)	0.40 (0.12-1.29)	133 (12.0)	1.04 (0.52-2.09)	1.13 (0.56-2.32)
Several/Permanent stresses	62 (12.9)	1.31 (0.54-3.16)	1.38 (0.56-3.41)	63 (3.2)	0.49 (0.10-2.29)	0.46 (0.10-2.23)	61 (9.8)	0.82 (0.31-2.13)	0.89 (0.34-2.35)
Ghana/No diabetes									
Never	628 (7.8)	1.00 (Reference)	1.00 (Reference)	634 (2.7)	1.00 (Reference)	1.00 (Reference)	628 (7.6)	1.00 (Reference)	1.00 (Reference)
Some stress	1163 (8.6)	1.06 (0.74-1.51)	0.97 (0.67-1.39)	1163 (3.7)	1.27 (0.71-2.27)	1.32 (0.74-2.34)	1158 (9.3)	1.15 (0.80-1.65)	1.10 (0.77-1.58)
Several/permanent stresses	339 (7.4)	0.88 (0.53-1.46)	0.76 (0.46-1.27)	341 (3.5)	1.24 (0.58-2.67)	1.35 (0.62-2.95)	339 (8.9)	1.07 (0.66-1.73)	1.00 (0.61-1.64)
Ghana/Diabetes									
Never	54 (38.9)	1.00 (Reference)	1.00 (Reference)	54 (11.1)	1.00 (Reference)	1.00 (Reference)	54 (37.0)	1.00 (Reference)	1.00 (Reference)
Some stress	116 (18.9)	**0.37 (0.37-0.77)**	**0.35 (0.17-0.75)**	116 (6.0)	0.47 (0.14-1.60)	0.45 (0.12-1.55)	116 (19.8)	**0.43 (0.21-0.89)**	**0.40 (0.19-0.86)**
Several/Permanent stresses	26 (25.0)	0.44 (0.44-1.29)	0.39 (0.13-1.19)	28 (10.7)	0.65 (0.13-3.21)	0.62 (0.12-3.23)	26 (30.8)	0.69 (0.25-1.93)	0.64 (0.22-1.87)
Depressive symptoms									
Europe/No diabetes									
No	2154 (8.0)	1.00 (Reference)	1.00 (Reference)	2122 (2.1)	1.00 (Reference)	1.00 (Reference)	2087 (8.1)	1.00 (Reference)	1.00 (Reference)
Yes	167 (5.4)	0.63 (0.32-1.25)	0.69 (0.34-1.38)	163 (2.0)	0.65 (0.15-2.72)	0.72 (0.17-3.04)	161 (6.8)	0.58 (0.25-1.35)	0.86 (0.46-1.64)
Europe/Diabetes									

No	351 (12.0)	1.00 (Reference)	1.00 (Reference)	335 (35.9)	1.00 (Reference)	1.00 (Reference)	329 (12.5)	1.00 (Reference)	1.00 (Reference)
Yes	39 (10.3)	0.79 (0.26-1.35)	0.73 (0.24-2.19)	39 (2.6)	0.49 (0.06-3.97)	0.49 (0.06-3.99)	38 (7.9)	0.89 (0.40-2.01)	0.60 (0.17-2.08)
Ghana/No diabetes									
No	2027 (8.3)	1.00 (Reference)	1.00 (Reference)	2035 (3.4)	1.00 (Reference)	1.00 (Reference)	2022 (8.8)	1.00 (Reference)	1.00 (Reference)
Yes	102 (4.9)	0.50 (0.20-1.25)	0.48 (0.19-1.19)	102 (2.9)	0.64 (0.19-2.13)	0.67 (0.20-2.21)	102 (7.8)	0.69 (0.32-1.46)	0.71 (0.34-1.51)
Ghana/Diabetes									
No	185 (26.5)	1.00 (Reference)	1.00 (Reference)	187 (8.7)	1.00 (Reference)	1.00 (Reference)	185 27.6)	1.00 (Reference)	1.00 (Reference)
Yes	12 (8.3)	0.27 (0.03-2.13)	0.25 (0.03-2.01)	12 (0.0)	*** (****-****)	*** (***-***)	12 (8.3)	0.42 (0.05-3.32)	0.27 (0.03-2.19)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S4: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by hypertensive status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe/No hypertension									
No	568 (6.9)	1.00 (Reference)	1.00 (Reference)	562 (1.3)	1.00 (Reference)	1.00 (Reference)	551 (7.1)	1.00 (Reference)	1.00 (Reference)
Yes	743 (5.0)	0.72 (0.45-1.15)	0.78 (0.48-1.27)	740 (0.8)	0.59 (0.19-1.77)	0.60 (0.20-1.83)	724 (5.1)	0.71 (0.44-1.13)	0.75 (0.46-1.22)
Europe/Hypertension									
No	560 (9.6)	1.00 (Reference)	1.00 (Reference)	544 (4.0)	1.00 (Reference)	1.00 (Reference)	539 (10.0)	1.00 (Reference)	1.00 (Reference)
Yes	872 (11.4)	1.22 (0.86-1.73)	1.20 (0.83-1.73)	847 (3.9)	0.95 (0.54-1.67)	0.89 (0.49-1.62)	833 (11.6)	1.19 (0.83-1.69)	1.13 (0.78-1.62)
Ghana/No Hypertension									
No	540 (6.3)	1.00 (Reference)	1.00 (Reference)	543 (2.2)	1.00 (Reference)	1.00 (Reference)	540 (6.9)	1.00 (Reference)	1.00 (Reference)
Yes	1118 (5.6)	0.88 (0.57-1.36)	0.84 (0.54-1.31)	1124 (1.9)	0.82 (0.39-1.69)	0.86 (0.41-1.79)	1115 (6.4)	0.93 (0.61-1.40)	0.90 (0.59-1.36)
Ghana/Hypertension									
No	192 (21.9)	1.00 (Reference)	1.00 (Reference)	193 (10.9)	1.00 (Reference)	1.00 (Reference)	192 (22.4)	1.00 (Reference)	1.00 (Reference)
Yes	476 (18.1)	0.78 (0.52-1.18)	0.79 (0.52-1.20)	476 (6.9)	0.58 (0.32-1.04)	0.58 (0.33-1.05)	474 (18.4)	0.77 (0.50-1.16)	0.76 (0.51-1.16)
Discrimination									
Europe/No hypertension									
No	916 (6.3)	1.00 (Reference)	1.00 (Reference)	907 (0.8)	1.00 (Reference)	1.00 (Reference)	885 (6.8)	1.00 (Reference)	1.00 (Reference)
Yes	379 (3.7)	0.60 (0.33-1.09)	0.65 (0.36-1.21)	378 (1.1)	1.35 (0.39-4.74)	1.37 (0.38-4.89)	374 (3.2)	**0.47 (0.25-0.89)**	**0.51 (0.27-0.97)**
Europe/Hypertension									
No	983 (10.5)	1.00 (Reference)	1.00 (Reference)	960 (4.4)	1.00 (Reference)	1.00 (Reference)	947 (10.9)	1.00 (Reference)	1.00 (Reference)
Yes	431 (10.7)	1.03 (0.71-1.49)	1.05 (0.72-1.54)	413 (3.2)	0.73 (0.38-1.39)	0.75 (0.38-1.48)	408 (11.0)	1.03 (0.71-1.49)	1.04 (0.71-1.53)
Ghana/No hypertension									
No	1427 (5.7)	1.00 (Reference)	1.00 (Reference)	1437 (2.2)	1.00 (Reference)	1.00 (Reference)	1424 (6.5)	1.00 (Reference)	1.00 (Reference)

Yes	81 (7.4)	1.30 (0.55-3.09)	1.30 (0.55-3.10)	81 (0.0)	**** (***-***)	**** (***-***)	81 (7.4)	1.21 (0.51-2.88)	1.22 (0.51-2.89)
Ghana/Hypertension									
No	606 (20.3)	1.00 (Reference)	1.00 (Reference)	609 (7.9)	1.00 (Reference)	1.00 (Reference)	606 (20.3)	1.00 (Reference)	1.00 (Reference)
Yes	23 (8.7)	0.38 (0.09-1.68)	0.40 (0.09-1.74)	23 (8.7)	1.27 (0.28-5.70)	1.20 (0.26-5.44)	23 (4.4)	0.19 (0.03-1.44)	0.19 (0.03-1.45)
Stress at home/work									
Europe/No hypertension									
Never	644 (6.1)	1.00 (Reference)	1.00 (Reference)	640 (1.3)	1.00 (Reference)	1.00 (Reference)	625 (5.8)	1.00 (Reference)	1.00 (Reference)
Some stress	468 (4.5)	0.74 (0.43-1.27)	0.81 (0.46-1.43)	464 (0.4)	0.37 (0.07-1.74)	0.41 (0.09-2.01)	457 (4.8)	0.84 (0.49-1.45)	0.91 (0.52-1.60)
Several/Permanent stresses	192 (6.8)	1.07 (0.56-2.05)	1.19 (0.61-2.29)	191 (1.6)	1.49 (0.38-5.78)	1.52 (0.39-5.98)	186 (8.1)	1.38 (0.74-2.60)	1.49 (0.79-2.84)
Europe/Hypertension									
Never	686 (10.2)	1.00 (Reference)	1.00 (Reference)	665 (5.4)	1.00 (Reference)	1.00 (Reference)	657 (11.1)	1.00 (Reference)	1.00 (Reference)
Some stress	534 (11.1)	1.03 (0.71-1.49)	1.05 (0.72-1.54)	520 (2.3)	**0.49 (0.25-0.96)**	**0.47 (0.23-0.95)**	511 (10.9)	0.97 (0.67-1.41)	0.99 (0.67-0.47)
Several/Permanent stresses	205 (11.2)	1.11 (0.67-1.82)	1.12 (0.67-1.87)	199 (3.0)	0.56 (0.23-1.37)	0.58 (0.24-1.43)	197 (11.2)	0.99 (0.59-1.64)	1.03 (0.61-1.74)
Ghana/No hypertension									
Never	495 (5.5)	1.00 (Reference)	1.00 (Reference)	498 (1.4)	1.00 (Reference)	1.00 (Reference)	495 (5.9)	1.00 (Reference)	1.00 (Reference)
Some stress	899 (5.9)	1.07 (0.66-1.73)	0.99 (0.61-1.60)	901 (2.2)	1.30 (0.54-3.15)	1.39 (0.57-3.37)	896 (6.5)	1.04 (0.65-1.65)	1.00 (0.63-1.59)
Several/permanent stresses	263 (5.7)	1.01 (0.53-1.95)	0.89 (0.46-1.72)	267 (2.6)	1.69 (0.58-5.01)	1.89 (0.63-5.65)	263 (7.6)	1.21 (0.67-2.20)	1.15 (0.63-2.11)
Ghana/Hypertension									
Never	187 (22.9)	1.00 (Reference)	1.00 (Reference)	190 (8.4)	1.00 (Reference)	1.00 (Reference)	187 (20.9)	1.00 (Reference)	1.00 (Reference)
Some stress	379 (18.2)	0.74 (0.48-1.14)	0.68 (0.43-1.05)	377 (7.9)	0.95 (0.50-1.80)	0.99 (0.51-1.91)	377 (19.4)	0.90 (0.58-1.40)	0.87 (0.55-1.36)
Several/Permanent stresses	102 (15.7)	0.62 (0.33-1.17)	0.54 (0.28-1.04)	102 (7.8)	0.92 (0.37-2.26)	0.97 (0.39-2.43)	102 (17.7)	0.79 (0.42-1.49)	0.76 (0.40-1.43)
Depressive symptoms									
Europe/No hypertension									

No	1195 (5.9)	1.00 (Reference)	1.00 (Reference)	1187 (1.1)	1.00 (Reference)	1.00 (Reference)	1162 (6.0)	1.00 (Reference)	1.00 (Reference)
Yes	101 (3.9)	0.59 (0.21-1.65)	0.64 (0.23-1.82)	99 (1.0)	1.18 (0.15-2.72)	1.27 (0.16-10.17)	98 (5.1)	0.77 (0.30-1.97)	0.84 (0.33-2.17)
Europe/Hypertension									
No	1310(10.9)	1.00 (Reference)	1.00 (Reference)	1270 (4.1)	1.00 (Reference)	1.00 (Reference)	1254 (11.2)	1.00 (Reference)	1.00 (Reference)
Yes	105 (8.6)	0.76 (0.37-1.53)	0.75 (0.37-1.55)	103 (1.9)	0.52 (0.12-2.18)	0.56 (0.13-2.38)	101 (8.9)	0.77 (0.38-1.58)	0.80 (0.39-1.63)
Ghana/No hypertension									
No	1575 (5.9)	1.00 (Reference)	1.00 (Reference)	1584 (2.1)	1.00 (Reference)	1.00 (Reference)	1572 (6.7)	1.00 (Reference)	1.00 (Reference)
Yes	82 (2.4)	0.36 (0.09-1.51)	0.35 (0.08-1.44)	82 (1.2)	0.39 (0059-2.95)	0.39 (0.05-2.97)	82 (3.7)	0.44 (0.13-1.42)	0.43 (0.13-1.40)
Ghana/Hypertension									
No	636 (19.5)	1.00 (Reference)	1.00 (Reference)	637 (8.2)	1.00 (Reference)	1.00 (Reference)	634 (19.6)	1.00 (Reference)	1.00 (Reference)
Yes	32 (12.5)	0.59 (0.20-1.72)	0.59 (0.20-1.74)	32 (6.3)	0.74 (0.17-3.25)	0.76 (0.17-3.33)	32 (18.8)	0.94 (0.0.37-2.37)	0.94 (0.38-2.37)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 lines 1-3	We have included a commonly used term in the title and abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3 lines 87-116	Our study shows no convincing evidence for associations between stress as indicated by four PS constructs and prevalence of CKD. Further studies aimed at identifying potential factors driving the high prevalence of CKD among these populations are needed.
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5 lines 180-226	The theoretical and scientific background as well as the rationale for conducting the study have been provided in the introduction section.
Objectives	3	State specific objectives, including any pre specified hypotheses	5 lines 222-226	We examined the association between PS and CKD prevalence among rural and urban Ghanaians and their migrants living in three European cities. We also

				assessed if the influence of PS on CKD is partially mediated by primary risk factors (hypertension and diabetes) of CKD.
Methods				
Study design	4	Present key elements of study design early in the paper	-6-7 lines 232-264	Details given in the methods
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7 lines 232-264	Rural or urban Ghana and three (Amsterdam, Berlin, London) European cities (migrants)
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Pg. 7 lines 254-264	A multi-centred cross sectional baseline data from the Research on Obesity and Diabetes among African Migrants (RODAM) study. A random sample of 5,659 adults (Europe, 3167, rural, 1,043, Urban Ghana, 1,449, Ghana) aged 25 to 70 years.
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Pg. 7-10 lines 266-357	The main outcomes have been clearly defined.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Pg. 7-10 lines 266-357	We defined each variable of interest in the methods

				accordingly
Bias	9	Describe any efforts to address potential sources of bias	Pg. 9 lines 315-331	Potential sources of bias have been reported in the methods sections.
Study size	10	Explain how the study size was arrived at	Pg. 7 lines 259-264	Given in the methods section and we have also referred to the RODAM study methods paper

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Pg. 10-11 lines 368-388	Please see methods
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Pg. 10-11 lines 367-387	Please see methods
		(*b*) Describe any methods used to examine subgroups and interactions	Pg. 10-11 lines 367-387	Please see methods
		(*c*) Explain how missing data were addressed	Pg. 7 lines 259-264	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NA	We have reported non-response across sites
		(*e*) Describe any sensitivity analyses	NA	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Pg. 7 lines 254-264	Non-response analysis was done to shed light on the differential response rates across sites
		(b) Give reasons for non-participation at each stage	Pg. 7 lines 259-264	
		(c) Consider use of a flow diagram	Pg. 6 lines 232-234	We have also referred to RODAM methods paper
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Pg. 7 lines 269-357	We have also referred to RODAM methods paper
		(b) Indicate number of participants with missing data for each variable of interest	Pg. 7 lines 260-264	We have also referred to RODAM methods paper
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*NA*	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*NA*	

		Cross-sectional study—Report numbers of outcome events or summary measures	Pg. 11-13	Summary measures are given in the results section and in tables and figures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	*Pg. 11-23 lines 406-521*	Unadjusted and adjusted estimates are given in the results section and in figures
		(*b*) Report category boundaries when continuous variables were categorized	*Pg. 11-23 lines 389-521*	We have provided mean and corresponding standard deviations for the continuous variables.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time	NA	

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	
Discussion				
Key results	18	Summarise key results with reference to study objectives	Pg. 24 lines 524--531	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Pg. 25 lines 584-596	Key limitations regarding study methods including differential response rates and sampling methods in the various study sites have been provided
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Pg. 24-26 lines 522-603	Cautious overall interpretation of the key findings have been provided.
Generalisability	21	Discuss the generalisability (external validity) of the study results	Pg. 25 lines 584-596	
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Pg. 26 lines 624-630	The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.

BMJ Open

A CROSS-SECTIONAL STUDY OF ASSOCIATION BETWEEN PSYCHOSOCIAL STRESSORS WITH CHRONIC KIDNEY DISEASE AMONG MIGRANT AND NON-MIGRANT GHANAIANS LIVING IN EUROPE AND GHANA: THE RODAM STUDY

Journal:	*BMJ Open*
Manuscript ID	bmjopen-2018-027931.R2
Article Type:	Research
Date Submitted by the Author:	28-May-2019
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Primary Subject Heading:	Public health
Secondary Subject Heading:	Epidemiology, Public health, Renal medicine
Keywords:	Chronic Kidney Disease, Psychosocial stressors, migrants, rodam study, Europe, Ghana

A CROSS SECTIONAL STUDY OF ASSOCIATION BETWEEN PSYCHOSOCIAL STRESSORS WITH CHRONIC KIDNEY DISEASE AMONG MIGRANT AND NON-MIGRANT GHANAIANS LIVING IN EUROPE AND GHANA: THE RODAM STUDY

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Abstract

Objectives: The association between Psychosocial stressors (PS) and CKD among sub-Saharan African (SSA) populations is unknown. We examined the association between PS and CKD prevalence among rural and urban Ghanaians and Ghanaian migrants living in three European cities. We also assessed if the influence of PS on CKD is partially mediated by primary risk factors (hypertension and diabetes) of CKD

Design: A multi-centred cross sectional data from the Research on Obesity and Diabetes among African Migrants (RODAM) study

Setting: Rural and urban Ghana and three European cities (Amsterdam, Berlin and London).

Participants: A random sample of 5,659 adults (Europe 3167, rural Ghana 1,043, and Urban Ghana 1,449) aged 25 to 70 years

Explanatory measures: PS defined by negative life events, perceived discrimination, perceived stress at work/home and depressive symptoms. Three CKD outcomes were considered using the 2012 KDIGO (Kidney Disease: Improving Global Outcomes) severity of CKD classification. Comparisons between PS and CKD outcomes were made using logistic regression analyses across all sites

Results: We observed higher proportion of negative life events (68.7%) and perceived permanent stress (15.9%) among Ghanaians living in Ghana than Ghanaians living in Europe. Depressive symptoms (7.5%) and perceived discrimination (29.7%) were more common among Ghanaians living in Europe than Ghanaians living in Ghana. No significant association was observed between any of the PS constructs and CKD outcomes across sites except for positive association between stress at work/home and albuminuria (2.81, 95% C.I. 1.46-5.40) and CKD risk (2.78, 95% C.I. 1.43-5.43) among Ghanaians living in Berlin

Conclusion: Our study found a positive association between stress at work/home and albuminuria and CKD risk. There was no convincing evidence of associations between the other PS constructs and the prevalence of CKD risk. Further studies, are needed to identify potential factors driving the high prevalence of CKD among these populations.

Index Words: Chronic kidney disease; psychosocial stressors; risk factor; migrants; RODAM study, Europe, Ghana

Strengths and limitations of the study

- This study used all three categories of CKD definitions (albuminuria, reduced eGFR and CKD risk) by KDIGO 2012 in assessing association of SS with CKD across all sites. This provided more detailed information on CKD outcomes.
- All sites in our study used well standardized study protocols and this eliminated intra protocol variability.
- The use of four constructs of psychosocial stressors (negative life events, perceived discrimination, perceived stress at work/home and depressive symptoms) provided a robust approach to assessing SS associations with CKD.
- The limitation of intra laboratory variability in earlier studies was eliminated using the same standard operating procedures in the same laboratory for running all samples for all sites.
- PS is captured and experienced in different magnitude across different populations. We were unable to ascertain if PS as defined in this study was adequately captured among Ghanaians living in rural and urban Ghana.

Introduction

Worldwide, Chronic Kidney Disease (CKD) is a leading cause of mortality and morbidity with several risk factors (diabetes mellitus, obesity, hypertension and cardiovascular disease) [1]. The epidemiologic transition in low-and-middle income countries (LMICs) shows increased burden of these risk factors [2-4]. CKD's high morbidity and mortality is mostly driven by uncontrolled comorbidities such as diabetes and hypertension [5 6]. CKD treatment and management cost is very high and not sustainable even in high-income countries and this underscores the need for prevention [7]. Available literature has shown that both individual and community level economic factors influence CKD [8-10]. However, after adjusting for both individual and community level socioeconomic position, differences in CKD risk among different populations remained [8 10 11]. These findings seem to suggest that other social environmental factors may be driving CKD prevalence and progression in high-risk populations. Recent studies have shown that whereas Ghanaians living in Europe have a higher CKD risk compared to their host nation populations, they have a lower CKD risk compared with their peers living in urban Ghana [12]. The increased risk of CKD observed in urban Ghana was not fully explained by conventional risk factors [12] and socio-economic status [13]. This underscores the need to identify other modifiable risk factors of CKD for prevention, optimum treatment and efficient management.

Evidence shows that where an individual works or stays influences his or her physiological wellbeing leading to an increased risk of chronic diseases [14 15]. Thus, migrants' physiological wellbeing is influenced by the environment (host nations) they move to stay. The association between PS and CKD as well as the biological pathways through which PS influences CKD progression is poorly understood and complex [5] although several pathways have been suggested [16 17]. Specifically, PS have been reported to be associated with alteration in the sympathetic/autonomic nervous system activity leading to higher rates of traditional risk factors of CKD including hypertension and diabetes [18-20]. Environmental stressors have been reported to contribute to the development of insulin resistance, metabolic syndrome, obesity and diabetes which if uncontrolled leads to CKD incidence [21 22]. Other studies [23 24] have suggested that stress attributable to social and/or economic disadvantage is associated with CKD development and progression through an interaction between other psychosocial factors and comorbid behaviors such as alcohol, tobacco and drug use [25]. In addition, undernutrition due to stress adversely impact on fetal environment by impeding fetal growth leading to low birth weight, which has been shown to be associated with CKD in adult life [25 26].

However, studies linking psychosocial stressors (PS) to CKD prevalence and progression vary greatly among different geographical populations. [5 16 27-31]. Specifically, in the USA whereas no association was

found between PS and CKD [31-33] another study reported lower prevalence of CKD was associated with greater life stressors at baseline [31]. In contrast, in the Netherlands depressive and anxiety symptoms were observed to be common among CKD patients and such patients had increased risk of poor clinical outcomes [28]. Similarly, a study conducted in Korea reported a positive relationship between depressive symptoms and CKD [27]. These observations suggest differential impact of PS at different geographical locations. For example, discrimination among migrants may differ greatly between host population and from their SSA compatriots. Specifically, some studies have reported differences in PS among rural and urban populations [34].

Current literature on the association between PS and CKD among sub-Saharan African populations and their migrants in Europe is scanty and uncertain. We therefore sought to determine the association between PS and CKD prevalence among Ghanaians in rural and urban Ghana and their migrants living in three European cities. Furthermore, we examined the influence of psychosocial stressors on risk factors (obesity, diabetes and hypertension) of CKD.

Methods

Study population and study design

For this study, data from the Research on Obesity & Diabetes among African Migrants (RODAM) study, a multi-centre cross sectional study, were used. The rationale, conceptual framework, design and methodology of the RODAM study have been described in detail elsewhere [12 13 35 36]. To summarize, the study was conducted from 2012 to 2015. Ghanaians aged 25–70 years living in rural and urban communities in Ghana as well as in three European cities (Amsterdam, Berlin and London) were included in this study. We standardized data collection across all sites. The ethics committees in Ghana, the Netherlands, Germany and the UK approved the study protocol prior to data collection. Informed consent was obtained from each participant prior to enrollment in the study. In Ghana, participants were randomly drawn from a list of 30 enumeration areas in the Ashanti region based on the 2010 population census. These enumeration areas came from both rural areas and two purposively selected urban cities (Kumasi and Obuasi). For Ghanaians in Amsterdam, we randomly drew participants from the Municipal register. This register holds data on country of birth of citizens and their parents, thus allowing for sampling based on the Dutch standard indicator for ethnic origin. London lacked a population register for migrant groups. Thus, Ghanaian organizations served as sampling frame for the study. Lists of these organizations were obtained from the Ghanaian Embassy and the Association of Ghanaian Churches in the UK in the boroughs known to have the greatest concentration of Ghanaians. Members were selected from the lists of all members of these organizations. In Berlin, the registration office of the federal state of Berlin provided a list of Ghanaian

individuals in Berlin but this resulted in low response rate. Because of this, a change was made to use lists of Ghanaian churches and organizations as the sampling frame. Across all sites in Europe, all selected participants were sent a written invitation combined with written information (information sheet) regarding the study and a response card. The participants were contacted by phone to schedule a date and location of the interview with a trained research assistant or opt for the self-administration of the paper questionnaire or digital online version depending on the preference of the participant. After the completion of the questionnaire, a date for physical examination was then scheduled after a positive response. The participants were instructed to fast from 10.00 p.m. the night before the physical examination. The response rate was 76% in rural Ghana and 74% in urban Ghana. In London, of those individuals who were registered in the various Ghanaian organizations and were invited, 75% agreed and participated in the study, while in Berlin, this figure was 68%, and 53% in Amsterdam. For the current study, 5898 participants with data available on both questionnaire data and physical measurements were used. Individuals who were outside the age range of 25–70 years (n=239) were excluded because not all the study sites had individuals outside this age range resulting in 5659 individuals comprising of 2492 from rural and urban Ghana and 3167 from the three European cities. In the conduct of analysis, we further excluded individuals with no data on CKD and all other indicators (n=52), resulting in a data set of 5607 participants for analysis.

Measurements

Covariates

Demographic and lifestyle factors

For this study, we obtained information on demographics, educational level and lifestyle factors (smoking and physical activity) by questionnaire. Physical examinations were performed across all sites using validated devices per standardized operational procedures. Educational level was based on the highest qualification gained either in the Netherlands or in the country of origin and was classified into 4 groups: those who have never been to school or had elementary schooling only, those with lower vocational schooling or lower secondary schooling, those with intermediate vocational schooling or intermediate/higher secondary education schooling, and those with higher vocational schooling or university. The four categories were further categorized into three categories by combining the second and third categories. Smoking status was determined from the response to the question “Do you smoke at all?” and was classified into nonsmokers and current smokers. Physical activity was assessed using the WHO Global Physical Activity Questionnaire V.2. Weight was measured in light clothing and without shoes with SECA 877 scales to the nearest 0.1 kg. Height was measured without shoes with a portable stadiometer (SECA 217) to the nearest 0.1 cm. Body mass index (BMI) was calculated as weight (kg) divided by height

squared (m2). Overweight was defined as BMI of 25 to < 30 kg/m^2 and obesity as BMI ≥30 kg/m^2. Waist circumference was measured in centimetres at the midpoint between the lower rib and the upper margin of the iliac crest. We used the same assessor for each participant in measuring all anthropometrics and each was measured twice; the average of the two measurements was used for analyses.

Predictor: SS

For this study, four constructs of psychosocial stress (discrimination, perceived stress at work or at home, negative life events and depressive symptoms) were used as explanatory variables.

Perceived discrimination

Everyday discrimination as perceived by participants was reported as routinely experiencing instances of unfair treatment. We used the Everyday Discrimination Scale (EDS). The EDS comprises of a 9-items which rates the frequency at which participants experience daily mistreatment and it focuses on being treated with less courtesy or less respect, receiving poorer service than other people or being called names or insulted. Participants had the option of rating each of the 9-items from "never" = 1 to "very often" = 5. The obtained scores were summed and an average of the scores was computed to obtain a final score of 1 to 5. This scale was used because it is commonly used for self-reported discrimination [37], with consistent high reliability among a variety of ethnicities [38], comprising African migrants in the Netherland [39].

Perceived stress at work or at home

We defined perceived stress at work or at home as "sense of irritation, filled with anxiety, or as having difficulties in sleeping because of circumstances at work or at home". We used the psychological stress scale created by the INTERHEART study [40]. Participants in the study were asked about their opinion on frequency of stress at work and at home, and could answer "never", "some periods", "several periods", or "continually". Both answers were then combined into a composite score and graded into four categories: never experienced to experienced permanent stress at home or at work [40]. Due to the very small numbers in the permanent periods of stress group, we combined experienced several periods of stress at home or at work and permanent periods of stress at home or at work.

Negative life events

The presence of major negative life events among participants was perceived as any event that could cause acute stress to an individual. We therefore applied the well-validated and widely used List of Threatening Experiences (LTE) [41 42]. The scale comprised of 12 unpleasant events participants perceived to have experienced in the past 12 months. We used a slightly-altered version of LTE consisting of 9 unpleasant items. We dichotomized participants into two groups namely "no negative life events" and "one or more events" and participants in the second category were expected to have higher levels of stress [42].

Depressive symptoms

Depressive symptoms were measured by the 9-item Patient Health Questionnaire (PHQ-9). The PHQ-9 consists of nine items, with a response scales 0 'not at all', 1 'on several days', 2 'on more than half of the days' and 3 'nearly every day'. A participant was considered to be in a significant depressed mood (SDM) when one or both of the items 1 (little interest or pleasure in doing things) and 2 (feeling down, depressed, or hopeless) were answered with at least 'on more than half of the days', and at least 5 of the 9 items were answered with at least 'on more than half of the days'[43].

Co-morbidity factors

Blood pressure (BP) was measured three times using a validated semi-automated device (The Microlife WatchBP home) with appropriate cuffs in a sitting position after at least 5min rest. The mean of the last two BP measurements was used in the analyses. Hypertension was defined as systolic BP 140mmHg and/or diastolic BP 90mmHg, and/or being on antihypertensive medication treatment, and/or self-reported hypertension. Trained research assistants in all sites collected fasting venous blood samples according to standard operation procedures, and then temporarily stored at the local research location. The stored blood samples from the local research centres were transported to Berlin, Germany, according to standardized procedures, for biochemical analyses. This was done to avoid intra-laboratory variability. Fasting plasma glucose concentration was measured using an enzymatic method (hexokinase). We defined Type 2 diabetes according to the World Health Organization diagnostic criteria (fasting glucose 7.0mmol/L, and/or current use of medication prescribed to treat diabetes, and/or self-reported diabetes) [44]. We assessed concentration of total cholesterol using colorimetric test kits. All biochemical analyses were performed using an ABX Pentra 400 Chemistry Analyzer (ABX Pentra; Horiba 90 ABX, Germany). Hypercholesterolaemia was defined as total cholesterol level ≥6.22mmol/L. Serum creatinine concentration (in mol/L) was determined by a kinetic colorimetric spectrophotometric isotope dilution mass spectrometry calibration method (Roche Diagnostics).

Outcome: CKD prevalence

We asked participants to bring an early morning urine sample for the analyses of albuminuria and creatinine levels. Urinary albumin concentration (in µmol/L) was measured by an immunochemical turbidimetric method (Roche Diagnostics). Urinary creatinine concentration (in l mol/L) was measured by a kinetic spectrophotometric method (Roche Diagnostics). Extensive quality checks were done inclusive of blinded serial measurements. Estimated glomerular filtration rate (eGFR) was calculated using the CKDEPI (CKD Epidemiology Collaboration) creatinine equation [45]. Urinary albumin–creatinine ratio (ACR; expressed in mg/mmol) was calculated by taking the ratio between urinary albumin and urinary creatinine. eGFR and

albuminuria were categorized according to the 2012 KDIGO classification [46]. eGFR was categorized as follows: G1, 90mL/min/1.73m^2 (normal kidney function); G2, 60–89mL/min/1.73m^2 (mildly decreased); G3a, 45–59mL/min/1.73m^2 (mildly to moderately decreased); G3b, 30–44mL/min/1.73m^2 (moderately to severely decreased); G4, 15–29 mL/min/1.73 m^2 (severely decreased); and G5, <15mL/min/1.73m^2 (kidney failure). Albuminuria categories were derived from ACR and were as follows: A1, < 3mg/mmol (normal to mildly increased); A2, 3–30mg/mmol (moderately increased); and A3, > 30mg/mmol (severely increased). CKD risk was categorized according to severity of kidney disease (green, low risk; yellow, moderately increased risk; orange, high risk; and red, very high risk) using the combination of eGFR (G1–G5) and albuminuria (A1–A3) levels defined by the 2012 KDIGO guideline [47]. Due to the small number of participants in the very high-risk category of CKD (n=27), the high and very high-risk groups were combined. Because of the small number of participants in the severely increased albuminuria category (A3, n=62), we defined albuminuria as ACR 3mg/ mmol by combining the moderately increased (A2) and severely increased (A3) categories.

Covariates assessed were age, sex, educational level and length of stay in Europe, hypertension and diabetes. Length of stay was assessed for Ghanaian migrants only. Length of stay was defined as the number of years lived in Europe at the time of data collection. Length of stay was controlled for due to evidence suggesting that it influences mental health [48]. Other covariates were hypertension, obesity and diabetes.

Patient and Public Involvement

Community leaders were involved in the recruitment of patients. These comprised of religious communities (churches and mosques), endorsement from local key leaders and establishing relationships with healthcare organizations. We also provided information on the study by involving the local media (radio and television stations). We sent letters to all selected health and community authorities to notify participants of the study. Team members were sent to the various communities to stay among the community and organize mini clinics for a period of 1-2 weeks. Results of the study were disseminated through seminars, durbars and via radio and television stations.

Statistical methods

Characteristics of participants were expressed as absolute numbers and percentages for categorical variables and means and standard deviations for continuous variables. The z-test for proportions was used to compare proportions of demographic and clinical variables among the various sites and the independent t-test was also used to test for mean differences between the two sites. Odds Ratios (ORs) and their corresponding 95% confidence intervals (CIs) were estimated by means of binary logistic regression analyses to study the

associations of albuminuria (ACR>3 mg/mmol, A2-A3, moderately to severely increased albuminuria), reduced kidney function (eGFR< 60 mL/min/1.73m^2, G3-G5 moderately to severely decreased kidney function) and increased CKD risk (high and very high CKD risk), with adjustments for covariates [49]. The Spearman's correlation test was used to test for associations between all four constructs of PS. Three models were used to examine the data. Model 1 was adjusted for age and sex, model 2 was adjusted for age and sex and educational level for Ghanaians living in SSA while age, sex, educational level and length of stay for Ghanaians living in Europe [50-52]. Model 3 was adjusted for sex, age, educational level and conventional risk factors (hypertension, diabetes, hypercholesterolemia, BMI, physical activity and smoking status) of CKD. The analyses were performed for all 4 constructs of PS using individuals who have not experienced either of the PS per outcome as reference. All tests were stratified per sites due to interactions, Ghanaians living in SSA and Europe; Ghanaians living in rural and urban Ghana and Ghanaians living in Amsterdam, Berlin and London due to an observed interaction between PS and site. Furthermore, the analyses were stratified for those with and without obesity, diabetes, hypertension across all sites due to interactions between these disease risks. P-values less than 0.05 were interpreted as statistically significant. All analyses were performed using STATA, version 14.0 (StataCorp LP).

Results

Characteristics of the study population

Participants characteristics are shown in Table 1. Ghanaians living in Ghana were significantly older than their peers living in Europe (47.7±11.9 versus 46.6±9.9, p=0.006). There were more female participants in the Ghana sample compared with European sample (67.1% versus 58.5%, p=0.001). Ghanaians living in Ghana were significantly less educated than those living in Europe. Higher proportion of Ghanaians living in Ghana had experienced negative life events in the last 12 months compared with their peers living in Europe (68.7% versus 59.0%, p=0.001). More than half of Ghanaians living in Ghana had experienced some stress at home or work whereas only a third of those living in Europe had experienced some stress at home or work (p=0.001). Permanent stress at home/work was fairly the same among Ghanaians living in SSA and Europe. Perceived discrimination was significantly higher among Ghanaians living in Europe compared with their peers living in Ghana (29.7% versus 4.8%, p=0.001). Depressive symptoms were more prevalent among Ghanaians living in Europe 7.5% compared with their peers living in Ghana 5.1%. Almost all Ghanaians living in Europe were first generation migrants. Ghanaians in Europe were significantly more obese, more likely to smoke and less physically active compared with their peers living in Ghana. Prevalence of hypercholesterolemia was significantly higher, but type 2 diabetes and hypertension were significantly lower among Ghanaians living in Ghana compared with their peers living in Europe (p=0.001).

Prevalence of albuminuria, reduced eGRF and CKD risk were higher in Ghanaians living in Ghana compared with those living in Europe.

Table 1: Baseline characteristics of respondents

	Ghanaians (SSA) n (%)	Ghanaians (Europe) n (%)	p-value
N	2,492 (44.1)	3,167 (55.9)	0.001
Female sex	1672 (67.1)	1,851 (58.5)	0.001
Age (years)	47.7±11.9	46.6±9.9	0.006
Educational status			
Low	1169 (49.2)	635 (21.8)	0.001
Middle	858 (36.1)	1111 (38.1)	
High	347 (14.6)	1168 (40.1)	
Negative life events in the past 12 months			
No	739 (31.3)	1158 (41.0)	0.001
Yes	1619 (68.7)	1667 (59.0)	
Perceived stress at home/work			
Never	692 (29.4)	1371 (48.8)	0.001
Some periods	1290 (54.7)	1033 (36.8)	
Several/Permanent	375 (15.9)	407 (14.4)	
Perceived discrimination			
No	2065 (95.2)	1960 (70.3)	0.001
Yes	104 (4.8)	829 (29.7)	
Depressive symptoms			
No	2239 (94.9)	2582 (92.5)	0.001

Yes	119 (5.1)	209 (7.5)	
Migration generation			
First	Not applicable	2868 (98.7)	Not applicable
Second	Not applicable	38 (1.3)	Not applicable
BMI			
Normal (<25kg/m2)	1373 (55.2)	643 (20.4)	0.001
Overweight (25 ≤ 30kg/m2)	684 (27.5)	1,350 (42.8)	
Obese (>30kg/m2)	432 (17.3)	1163 (36.8)	
Currently smoking	36 (1.5)	121 (4.1)	0.001
Physical activity	1255 (52.8)	1131 (44.0)	0.001
Hypocholesteraemia	352 (14.2)	354 (11.3)	0.007
Type 2 diabetes	206 (8.3)	444 (14.0)	0.001
Hypertension	837 (33.6)	1801 (56.9)	0.001
ACR			
A1 < 3mg/mmol	2215 (90.2)	2814 (91.8)	0.001
A2-A ≥ 3mg/mmol	243 (9.8)	252 (8.2)	
eGFR			
G1-G2 ≥ 60 mL/min/1.73 m2	2377 (96.3)	2936 (97.4)	0.018
G3a-G5 < 60 mL/min/1.73 m2	85 (3.7)	78 (2.6)	
CKD Risk			
Low risk	2197 (89.6)	2705 (91.5)	0.015
Moderate-very high risk	256 (10.4)	252 (8.5)	

Abbreviations: N, number of respondents; BMI, body mass index; eGFR, estimated glomerular filtration rate; G1-G2, normal to high kidney function to mildly decreased; G3a-G5, mildly to moderately decreased to Kidney failure; ACR, albumin creatinine ratio; A1, normal to mildly increased; A2-A3, moderately increased to severely increased; CKD, Chronic kidney disease; SSA, Sub-Saharan Africa; CI, confidence intervals.

Association between PS and CKD

Figure 1-4 shows CKD prevalence by negative life events in the past 12 months among Ghanaians living in Ghana and Europe. In Europe, CKD prevalence was fairly the same among those who had experienced any negative life events compared with those who had not in the last 12 months. Prevalence of CKD was higher among Ghanaians who had not experienced any negative life events in the past 12 months (10.9%)

compared with those who had experienced some negative life events (9.9%) and living in Ghana. CKD prevalence was higher among Ghanaians who had not experienced any form of discrimination (10.6%) than those who had (6.7%) in Ghana as well as in Europe (Figure 2). CKD prevalence was slightly higher among Ghanaians who had experienced several/permanent stress at work/home in the past 12 months and living in Ghana (10.4%) or Europe (9.7%) (Figure 3). Ghanaians who did not report any form of depressive symptoms had a significantly higher CKD prevalence than those who did and living in Ghana (10.4%) and Europe (8.7**%)** (Figure 4).

Table 2 shows the correlation matrix between the 4 constructs of PS among Ghanaians living in Ghana and those living in Europe. All four constructs of PS were positively correlated with each other among Ghanaians living in Europe and Ghanaians living in Ghana ($p<0.001$), except stress at work/home and discrimination among Ghanaians living in Ghana.

Table 2: Relationship between PS constructs (negative life events, discrimination, stress at work or home and depression) by Ghanaians (SSA) and Ghanaians (Europe)

Correlation matrix	Negative events	Discrimination	Stress at work/home	Depression
Europe				
Negative events	1.000			
Discrimination	**0.152****	1.000		
Stress at work/home	**0.297****	**0.161****	1.000	
Depressive symptoms	**0.143****	**0.136****	**0.285****	1.000
Ghana				
Negative events	1.000			
Discrimination	**0.079****	1.000		
Stress at work/home	**0.101****	-0.032	1.000	
Depressive symptoms	**0.091****	0.042	**0.185****	1.000

****Significant at 1%, Spearman's correlation**

Table 3 shows association between all 4 constructs of PS and CKD among Ghanaians living in Ghana and those living in Europe. There was no statistically significant association between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living in Ghana and those living in Europe except individuals living in Europe with some stress and lower risk of reduced eGFR (0.46, 95% C.I. 0.24-0.88).

Table S1 shows further adjustments for conventional risk factors of CKD. This did not show any statistically significant associations between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living in Ghana and Europe (Table S1). Table S2 shows further stratification based on obesity status. We did not find any association between PS and CKD for obese participants and those who were not obese for Ghanaians living in rural and urban Ghana and those living in Europe. However, we observed an inverse association between PS and CKD among migrants who were not obese but have experienced discrimination for the past 12 months (0.63 95% C.I. 0.41-0.97) (Table S2). In Table S3 we stratified our analysis based on diabetic status. We did not find any associations between PS and CKD for participants with and without diabetes for both Ghanaians living in rural and urban Ghana and their migrant peers in Europe (Table S3). Finally, Table S4 stratified analysis by hypertension status. No associations were observed between PS and CKD for individuals who had hypertension and those who did not have hypertension for both those living in rural and urban Ghana as well as their compatriots living in Europe. An inverse association was observed between PS and CKD among Ghanaians who have experienced discrimination in the last 12 months with no hypertension and living in Europe (0.51, 95% C.I. 0.27-0.97). Also, we observed that having experienced some stress at home/work was inversely associated with reduced eGFR among Ghanaians with hypertension and living in Europe (0.47, 95% C.I. 0. 0.23-0.95) (Table S4).

Table 3: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe									
No	1128 (8.2)	1.00 (Reference)	1.00 (Reference)	1106 (2.6)	1.00 (Reference)	1.00 (Reference	1090 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	1615 (8.4)	1.03 (0.78-1.35)	1.07 (0.80-1.42)	1587 (2.5)	0.86 (0.53-1.42)	0.83 (0.49-1.39)	1557 (8.6)	0.97 (0.76-1.32)	0.99 (0.74-1.32)
Ghana									
No	732 (8.7)	1.00 (Reference)	1.00 (Reference)	736 (4.5)	1.00 (Reference)	1.00 (Reference)	732 (10.9)	1.00 (Reference)	1.00 (Reference)
Yes	1595 (3.8)	0.87 (0.65-1.16)	0.85 (0.63-1.14)	1601 (3.4)	0.69 (0.45-1.08)	0.67 (0.44-1.09)	1590 (9.9)	0.88 (0.66-1.17)	0.86 (0.64-1.15)
Discrimination									
Europe									
No	1899 (8.5)	1.00 (Reference)	1.00 (Reference)	1867 (2.6)	1.00 (Reference)	1.00 (Reference)	1832 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	810 (7.4)	0.87 (0.64-1.19)	0.92 (0.67-1.26)	791 (2.2)	0.83 (0.47-1.47)	0.84 (0.46-1.52)	782 (7.3)	0.82 (0.59-1.12)	0.84 (0.60-1.16)
Ghana									
No	2034 (10.0)	1.00 (Reference)	1.00 (Reference)	2047 (3.9)	1.00 (Reference)	1.00 (Reference)	2031 (10.6)	1.00 (Reference)	1.00 (Reference)
Yes	104 (7.7)	0.83 (0.39-1.73)	0.91 (0.67-1.24)	104 (1.9)	0.67 (0.15-2.85)	0.67 (0.16-2.84)	104 (6.7)	0.70 (0.32-1.55)	0.71 (0.32-1.55)
Stress at home/work									
Europe									
Never	1330 (8.2)	1.00 (Reference)	1.00 (Reference)	1305 (3.4)	1.00 (Reference)	1.00 (Reference)	1282 (8.5)	1.00 (Reference)	1.00 (Reference)
Some stress	1002 (7.9)	0.97 (0.72-1.31)	1.04 (0.76-1.42)	984 (1.4)	**0.47 (0.26-0.87)**	**0.46 (0.24-0.88)**	968 (8.6)	0.96 (0.71-1.30)	1.02 (0.74-1.39)
Several/Permanent stresses	397 (9.1)	1.11 (0.74-1.64)	1.153 (0.77-1.72)	390 (2.3)	0.73 (0.35-1.52)	0.76 (0.36-1.61)	383 (9.7)	1.13 (0.77-1.68)	1.19 (0.80-1.79)
Ghana									
Never	682 (10.3)	1.00 (Reference)	1.00 (Reference)	688 (3.3)	1.00 (Reference)	1.00 (Reference)	682 (9.9)	1.00 (Reference)	1.00 (Reference)

Some stress	1279 (9.5)	0.87 (0.64-1.19)	0.80 (0.59-1.11)	1279 (3.9)	1.06 (0.63-1.77)	1.11 (0.66-1.87)	1274 (10.3)	0.95 (0.69-1.30)	0.92 (0.67-1.26)
Several/Permanent stresses	365 (8.5)	0.75 (0.48-1.18)	0.68 (0.59-1.11)	369 (4.1)	1.13 (0.57-2.23)	1.22 (0.61-2.46)	365 (10.4)	0.96 (0.63-1.47)	0.92 (0.59-1.42)
Depressive symptoms									
Europe									
No	2505 (8.5)	1.00 (Reference)	1.00 (Reference)	2457 (2.7)	1.00 (Reference)	1.00 (Reference)	2416 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	206 (6.3)	0.71 (0.39-1.27)	0.76 (0.43-1.36)	202 (1.5)	0.63 (0.19-2.03)	0.68 (0.21-2.23)	199 (7.1)	0.78 (0.44-1.37)	0.83 (0.47-1.46)
Ghana									
No	2212 (9.9)	1.00 (Reference)	1.00 (Reference)	2222 (3.8)	1.00 (Reference)	1.00 (Reference)	2207 (10.4)	1.00 (Reference)	1.00 (Reference)
Yes	114 (5.3)	0.45 (0.19-1.03)	0.45 (0.19-1.01)	114 (2.6)	0.52 (0.16-1.72)	0.53 (0.17-1.74)	114 (7.9)	0.62 (0.30-1.25)	0.61 (0.30-1.24)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe

Table 4 shows associations between all 4 constructs of PS and CKD stratified by Ghanaians living in urban and rural Ghana. There was no association between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living rural and urban Ghana.

Table 4: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depressive symptoms) with albuminuria, reduced eGFR and CKD risk among rural and urban Ghana

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Urban Ghana									
No	477 (11.9)	1.00 (Reference)	1.00 (Reference)	477 (4.4)	1.00 (Reference)	1.00 (Reference	477 (12.2)	1.00 (Reference)	1.00 (Reference)
Yes	912 (10.5)	0.87 (0.61-1.23)	0.87 (0.61-1.24)	911 (3.4)	0.73 (0.41-1.31)	0.72 (0.40-1.29)	910 (10.8)	0.87 (0.61-1.24)	0.87 (0.61-1.25)
Rural Ghana									
No	255 (7.5)	1.00 (Reference)	1.00 (Reference)	259 (4.6)	1.00 (Reference)	1.00 (Reference)	255 (8.6)	1.00 (Reference)	1.00 (Reference)
Yes	683 (7.6)	0.97 (0.56-1.69)	0.94 (0.54-1.64)	690 (3.5)	0.63 (0.31-1.31)	0.66 (0.32-1.37)	680 (8.8)	0.93 (0.55-1.58)	0.92 (0.54-1.56)
Discrimination									
Urban Ghana									
No	1326 (11.1)	1.00 (Reference)	1.00 (Reference)	1326 (3.9)	1.00 (Reference)	1.00 (Reference)	1325 (11.4)	1.00 (Reference)	1.00 (Reference)
Yes	71 (8.5)	0.85 (0.36-2.00)	0.89 (0.37-2.11)	71 (2.8)	1.17 (0.27-2.09)	1.16 (0.27-2.06)	71 (7.1)	0.69 (0.27-1.77)	0.72 (0.28-1.83)
Rural Ghana									
No	708 (8.1)	1.00 (Reference)	1.00 (Reference)	721 (3.9)	1.00 (Reference)	1.00 (Reference)	706 (9.2)	1.00 (Reference)	1.00 (Reference)
Yes	33 (6.1)	0.79 (0.18-3.47)	0.84 (0.19-2.65)	33 (0.0)	***	***	33 (6.1)	0.75 (0.17-2.89)	0.83 (0.19-2.65)
Stress at home/work									
Urban Ghana									
Never	460 (10.9)	1.00 (Reference)	1.00 (Reference)	460 (3.3)	1.00 (Reference)	1.00 (Reference)	460 (10.2)	1.00 (Reference)	1.00 (Reference)
Some stress	732 (11.5)	1.04 (0.71-1.51)	0.91 (0.62-1.37)	730 (4.1)	1.27 (0.66-2.43)	1.30 (0.67-2.51)	730 (11.8)	1.13 (0.77-1.65)	1.04 (0.71-1.53)
Several/Permanent stresses	197 (9.6)	0.87 (0.50-1.52)	0.74 (0.42-1.02)	198 (3.5)	1.17 (0.46-2.84)	1.20 (0.47-3.09)	197 (11.7)	1.15 (0.68-1.71)	1.05 (0.61-1.81)

Rural Ghana									
Never	222 (9.0)	1.00 (Reference)	1.00 (Reference)	228 (3.5)	1.00 (Reference)	1.00 (Reference)	222 (9.5)	1.00 (Reference)	1.00 (Reference)
Some stress	547 (6.9)	0.69 (0.39-1.23)	0.68 (0.38-1.22)	549 (3.6)	0.88 (0.38-2.07)	0.92 (0.39-2.18)	544 (8.3)	0.74 (0.42-1.30)	0.75 (0.42-1.31)
Several/Permanent stresses	168 (7.1)	0.63 (0.30-1.37)	0.60 (0.28-1.29)	171 (4.7)	1.07(0.38-3.03)	1.21(0.43-3.46)	168 (8.9)	0.71 (0.34-1.50)	0.73 (0.35-1.50)
Depressive symptoms									
Urban Ghana									
No	1336 (11.3)	1.00 (Reference)	1.00 (Reference)	1335 (3.8)	1.00 (Reference)	1.00 (Reference)	1334 (11.5)	1.00 (Reference)	1.00 (Reference)
Yes	52 (3.9)	0.30 (0.07-1.25)	0.30 (0.07-1.27)	52 (1.9)	0.46 (0.06-2.50)	0.45 (0.06-2.13)	52 (5.8)	0.44 (0.14-1.45)	0.45 (0.14-1.48)
Rural Ghana									
No	876 (7.7)	1.00 (Reference)	1.00 (Reference)	887 (3.8)	1.00 (Reference)	1.00 (Reference)	873 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	62 (6.5)	0.67 (0.23-1.94)	0.67 (0.23-1.94)	62 (3.2)	0.58 (0.13-2.56)	0.61 (0.14-2.68)	62 (9.7)	0.82 (0.33-2.01)	0.85 (0.34-2.09)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in urban and rural Ghana among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in rural and urban Ghana. ***; no case of CKD and therefore odds ratios were not calculated

Table 5 shows associations between all 4 constructs of PS and CKD stratified by Ghanaians living in Amsterdam, Berlin and London. There were no associations between PS and albuminuria, reduced eGFR and CKD risk among Ghanaians living in Europe except for positive association between stress at work/home and albuminuria (2.81, 95% C.I. 1.46-5.40) and CKD risk (2.78, 95% C.I. 1.43-5.43) among Ghanaians living in Berlin.

Table 5: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depressive symptoms) with albuminuria, reduced eGFR and CKD risk among Ghanaians in three European cities.

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2
Negative events									
Amsterdam									
No	548 (7.3)	1.00 (Reference)	1.00 (Reference)	534 (2.4)	1.00 (Reference)	1.00 (Reference))	521 (7.5)	1.00 (Reference)	1.00 (Reference)
Yes	784 (7.8)	1.08 (0.71-1.63)	1.18 (0.77-1.81)	764 (2.9)	1.11 (0.55-2.23)	1.15 (0.55-2.37)	742 (8.0)	1.06 (0.69-1.62)	1.08 (0.71-1.66)
Berlin									
No	213 (9.9)	1.00 (Reference)	1.00 (Reference)	213 (2.4)	1.00 (Reference)	1.00 (Reference)	213 (10.8)	1.00 (Reference)	1.00 (Reference)
Yes	329 (10.9)	1.12 (0.63-1.99)	1.19 (0.67-2.15)	330 (1.8)	0.64 (0.19-2.17)	0.61 (0.18-2.11)	329 (9.4)	0.86 (0.48-1.52)	0.91 (0.51-1.63)
London									
No	367 (8.7)	1.00 (Reference)	1.00 (Reference)	359 (3.1)	1.00 (Reference)	1.00 (Reference)	356 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	502 (7.8)	0.89 (0.55-1.46)	0.83 (0.49-1.41)	493 (2.2)	0.68 (0.28-1.65)	0.58 (0.22-1.51)	486 (9.1)	1.04 (0.64-1.68)	0.99 (0.58-1.68)
Discrimination									
Amsterdam									
No	956 (8.3)	1.00 (Reference)	1.00 (Reference)	935 (2.9)	1.00 (Reference)	1.00 (Reference)	909 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	363 (5.0)	0.59 (0.34-1.00)	0.59 (0.35-1.02)	349 (2.1)	0.69 (0.30-1.62)	0.81 (0.34-1.91)	342 (5.9)	0.69 (0.41-1.14)	0.69 (0.41-1.16)
Berlin									
No	329(10.0)	1.00 (Reference)	1.00 (Reference)	329 (2.1)	1.00 (Reference)	1.00 (Reference)	329 (10.3)	1.00 (Reference)	1.00 (Reference)
Yes	209 (11.0)	1.11 (0.63-1.95)	1.16 (0.65-2.05)	210 (1.9)	0.83 (0.24-2.93)	0.82 (0.23-2.91)	209 (9.1)	0.86 (0.48-1.56)	0.89 (0.49-1.63)
London									
No	614 (7.9)	1.00 (Reference)	1.00 (Reference)	603 (2.5)	1.00 (Reference)	1.00 (Reference)	594 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	238 (7.9)	1.03 (0.59-1.81)	1.18 (0.65-2.15)	232 (2.6)	1.29 (0.46-3.59)	1.09 (0.35-3.43)	231 (7.8)	0.93 (0.53-1.63)	0.98 (0.52-1.82)
Stress at home/work									

Amsterdam									
Never	634 (8.4)	1.00 (Reference)	1.00 (Reference)	622 (3.2)	1.00 (Reference)	1.00 (Reference)	603 (8.0)	1.00 (Reference)	1.00 (Reference)
Some stress	478 (5.7)	0.68 (0.42-1.11)	0.69 (0.42-1.13)	462 (1.9)	0.64 (0.29-1.43)	0.68 (0.30-1.52)	452 (6.0)	0.74 (0.45-1.20)	0.74 (0.45-1.22)
Several/Permanent stresses	210 (9.1)	1.09 (0.63-1.91)	1.12 (0.64-1.95)	204 (2.5)	0.71 (0.26-1.95)	0.77 (0.28-2.14)	198 (10.1)	1.24 (0.71-2.14)	1.26 (0.73-2.20)
Berlin									
Never	250 (9.0)	1.00 (Reference)	1.00 (Reference)	250 (2.0)	1.00 (Reference)	1.00 (Reference)	250 (6.4)	1.00 (Reference)	1.00 (Reference)
Some stress	196 (15.3)	**2.50 (1.33-4.71)**	**2.81 (1.46-5.40)**	197 (1.5)	0.88 (0.20-3.79)	0.83 (0.19-3.62)	196 (14.8)	**2.57 (1.34-4.90)**	**2.78 (1.43-5.43)**
Several/Permanent stresses	96 (10.4)	1.64 (0.72-3.73)	1.69 (0.73-3.91)	197 (3.1)	2.10 (0.47-9.46)	2.04 (0.44-9.26)	76 (9.4)	1.52 (0.65-3.58)	1.58 (0.66-3.75)
London									
Never	446 (9.2)	1.00 (Reference)	1.00 (Reference)	433 (4.4)	1.00 (Reference)	1.00 (Reference)	429 (10.5)	1.00 (Reference)	1.00 (Reference)
Some stress	328 (7.0)	0.73 (0.43-1.25)	0.79 (0.44-1.40)	325 (0.6)	0.17 (0.04-0.73)	0.09 (0.01-0.67)	320 (6.9)	0.65 (0.38-1.10)	0.66 (0.37-1.19)
Several/permanent stresses	91 (7.7)	0.81 (0.35-1.87)	0.86 (0.35-2.14)	90 (1.1)	0.27 (0.03-2.12)	0.24 (0.03-2.05)	74 (8.9)	0.83 (0.38-1.83)	0.92 (0.39-2.16)
Depressive symptoms									
Amsterdam									
No	1199 (7.8)	1.00 (Reference)	1.00 (Reference)	1135 (2.8)	1.00 (Reference)	1.00 (Reference)	1135 (7.9)	1.00 (Reference)	1.00 (Reference)
Yes	121 (6.6)	0.81 (0.39-1.72)	0.83 (0.39-1.76)	118 (1.7)	0.65 (0.15-2.77)	0.71 (0.16-3.06)	116 (6.9)	0.83 (0.39-1.76)	0.82 (0.38-1.74)
Berlin									
No	503 (10.7)	1.00 (Reference)	1.00 (Reference)	504 (2.2)	1.00 (Reference)	1.00 (Reference)	503 (10.1)	1.00 (Reference)	1.00 (Reference)
Yes	34 (5.9)	0.53 (0.12-2.27)	0.49 (90.11-2.13)	34 (0.0)	***	***	34 (5.9)	0.55 (0.13-2.37)	0.52 (0.12-2.24)
London									
No	803 (8.3)	1.00 (Reference)	1.00 (Reference)	785 (2.6)	1.00 (Reference)	1.00 (Reference)	778 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	51 (5.9)	0.67 (0.20-2.21)	0.91 (0.27-3.07)	50 (2.0)	0.91 (0.11-7.43)	1.15 (0.14-9.54)	49 (8.2)	0.94 (0.33-2.69)	1.30 (0.44-3.81)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, educational level and length of stay; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Amsterdam, Berlin and London among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Europe ***; no case of CKD and therefore odds ratios were not calculated.

Discussion

Key findings

Whereas there was an association between those who have experienced some stress at home/work and reduced eGFR among Ghanaians living in Europe, we did not find any association between PS and CKD among Ghanaians living in rural and urban Ghana and their peers in Europe. Also, PS was not associated with CKD for those living in rural and urban Ghana and neither for those living in the three European cities. However, there was an association between stress at work/home and albuminuria and CKD risk among Ghanaians living in Berlin. Further adjustment for conventional risk factors of CKD yielded similar results.

Discussion of key findings

Association between PS and CKD in Ghana

Our study did not find any association between any of the four constructs of PS and prevalence of CKD (albuminuria, reduced eGFR and CKD risk) among Ghanaians living in rural and urban Ghana. Our findings are however in contrast with earlier studies which reported positive associations between PS and prevalent of CKD [28 31 53]. Other studies have hypothesised that the influence of PS on CKD may be important in only those with hypertension and diabetes and that PS may mediate or moderate the association between renal functioning and lifestyle behaviours such as smoking and physical activity [33]. For example, they argue that stress enhances Sympathetic Nervous System (SNS) activity to increase glucocorticoid secretion and inflammatory cytokines, which heavily contribute to hypertension, diabetes and vascular disease, which are major risk factors of CKD incidence and prevalence [54]. The lack of association between PS and CKD in this present study is unclear due to lack of literature on the association between PS and CKD prevalence particularly in rural and urban populations. Worth noting, however, is the presence of rich family support systems in the Ghanaian context especially in rural Ghana, which may help individuals with CKD to cope with PS thereby minimizing its effect. For example, patients with limited social networks and low social support have been shown to have augmented risk of morbidity and mortality [55-57]. Specifically, there is evidence that positive social support is a protective factor for persons dealing with long-term disease conditions [58]. Other studies have reported a protective relationship between social networks, emotionally supportive relationship and threats to physiological and psychosocial health [59].

Association between PS and CKD Amsterdam, Berlin and London

Literature on the association between PS and CKD prevalence among migrants is scant and absent in most European populations. The lack of positive association between PS and CKD in our study is consistent with

recent studies conducted among African Americans [31 33] and other populations [32 60]. Specifically, a recent study using data from the Jackson Heart Study, which comprised of extensive constructs of psychosocial variables reported that greater life stressors were associated with lower prevalence of CKD at baseline [31]. Several studies in other parts of the world have reported a positive relationship between higher prevalence of stressors and CKD risk [27 28], although the study findings have been inconsistent. Whereas some did not find any associations among African Americans [31] others found associations in other populations. Even among those who found some associations the directions differed [28]. Reasons for the lack of association observed in our study among migrants are not fully understood but may reflect the real world situation. First, migrants from Ghana practice both nuclear and extended family support system as their peers living in rural and urban, this practice may mitigate the impact of stressors such as unemployment, death of a love one, discrimination, etc. They also belong to several religious organisations such as churches, which provide similar support systems against stressors. Moreover, there are several associations of the various ethnic groups (Akan, Ga and Ewe) providing such support when the need arises. These systems provide both instrumental and/or emotional social support [61]. These assertions are supported by several studies. Specifically, these studies have shown that social support positively affect health outcomes through mechanisms such as increased patient compliance with therapies, decreased levels of depressive affect, direct physiologic effects on the immune system and improved perception of quality of life [58 59]. The lack of association observed in this study may also be attributed to other mechanisms, which influence the associations between PS and CKD. Another reason for the lack of association between PS and CKD in this study could be the cross-sectional analysis of our study. The association between PS and CKD has been shown to be cumulative and builds over substantial period of time[62]. To effectively evaluate this, longitudinal study design is required. This suggests the needs for more longitudinal studies in future research in assessing the associations between PS and CKD outcomes [62 63].

Strength and limitation

Our study is the first to use all four robust constructs of PS to determine association between PS and CKD. This gave our study a more robust definition of PS compared to other similar studies. The use of all three definitions of CKD per KDIGO guidelines also provided a broader definition of CKD and allowed comparison between different geographical regions. The use of a homogenous population of Ghanaians and standardized protocols and diagnostic criteria in this study also provided a novel opportunity to compare Ghanaians living in rural and urban Ghana and their compatriots living in Europe. There are limitations to our study. The effect of PS on CKD has been reported to be cumulative and takes a long period of time, therefore the use of cross-sectional design prevented us from determining the longitudinal and cumulative

effect of repeated exposure to PS among the two populations. PS is captured and experienced in different magnitude across different populations. We were unable to ascertain if PS as defined in this study was adequately captured among Ghanaians living in rural and urban Ghana. Lastly, the four PS measures were assessed separately because of multicollinearity among the measures. There are several methods of addressing multicollinearity among measures such as partial least squares regression, principal component analysis, data reduction technique, which when used could have influenced the interpretation of the study results.

Conclusion

We identified positive association between stress at work/home and albuminuria and CKD risk among Ghanaians living in Berlin. Conversely, our study shows no associations between stress as indicated by four PS indicators and prevalence of CKD. Consequently, there is the need to explore other factors that may be responsible for the observed differences in the prevalence of CKD among Ghanaians living in rural and urban Ghana and their peers living in Europe.

Acknowledgement

The authors are very grateful to the research assistants, interviewers and other staff of the five research locations who took part in gathering the data and the Ghanaian volunteers in all the participating RODAM sites. We gratefully acknowledge the advisory board members for their valuable support in shaping the RODAM study methods and the Academic Medical Centre Biobank for their support in biobank management and high-quality storage of collected samples.

Contributors

My co-authors have all contributed substantially to this manuscript and approve of this submission. Research idea and study design: DNA, CA, KS, DA, EB, KM, JA; data acquisition and curation: DNA, CA, EB, KM, data analysis/interpretation: DNA, CA, KS, DA, EB, KM, LS, JA, EOD, KKG, FPM, MBS, ID, JS, SB; statistical analysis: DNA, CA, KS. DNA, CA, KS, DA, EB, KM, LS, JA, EOD, KKG, FPM, MBS, ID, JS, SB; contributed important intellectual content during manuscript drafting or revision and accepts accountability for the overall work by ensuring that questions pertaining to the accuracy or integrity of any portion of the work are appropriately investigated and resolved. DNA and CA takes responsibility that this study has been reported honestly, accurately, and transparently; that no important aspects of the study have been omitted; and that any discrepancies from the study as planned have been explained.

Funding

This work was supported by the European Commission under the Framework Programme (Grant Number: 278901). The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript. The Wellcome Trust supported Professor Smeeth's contribution, grant number WT082178. Professor Joachim Spranger was supported by the DZHK (German Center for cardiovascular research) and the Berlin Institute of Health (BIH).

Competing interest: None Declared

Patient Consent: None declared

Ethics approval: IRBs at each participating site.

Data sharing statement: Data are available from the RODAM research cohort, a third party. Dr. Eric Beune affiliated with the RODAM research cohort and a co-author of this paper in accordance with the RODAM requirements for collaboration. Dr. Beune is the Data Collection Coordinator of RODAM and may be contacted with further questions (e.j.beune@amc.uva.nl). Additionally, researchers interested in further collaboration with RODAM may see the following URL: http://www.rod-am.eu/

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Legend for figures

Figure 1: Prevalence of CKD risk among Ghanaians who have experienced negative life events and those who have not experienced any negative life events stratified by site. Definition per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 2: Prevalence of CKD risk among Ghanaians who have experienced discrimination and those who have not experienced any discrimination stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 3: Prevalence of CKD risk among Ghanaians who have experienced stress at home/work and those who have not experienced any stress at home/work in the past 12 months stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Figure 4: Prevalence of CKD risk among Ghanaians who have depressive symptoms and those who do not have depressive symptoms stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Legend for Supplementary Tables

S1: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe.

S2: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by obesity status.

S3: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by diabetes status.

S4: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by hypertensive status.

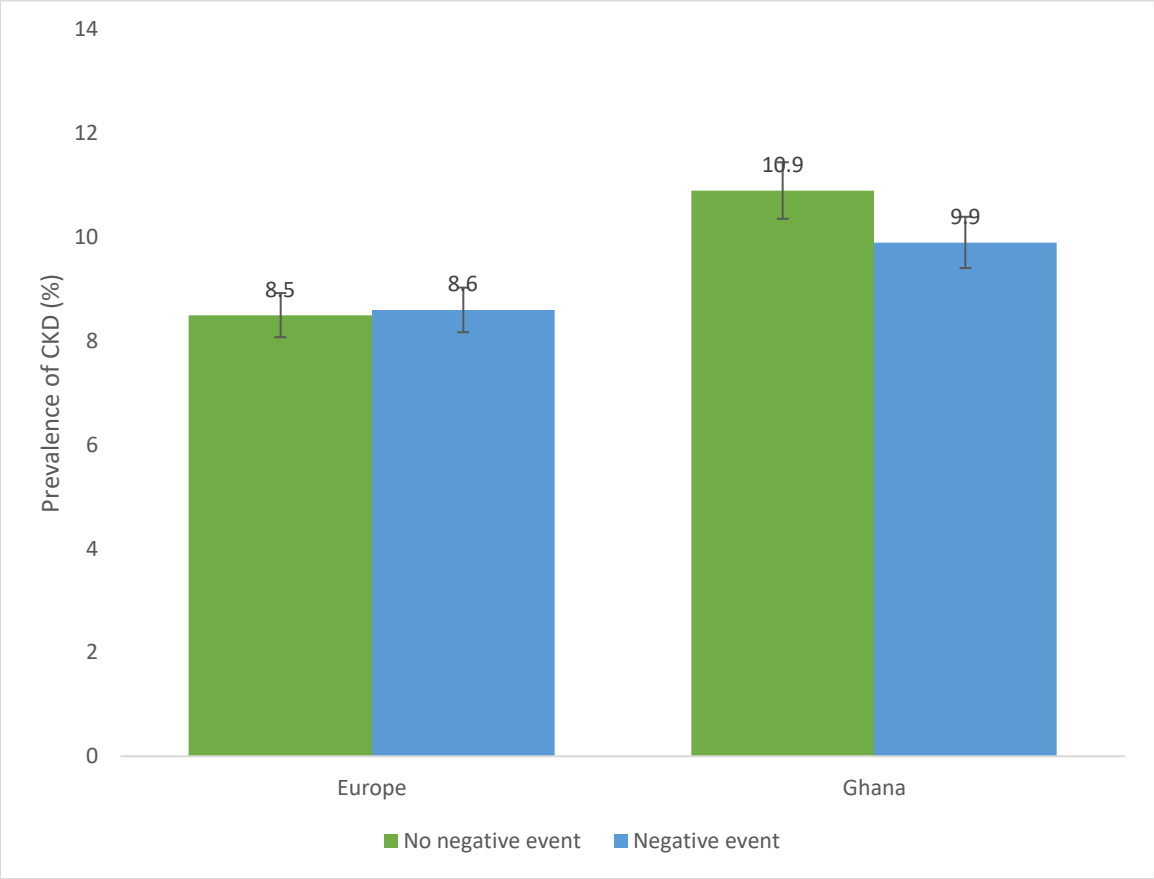

Figure 1: Prevalence of CKD risk among Ghanaians who have experienced negative life events and those who have not experienced any negative life events stratified by site. Definition per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

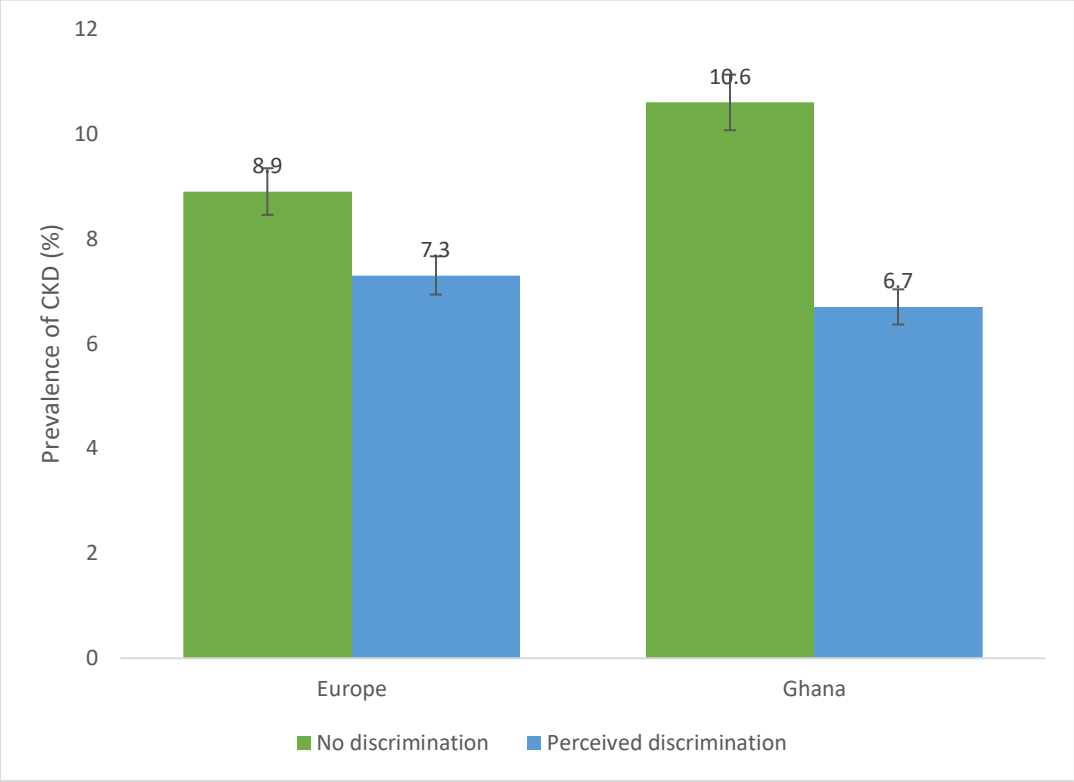

Figure 2: Prevalence of CKD risk among Ghanaians who have experienced discrimination and those who have not experienced any discrimination stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

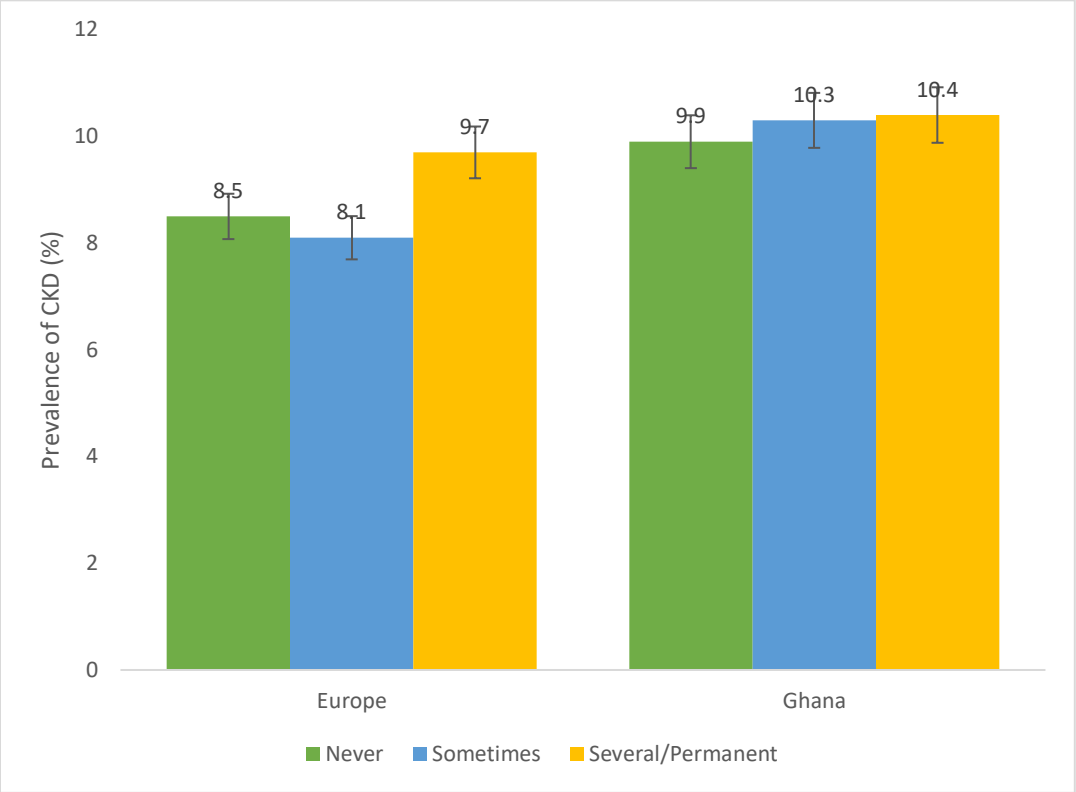

Figure 3: Prevalence of CKD risk among Ghanaians who have experienced stress at home/work and those who have not experienced any stress at home/work in the past 12 months stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

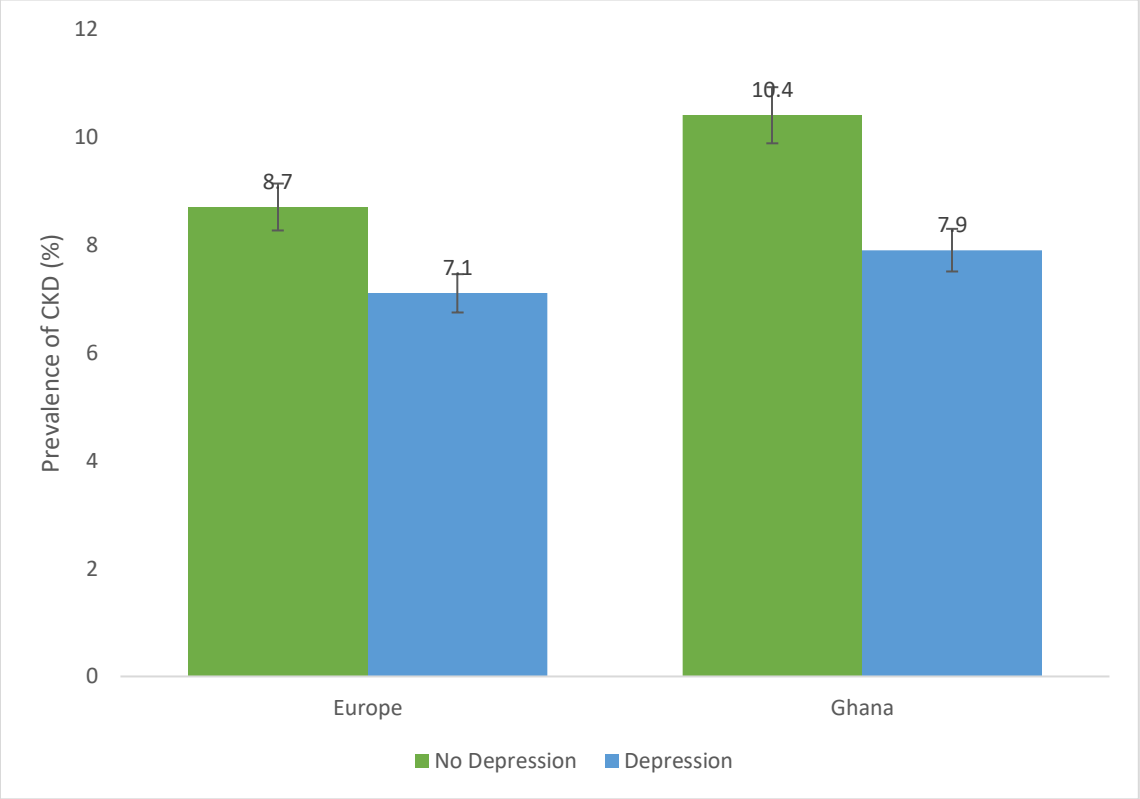

Figure 4: Prevalence of CKD risk among Ghanaians who have depressive symptoms and those who do not have depressive symptoms stratified by site. Definitions per 2012 KDIGO (Kidney Disease: Improving Global Outcomes) guidelines.

Supplementary Tables

S1: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe

	Albuminuria (ACR ≥ 3 mg/mmol)		eGFR < 60 mL/min/1.73 m2		High to very high CKD risk (KDIGO, 2012)	
	n (%)	OR (95% CI) Model 3	n (%)	OR (95% CI) Model 3	n cases (%)	OR (95% CI) Model 3
Negative events						
Europe						
No	1128 (8.2)	1.00 (Reference)	1106 (2.6)	1.00 (Reference)	1090 (8.5)	1.00 (Reference)
Yes	1615 (8.4)	0.95 (0.70-1.30)	1587 (2.5)	0.77 (0.44-1.37)	1557 (8.6)	0.92 (0.67-1.26)
Ghana						
No	732 (10.4)	1.00 (Reference)	736 (4.5)	1.00 (Reference)	732 (10.9)	1.00 (Reference)
Yes	1595 (9.2)	0.79 (0.58-1.07)	1601 (3.4)	0.69 (0.43-1.09)	1590 (9.9)	0.79 (0.58-1.06)
Discrimination						
Europe						
No	1899 (8.5)	1.00 (Reference)	1867 (2.6)	1.00 (Reference)	1832 (8.9)	1.00 (Reference)
Yes	810 (7.4)	0.87 (0.61-1.21)	791 (2.2)	0.87 (0.45-1.65)	782 (7.3)	0.79 (0.55-1.12)
Ghana						
No	2034 (10.0)	1.00 (Reference)	2047 (3.9)	1.00 (Reference)	2031 (10.6)	1.00 (Reference)
Yes	104 (7.7)	0.92 (0.43-1.98)	104 (1.9)	0.65 (0.15-2.79)	104 (6.7)	0.74 (0.33-1.66)
Stress at home/work						
Europe						
Never	1330 (8.2)	1.00 (Reference)	1305 (3.4)	1.00 (Reference)	1282 (8.5)	1.00 (Reference)
Some stress	1002 (7.9)	1.01 (0.72-1.41)	984 (1.4)	0.51 (0.25-1.04)	968 (8.1)	1.01 (0.72-1.42)
Several/Permanent stresses	397 (9.1)	1.00 (0.64-1.59)	390 (2.3)	0.91 (0.40-2.03)	383 (9.7)	1.15 (0.74-1.79)
Ghana						

Never	682 (10.3)	1.00 (Reference)	688 (3.3)	1.00 (Reference)	682 (9.9)	1.00 (Reference)
Some stress	1279 (9.5)	0.78 (0.56-1.09)	1279 (3.9)	1.14 (0.67-1.93)	1274 (10.3)	0.93 (0.67-1.29)
Several/Permanent stresses	365 (8.5)	0.70 (0.43-1.13)	369 (4.1)	1.32 (0.65-1.68)	365 (10.4)	0.97 (0.62-1.52)
Depressive symptoms						
Europe						
No	2505 (8.5)	1.00 (Reference)	2457 (2.7)	1.00 (Reference)	2416 (8.7)	1.00 (Reference)
Yes	206 (6.3)	0.65 (0.33-1.28)	202 (1.5)	0.94 (0.28-3.14)	199 (7.1)	0.78 (0.41-1.47)
Ghana						
No	2212 (9.9)	1.00 (Reference)	2222 (3.8)	1.00 (Reference)	2207 (10.4)	1.00 (Reference)
Yes	114 (5.3)	0.41 (0.16-1.04)	114 (2.6)	0.58 (0.17-1.95)	114 (7.9)	0.62 (0.28-1.31)

Model 3, adjusted for age, sex educational level, hypertension, diabetes, hypercholesterolemia, BMI, physical activity and smoking; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S2: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by obesity status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe/Not obese									
No	736 (7.4)	1.00 (Reference)	1.00 (Reference)	729 (2.5)	1.00 (Reference)	1.00 (Reference)	719 (8.5)	1.00 (Reference)	1.00 (Reference)
Yes	1003 (7.7)	0.98 (0.67-1.40)	0.99 (0.69-1.43)	992 (2.0)	0.77 (0.40-1.48)	0.71 (0.36-1.42)	971 (7.9)	0.91 (0.64-1.29)	0.89 (0.62-1.29)
Europe/Obese									
No	390 (9.2)	1.00 (Reference)	1.00 (Reference)	375 (2.9)	1.00 (Reference)	1.00 (Reference)	369 (8.7)	1.00 (Reference)	1.00 (Reference)
Yes	607 (9.6)	1.05 (0.67-1.63)	1.14 (0.72-1.82)	590 (3.2)	0.97 (0.44-2.11)	1.01 (0.44-2.26)	581 (9.6)	1.15 (0.73-1.82)	1.15 (0.71-1.85)
Ghana/Not obese									
No	588 (9.5)	1.00 (Reference)	1.00 (Reference)	592 (4.7)	1.00 (Reference)	1.00 (Reference)	588 (10.0)	1.00 (Reference)	1.00 (Reference)
Yes	1324 (8.5)	0.86 (0.61-1.21)	0.83 (0.59-1.17)	1331 (3.4)	0.64 (0.39-1.05)	0.65 (0.39-1.83)	1321 (9.0)	0.86 (0.61-1.20)	0.84 (0.60-1.18)
Ghana/Obese									
No	144 (13.9)	1.00 (Reference)	1.00 (Reference)	144 (3.5)	1.00 (Reference)	1.00 (Reference)	144 (14.6)	1.00 (Reference)	1.00 (Reference)
Yes	268 (13.1)	0.91 (0.50-1.64)	0.91 (0.49-1.65)	267 (3.8)	1.04 (0.34-3.16)	1.09 (0.35-3.37)	266 (14.3)	0.94 (0.52-1.68)	0.94 (0.52-1.67)
Discrimination									
Europe/Not obese									
No	1186 (8.4)	1.00 (Reference)	1.00 (Reference)	1172 (2.4)	1.00 (Reference)	1.00 (Reference)	1150 (9.4)	1.00 (Reference)	1.00 (Reference)
Yes	538 (5.9)	0.69 (0.46-1.05)	0.71 (0.46-1.11)	532 (1.5)	0.62 (0.28-1.37)	0.57 (0.24-1.34)	525 (5.9)	**0.63 (0.42-0.96)**	**0.63 (0.41-0.97)**
Europe/Obese									
No	709 (8.7)	1.00 (Reference)	1.00 (Reference)	691 (3.0)	1.00 (Reference)	1.00 (Reference)	678 (8.9)	1.00 (Reference)	1.00 (Reference)
Yes	269 (10.0)	1.14 (0.71-1.85)	1.29 (0.78-2.12)	256 (3.5)	1.15 (0.50-2.63)	1.27 (0.54-2.99)	254 (9.8)	1.13 (0.69-1.86)	1.22 (0.73-2.13)
Ghana/Not obese									
No	1648 (9.1)	1.00 (Reference)	1.00 (Reference)	1661 (3.9)	1.00 (Reference)	1.00 (Reference)	1646 (9.6)	1.00 (Reference)	1.00 (Reference)
Yes	81 (8.6)	1.06 (0.48-2.38)	1.04 (0.47-2.32)	81 (2.5)	1.04 (0.48-2.32)	0.86 (0.20-3.69)	81 (7.4)	0.90 (0.38-2.12)	0.89 (0.38-2.11)
Ghana/Obese									

No	383 (13.8)	1.00 (Reference)	1.00 (Reference)	383 (3.7)	1.00 (Reference)	1.00 (Reference)	382 (14.9)	1.00 (Reference)	1.00 (Reference)
Yes	23 (4.4)	0.31 (0.04-2.36)	0.40 (0.05-3.11)	23 (0.0)	**** (***-***)	**** (***-***)	23 (4.4)	0.29 (0.04-2.22)	0.34 (0.04-2.66)
Stress at home/work									
Europe/Not obese									
Never	855 (7.4)	1.00 (Reference)	1.00 (Reference)	847 (3.4)	1.00 (Reference)	1.00 (Reference)	831 (8.2)	1.00 (Reference)	1.00 (Reference)
Some stress	629 (8.3)	1.16 (0.79-1.70)	1.20 (0.81-1.79)	627 (1.4)	0.52 (0.24-1.12)	0.47 (0.21-1.07)	615 (7.9)	0.98 (0.66-1.43)	0.98 (0.65-1.46)
Several/Permanent stresses	247 (6.9)	0.93 (0.53-1.62)	1.15 (0.77-1.72)	239 (2.3)	0.45 (0.13-1.52)	0.49 (0.15-1.67)	236 (9.1)	0.97 (0.57-1.65)	1.04 (0.61-1.78)
Europe/Obese									
Never	472 (9.8)	1.00 (Reference)	1.00 (Reference)	455 (3.9)	1.00 (Reference)	1.00 (Reference)	448 (10.3)	1.00 (Reference)	1.00 (Reference)
Some stress	372 (7.5)	0.72 (0.44-1.18)	0.79 (0.47-1.32)	356 (1.4)	0.41 (0.15-1.16)	0.43 (0.15-1.21)	352 (9.5)	0.94 (0.57-1.53)	1.05 (0.62-1.76)
Several/Permanent stresses	147 (12.2)	1.32 (0.74-2.38)	1.31 (0.72-2.42)	148 (4.1)	1.05 (0.40-2.79)	1.09 (0.40-2.91)	144 (8.5)	1.36 (0.74-2.49)	1.41 (0.75-2.64)
Ghana/Not obese									
Never	537 (9.7)	1.00 (Reference)	1.00 (Reference)	542 (3.1)	1.00 (Reference)	1.00 (Reference)	537 (8.9)	1.00 (Reference)	1.00 (Reference)
Some stress	1055 (8.3)	0.79 (0.56-1.15)	0.74 (0.52-1.07)	1057 (3.9)	1.16 (0.65-2.09)	1.21 (0.67-2.18)	1052 (9.0)	0.92 (0.64-1.35)	0.90 (0.62-1.32)
Several/permanent stresses	319 (8.5)	0.81 (0.49-1.32)	0.73 (0.44-1.20)	323 (4.3)	1.34 (0.64-2.83)	1.43 (0.67-3.04)	319 (10.7)	1.12 (0.69-1.79)	1.09 (0.68-1.76)
Ghana/Obese									
Never	145 (12.4)	1.00 (Reference)	1.00 (Reference)	146 (4.1)	1.00 (Reference)	1.00 (Reference)	145 (13.8)	1.00 (Reference)	1.00 (Reference)
Some stress	221 (14.9)	1.21 (0.64-2.26)	1.05 (0.55-1.99)	219 (3.7)	0.74 (0.25-2.22)	0.83 (0.26-2.06)	219 (15.9)	1.13 (0.62-2.07)	1.02 (0.55-1.89)
Several/Permanent stresses	46 (8.7)	0.64 (0.20-2.01)	0.52 (0.16-1.65)	46 (2.2)	0.41 (0.05-3.61)	0.45 (0.05-4.01)	46 (8.8)	0.55 (0.17-1.71)	0.47 (0.14-1.50)
Depressive symptoms									
Europe/Not obese									
No	1601 (7.9)	1.00 (Reference)	1.00 (Reference)	1586 (2.2)	1.00 (Reference)	1.00 (Reference)	1558 (8.3)	1.00 (Reference)	1.00 (Reference)
Yes	121 (4.9)	0.59 (0.25-1.36)	0.65 (0.27-1.48)	117 (1.7)	0.79 (0.18-2.35)	0.86 (0.21-3.80)	115 (5.22)	0.58 (0.25-1.35)	0.64 (0.27-1.49)
Europe/Obese									
No	899 (9.7)	1.00 (Reference)	1.00 (Reference)	866 (3.4)	1.00 (Reference)	1.00 (Reference)	853 (9.4)	1.00 (Reference)	1.00 (Reference)
Yes	83 (7.2)	0.71 (0.29-1.67)	0.72 (0.30-1.74)	83 (1.2)	0.46 (0.06-3.52)	0.46 (0.06-3.57)	82 (8.5)	0.89 (0.40-2.01)	0.90 (0.40-2.04)

Ghana/Not obese									
No	1811 (8.9)	1.00 (Reference)	1.00 (Reference)	1822 (3.9)	1.00 (Reference)	1.00 (Reference)	1808 (9.4)	1.00 (Reference)	1.00 (Reference)
Yes	100 (6.0)	0.57 (0.24-1.33)	0.56 (0.24-1.32)	100 (2.0)	0.38 (0.09-1.63)	0.38 (0.09-1.63)	100 (8.0)	0.69 (0.32-1.46)	0.69 (0.32-1.47)
Ghana/Obese									
No	398 (13.8)	1.00 (Reference)	1.00 (Reference)	397 (3.5)	1.00 (Reference)	1.00 (Reference)	396 (14.7)	1.00 (Reference)	1.00 (Reference)
Yes	14 (0.0)	*** (****-****)	*** (****-****)	14 (7.1)	1.76 (0.21-14.89)	2.14 (0.25-8.78)	14 (7.1)	0.42 (0.05-3.32)	0.38 (0.05-3.07)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S3: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by diabetes status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe/No diabetes									
No	986 (8.0)	1.00 (Reference)	1.00 (Reference)	971 (2.1)	1.00 (Reference)	1.00 (Reference)	957 (7.9)	1.00 (Reference)	1.00 (Reference)
Yes	1359 (7.7)	0.95 (0.70-1.29)	0.97 (0.71-1.34)	1340 (2.0)	0.90 (0.50-1.63)	0.90 (0.48-1.68)	1315 (8.1)	1.01 (0.75-1.37)	0.99 (0.72-1.36)
Europe/Diabetes									
No	142 (9.9)	1.00 (Reference)	1.00 (Reference)	135 (6.7)	1.00 (Reference)	1.00 (Reference)	133 (12.8)	1.00 (Reference)	1.00 (Reference)
Yes	256 (12.5)	1.28 (0.66-2.50)	1.41 (0.71-2.82)	247 (4.9)	0.75 (0.29-1.89)	10.68 (0.27-1.77)	242 (11.2)	0.87 (0.46-1.69)	0.96 (0.49-1.88)
Ghana/No diabetes									
No	683 (9.1)	1.00 (Reference)	1.00 (Reference)	687 (4.1)	1.00 (Reference)	1.00 (Reference)	683 (9.8)	1.00 (Reference)	1.00 (Reference)
Yes	1447 (7.7)	0.84 (0.60-1.16)	0.82 (0.59-1.14)	1451 (3.1)	0.69 (0.42-1.13)	0.69 (0.42-1.13)	1442 (8.3)	0.82 (0.59-1.12)	0.80 (0.58-1.10)
Ghana/Diabetes									
No	49 (28.3)	1.00 (Reference)	1.00 (Reference)	49 (10.2)	1.00 (Reference)	1.00 (Reference)	49 (26.4)	1.00 (Reference)	1.00 (Reference)
Yes	148 (24.3)	0.78 (0.37-1.61)	0.72 (0.34-1.52)	150 (7.3)	0.55 (0.16-1.81)	0.57 (0.17-1.88)	148 (26.4)	0.93 (0.45-1.97)	0.90 (0.43-1.92)
Discrimination									
Europe/No diabetes									
No	1629 (7.9)	1.00 (Reference)	1.00 (Reference)	1609 (2.2)	1.00 (Reference)	1.00 (Reference)	1580 (8.3)	1.00 (Reference)	1.00 (Reference)
Yes	684 (6.7)	0.85 (0.60-1.21)	0.89 (0.62-1.28)	669 (1.5)	0.68 (0.33-1.40)	0.69 (0.32-1.47)	661 (7.0)	0.84 (0.59-1.20)	0.86 (0.59-1.25)
Europe/Diabetes									
No	270 (11.9)	1.00 (Reference)	1.00 (Reference)	258 (5.4)	1.00 (Reference)	1.00 (Reference)	252 (13.1)	1.00 (Reference)	1.00 (Reference)
Yes	126 (11.1)	0.87 (0.44-1.71)	0.89 (0.45-1.76)	122 (5.7)	1.29 (0.48-3.45)	1.25 (0.46-3.37)	121 (9.1)	0.68 (0.32-1.40)	0.69 (0.33-1.42)
Ghana/No diabetes									
No	1854 (8.4)	1.00 (Reference)	1.00 (Reference)	1865 (3.5)	1.00 (Reference)	1.00 (Reference)	1851 (9.0)	1.00 (Reference)	1.00 (Reference)
Yes	99 (8.1)	1.03 (0.49-2.17)	1.04 (0.49-2.19)	99 (2.0)	0.79 (0.19-3.33)	0.78 (0.18-3.29)	99 (7.1)	0.87 (0.39-1.93)	0.88 (0.39-1.95)

Ghana/Diabetes									
No	180 (26.7)	1.00 (Reference)	1.00 (Reference)	182 (7.7)	1.00 (Reference)	1.00 (Reference)	180 (27.2)	1.00 (Reference)	1.00 (Reference)
Yes	5 (0.0)	**** (***-***)	0.40 (0.05-3.11)	5 (0.0)	**** (***-***)	**** (***-***)	5 (0.0)	**** (***-***)	**** (***-***)
Stress at home/work									
Europe/No diabetes									
Never	1137 (7.9)	1.00 (Reference)	1.00 (Reference)	1127 (2.3)	1.00 (Reference)	1.00 (Reference)	1102 (8.0)	1.00 (Reference)	1.00 (Reference)
Some stress	860 (7.2)	0.90 (0.65-1.27)	0.96 (0.68-1.36)	850 (1.2)	0.49 (0.24-1.02)	0.49 (0.22-1.07)	835 (7.4)	0.94 (0.67-1.31)	0.99 (0.69-1.41)
Several/Permanent stresses	335 (8.4)	1.04 (0.67-1.62)	1.07 (0.68-1.70)	327 (2.1)	0.84 (0.36-1.95)	0.92 (0.39-2.17)	322 (9.6)	1.20 (0.77-1.85)	1.28 (0.82-1.99)
Europe/Diabetes									
Never	193 (9.8)	1.00 (Reference)	1.00 (Reference)	184 (8.2)	1.00 (Reference)	1.00 (Reference)	180 (11.7)	1.00 (Reference)	1.00 (Reference)
Some stress	142 (12.7)	1.22 (0.61-2.45)	1.38 (0.67-2.81)	134 (3.0)	0.43 (0.13-1.39)	0.40 (0.12-1.29)	133 (12.0)	1.04 (0.52-2.09)	1.13 (0.56-2.32)
Several/Permanent stresses	62 (12.9)	1.31 (0.54-3.16)	1.38 (0.56-3.41)	63 (3.2)	0.49 (0.10-2.29)	0.46 (0.10-2.23)	61 (9.8)	0.82 (0.31-2.13)	0.89 (0.34-2.35)
Ghana/No diabetes									
Never	628 (7.8)	1.00 (Reference)	1.00 (Reference)	634 (2.7)	1.00 (Reference)	1.00 (Reference)	628 (7.6)	1.00 (Reference)	1.00 (Reference)
Some stress	1163 (8.6)	1.06 (0.74-1.51)	0.97 (0.67-1.39)	1163 (3.7)	1.27 (0.71-2.27)	1.32 (0.74-2.34)	1158 (9.3)	1.15 (0.80-1.65)	1.10 (0.77-1.58)
Several/permanent stresses	339 (7.4)	0.88 (0.53-1.46)	0.76 (0.46-1.27)	341 (3.5)	1.24 (0.58-2.67)	1.35 (0.62-2.95)	339 (8.9)	1.07 (0.66-1.73)	1.00 (0.61-1.64)
Ghana/Diabetes									
Never	54 (38.9)	1.00 (Reference)	1.00 (Reference)	54 (11.1)	1.00 (Reference)	1.00 (Reference)	54 (37.0)	1.00 (Reference)	1.00 (Reference)
Some stress	116 (18.9)	**0.37 (0.37-0.77)**	**0.35 (0.17-0.75)**	116 (6.0)	0.47 (0.14-1.60)	0.45 (0.12-1.55)	116 (19.8)	**0.43 (0.21-0.89)**	**0.40 (0.19-0.86)**
Several/Permanent stresses	26 (25.0)	0.44 (0.44-1.29)	0.39 (0.13-1.19)	28 (10.7)	0.65 (0.13-3.21)	0.62 (0.12-3.23)	26 (30.8)	0.69 (0.25-1.93)	0.64 (0.22-1.87)
Depressive symptoms									
Europe/No diabetes									
No	2154 (8.0)	1.00 (Reference)	1.00 (Reference)	2122 (2.1)	1.00 (Reference)	1.00 (Reference)	2087 (8.1)	1.00 (Reference)	1.00 (Reference)
Yes	167 (5.4)	0.63 (0.32-1.25)	0.69 (0.34-1.38)	163 (2.0)	0.65 (0.15-2.72)	0.72 (0.17-3.04)	161 (6.8)	0.58 (0.25-1.35)	0.86 (0.46-1.64)
Europe/Diabetes									

No	351 (12.0)	1.00 (Reference)	1.00 (Reference)	335 (35.9)	1.00 (Reference)	1.00 (Reference)	329 (12.5)	1.00 (Reference)	1.00 (Reference)
Yes	39 (10.3)	0.79 (0.26-1.35)	0.73 (0.24-2.19)	39 (2.6)	0.49 (0.06-3.97)	0.49 (0.06-3.99)	38 (7.9)	0.89 (0.40-2.01)	0.60 (0.17-2.08)
Ghana/No diabetes									
No	2027 (8.3)	1.00 (Reference)	1.00 (Reference)	2035 (3.4)	1.00 (Reference)	1.00 (Reference)	2022 (8.8)	1.00 (Reference)	1.00 (Reference)
Yes	102 (4.9)	0.50 (0.20-1.25)	0.48 (0.19-1.19)	102 (2.9)	0.64 (0.19-2.13)	0.67 (0.20-2.21)	102 (7.8)	0.69 (0.32-1.46)	0.71 (0.34-1.51)
Ghana/Diabetes									
No	185 (26.5)	1.00 (Reference)	1.00 (Reference)	187 (8.7)	1.00 (Reference)	1.00 (Reference)	185 27.6)	1.00 (Reference)	1.00 (Reference)
Yes	12 (8.3)	0.27 (0.03-2.13)	0.25 (0.03-2.01)	12 (0.0)	*** (****-****)	*** (***-***)	12 (8.3)	0.42 (0.05-3.32)	0.27 (0.03-2.19)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

S4: Association of psychosocial stressors (PS) indicators (negative life events, discrimination, stress at work/home and depression) with albuminuria, reduced eGFR and CKD risk for Ghanaians living in Ghana and those living in Europe stratified by hypertensive status

	Albuminuria (ACR ≥ 3 mg/mmol)			eGFR < 60 mL/min/1.73 m2			High to very high CKD risk (KDIGO, 2012)		
		OR (95% CI)			OR (95% CI)			OR (95% CI)	
	n (%)	Model 1	Model 2	n (%)	Model 1	Model 2	n cases (%)	Model 1	Model 2
Negative events									
Europe/No hypertension									
No	568 (6.9)	1.00 (Reference)	1.00 (Reference)	562 (1.3)	1.00 (Reference)	1.00 (Reference)	551 (7.1)	1.00 (Reference)	1.00 (Reference)
Yes	743 (5.0)	0.72 (0.45-1.15)	0.78 (0.48-1.27)	740 (0.8)	0.59 (0.19-1.77)	0.60 (0.20-1.83)	724 (5.1)	0.71 (0.44-1.13)	0.75 (0.46-1.22)
Europe/Hypertension									
No	560 (9.6)	1.00 (Reference)	1.00 (Reference)	544 (4.0)	1.00 (Reference)	1.00 (Reference)	539 (10.0)	1.00 (Reference)	1.00 (Reference)
Yes	872 (11.4)	1.22 (0.86-1.73)	1.20 (0.83-1.73)	847 (3.9)	0.95 (0.54-1.67)	0.89 (0.49-1.62)	833 (11.6)	1.19 (0.83-1.69)	1.13 (0.78-1.62)
Ghana/No Hypertension									
No	540 (6.3)	1.00 (Reference)	1.00 (Reference)	543 (2.2)	1.00 (Reference)	1.00 (Reference)	540 (6.9)	1.00 (Reference)	1.00 (Reference)
Yes	1118 (5.6)	0.88 (0.57-1.36)	0.84 (0.54-1.31)	1124 (1.9)	0.82 (0.39-1.69)	0.86 (0.41-1.79)	1115 (6.4)	0.93 (0.61-1.40)	0.90 (0.59-1.36)
Ghana/Hypertension									
No	192 (21.9)	1.00 (Reference)	1.00 (Reference)	193 (10.9)	1.00 (Reference)	1.00 (Reference)	192 (22.4)	1.00 (Reference)	1.00 (Reference)
Yes	476 (18.1)	0.78 (0.52-1.18)	0.79 (0.52-1.20)	476 (6.9)	0.58 (0.32-1.04)	0.58 (0.33-1.05)	474 (18.4)	0.77 (0.50-1.16)	0.76 (0.51-1.16)
Discrimination									
Europe/No hypertension									
No	916 (6.3)	1.00 (Reference)	1.00 (Reference)	907 (0.8)	1.00 (Reference)	1.00 (Reference)	885 (6.8)	1.00 (Reference)	1.00 (Reference)
Yes	379 (3.7)	0.60 (0.33-1.09)	0.65 (0.36-1.21)	378 (1.1)	1.35 (0.39-4.74)	1.37 (0.38-4.89)	374 (3.2)	**0.47 (0.25-0.89)**	**0.51 (0.27-0.97)**
Europe/Hypertension									
No	983 (10.5)	1.00 (Reference)	1.00 (Reference)	960 (4.4)	1.00 (Reference)	1.00 (Reference)	947 (10.9)	1.00 (Reference)	1.00 (Reference)
Yes	431 (10.7)	1.03 (0.71-1.49)	1.05 (0.72-1.54)	413 (3.2)	0.73 (0.38-1.39)	0.75 (0.38-1.48)	408 (11.0)	1.03 (0.71-1.49)	1.04 (0.71-1.53)
Ghana/No hypertension									
No	1427 (5.7)	1.00 (Reference)	1.00 (Reference)	1437 (2.2)	1.00 (Reference)	1.00 (Reference)	1424 (6.5)	1.00 (Reference)	1.00 (Reference)

Yes	81 (7.4)	1.30 (0.55-3.09)	1.30 (0.55-3.10)	81 (0.0)	**** (***-***)	**** (***-***)	81 (7.4)	1.21 (0.51-2.88)	1.22 (0.51-2.89)
Ghana/Hypertension									
No	606 (20.3)	1.00 (Reference)	1.00 (Reference)	609 (7.9)	1.00 (Reference)	1.00 (Reference)	606 (20.3)	1.00 (Reference)	1.00 (Reference)
Yes	23 (8.7)	0.38 (0.09-1.68)	0.40 (0.09-1.74)	23 (8.7)	1.27 (0.28-5.70)	1.20 (0.26-5.44)	23 (4.4)	0.19 (0.03-1.44)	0.19 (0.03-1.45)
Stress at home/work									
Europe/No hypertension									
Never	644 (6.1)	1.00 (Reference)	1.00 (Reference)	640 (1.3)	1.00 (Reference)	1.00 (Reference)	625 (5.8)	1.00 (Reference)	1.00 (Reference)
Some stress	468 (4.5)	0.74 (0.43-1.27)	0.81 (0.46-1.43)	464 (0.4)	0.37 (0.07-1.74)	0.41 (0.09-2.01)	457 (4.8)	0.84 (0.49-1.45)	0.91 (0.52-1.60)
Several/Permanent stresses	192 (6.8)	1.07 (0.56-2.05)	1.19 (0.61-2.29)	191 (1.6)	1.49 (0.38-5.78)	1.52 (0.39-5.98)	186 (8.1)	1.38 (0.74-2.60)	1.49 (0.79-2.84)
Europe/Hypertension									
Never	686 (10.2)	1.00 (Reference)	1.00 (Reference)	665 (5.4)	1.00 (Reference)	1.00 (Reference)	657 (11.1)	1.00 (Reference)	1.00 (Reference)
Some stress	534 (11.1)	1.03 (0.71-1.49)	1.05 (0.72-1.54)	520 (2.3)	**0.49 (0.25-0.96)**	**0.47 (0.23-0.95)**	511 (10.9)	0.97 (0.67-1.41)	0.99 (0.67-0.47)
Several/Permanent stresses	205 (11.2)	1.11 (0.67-1.82)	1.12 (0.67-1.87)	199 (3.0)	0.56 (0.23-1.37)	0.58 (0.24-1.43)	197 (11.2)	0.99 (0.59-1.64)	1.03 (0.61-1.74)
Ghana/No hypertension									
Never	495 (5.5)	1.00 (Reference)	1.00 (Reference)	498 (1.4)	1.00 (Reference)	1.00 (Reference)	495 (5.9)	1.00 (Reference)	1.00 (Reference)
Some stress	899 (5.9)	1.07 (0.66-1.73)	0.99 (0.61-1.60)	901 (2.2)	1.30 (0.54-3.15)	1.39 (0.57-3.37)	896 (6.5)	1.04 (0.65-1.65)	1.00 (0.63-1.59)
Several/permanent stresses	263 (5.7)	1.01 (0.53-1.95)	0.89 (0.46-1.72)	267 (2.6)	1.69 (0.58-5.01)	1.89 (0.63-5.65)	263 (7.6)	1.21 (0.67-2.20)	1.15 (0.63-2.11)
Ghana/Hypertension									
Never	187 (22.9)	1.00 (Reference)	1.00 (Reference)	190 (8.4)	1.00 (Reference)	1.00 (Reference)	187 (20.9)	1.00 (Reference)	1.00 (Reference)
Some stress	379 (18.2)	0.74 (0.48-1.14)	0.68 (0.43-1.05)	377 (7.9)	0.95 (0.50-1.80)	0.99 (0.51-1.91)	377 (19.4)	0.90 (0.58-1.40)	0.87 (0.55-1.36)
Several/Permanent stresses	102 (15.7)	0.62 (0.33-1.17)	0.54 (0.28-1.04)	102 (7.8)	0.92 (0.37-2.26)	0.97 (0.39-2.43)	102 (17.7)	0.79 (0.42-1.49)	0.76 (0.40-1.43)
Depressive symptoms									
Europe/No hypertension									

No	1195 (5.9)	1.00 (Reference)	1.00 (Reference)	1187 (1.1)	1.00 (Reference)	1.00 (Reference)	1162 (6.0)	1.00 (Reference)	1.00 (Reference)
Yes	101 (3.9)	0.59 (0.21-1.65)	0.64 (0.23-1.82)	99 (1.0)	1.18 (0.15-2.72)	1.27 (0.16-10.17)	98 (5.1)	0.77 (0.30-1.97)	0.84 (0.33-2.17)
Europe/Hypertension									
No	1310(10.9)	1.00 (Reference)	1.00 (Reference)	1270 (4.1)	1.00 (Reference)	1.00 (Reference)	1254 (11.2)	1.00 (Reference)	1.00 (Reference)
Yes	105 (8.6)	0.76 (0.37-1.53)	0.75 (0.37-1.55)	103 (1.9)	0.52 (0.12-2.18)	0.56 (0.13-2.38)	101 (8.9)	0.77 (0.38-1.58)	0.80 (0.39-1.63)
Ghana/No hypertension									
No	1575 (5.9)	1.00 (Reference)	1.00 (Reference)	1584 (2.1)	1.00 (Reference)	1.00 (Reference)	1572 (6.7)	1.00 (Reference)	1.00 (Reference)
Yes	82 (2.4)	0.36 (0.09-1.51)	0.35 (0.08-1.44)	82 (1.2)	0.39 (0059-2.95)	0.39 (0.05-2.97)	82 (3.7)	0.44 (0.13-1.42)	0.43 (0.13-1.40)
Ghana/Hypertension									
No	636 (19.5)	1.00 (Reference)	1.00 (Reference)	637 (8.2)	1.00 (Reference)	1.00 (Reference)	634 (19.6)	1.00 (Reference)	1.00 (Reference)
Yes	32 (12.5)	0.59 (0.20-1.72)	0.59 (0.20-1.74)	32 (6.3)	0.74 (0.17-3.25)	0.76 (0.17-3.33)	32 (18.8)	0.94 (0.0.37-2.37)	0.94 (0.38-2.37)

Model 1, adjusted for age and sex; Model 2, adjusted for age, sex, and educational level for Ghanaians (SSA) and length of stay for those in Europe; Abbreviations: CI, confidence interval; ACR, albumin creatinine ration; eGFR, estimated glomerular filtration rate; CKD, chronic kidney disease; OR, odds ratio, n= total number of Ghanaians living in Ghana and Europe among the various levels of PS constructs; %, proportion of individuals with CKD among the various levels of PS constructs in Ghana and Europe.

STROBE Statement—checklist of items that should be included in reports of observational studies

	Item No.	Recommendation	Page No.	Relevant text from manuscript
Title and abstract	1	(*a*) Indicate the study's design with a commonly used term in the title or the abstract	1 lines 1-3	We have included a commonly used term in the title and abstract
		(*b*) Provide in the abstract an informative and balanced summary of what was done and what was found	3 lines 87-116	Our study shows no convincing evidence for associations between stress as indicated by four PS constructs and prevalence of CKD. Further studies aimed at identifying potential factors driving the high prevalence of CKD among these populations are needed.
Introduction				
Background/rationale	2	Explain the scientific background and rationale for the investigation being reported	5 lines 180-226	The theoretical and scientific background as well as the rationale for conducting the study have been provided in the introduction section.
Objectives	3	State specific objectives, including any pre specified hypotheses	5 lines 222-226	We examined the association between PS and CKD prevalence among rural and urban Ghanaians and their migrants living in three European cities. We also

				assessed if the influence of PS on CKD is partially mediated by primary risk factors (hypertension and diabetes) of CKD.
Methods				
Study design	4	Present key elements of study design early in the paper	-6-7 lines 232-264	Details given in the methods
Setting	5	Describe the setting, locations, and relevant dates, including periods of recruitment, exposure, follow-up, and data collection	6-7 lines 232-264	Rural or urban Ghana and three (Amsterdam, Berlin, London) European cities (migrants)
Participants	6	(*a*) *Cohort study*—Give the eligibility criteria, and the sources and methods of selection of participants. Describe methods of follow-up *Case-control study*—Give the eligibility criteria, and the sources and methods of case ascertainment and control selection. Give the rationale for the choice of cases and controls *Cross-sectional study*—Give the eligibility criteria, and the sources and methods of selection of participants	Pg. 7 lines 254-264	A multi-centred cross sectional baseline data from the Research on Obesity and Diabetes among African Migrants (RODAM) study. A random sample of 5,659 adults (Europe, 3167, rural, 1,043, Urban Ghana, 1,449, Ghana) aged 25 to 70 years.
		(*b*) *Cohort study*—For matched studies, give matching criteria and number of exposed and unexposed *Case-control study*—For matched studies, give matching criteria and the number of controls per case		
Variables	7	Clearly define all outcomes, exposures, predictors, potential confounders, and effect modifiers. Give diagnostic criteria, if applicable	Pg. 7-10 lines 266-357	The main outcomes have been clearly defined.
Data sources/ measurement	8*	For each variable of interest, give sources of data and details of methods of assessment (measurement). Describe comparability of assessment methods if there is more than one group	Pg. 7-10 lines 266-357	We defined each variable of interest in the methods

				accordingly
Bias	9	Describe any efforts to address potential sources of bias	Pg. 9 lines 315-331	Potential sources of bias have been reported in the methods sections.
Study size	10	Explain how the study size was arrived at	Pg. 7 lines 259-264	Given in the methods section and we have also referred to the RODAM study methods paper

Continued on next page

Quantitative variables	11	Explain how quantitative variables were handled in the analyses. If applicable, describe which groupings were chosen and why	Pg. 10-11 lines 368-388	Please see methods
Statistical methods	12	(*a*) Describe all statistical methods, including those used to control for confounding	Pg. 10-11 lines 367-387	Please see methods
		(*b*) Describe any methods used to examine subgroups and interactions	Pg. 10-11 lines 367-387	Please see methods
		(*c*) Explain how missing data were addressed	Pg. 7 lines 259-264	
		(*d*) *Cohort study*—If applicable, explain how loss to follow-up was addressed *Case-control study*—If applicable, explain how matching of cases and controls was addressed *Cross-sectional study*—If applicable, describe analytical methods taking account of sampling strategy	NA	We have reported non-response across sites
		(*e*) Describe any sensitivity analyses	NA	
Results				
Participants	13*	(a) Report numbers of individuals at each stage of study—eg numbers potentially eligible, examined for eligibility, confirmed eligible, included in the study, completing follow-up, and analysed	Pg. 7 lines 254-264	Non-response analysis was done to shed light on the differential response rates across sites
		(b) Give reasons for non-participation at each stage	Pg. 7 lines 259-264	
		(c) Consider use of a flow diagram	Pg. 6 lines 232-234	We have also referred to RODAM methods paper
Descriptive data	14*	(a) Give characteristics of study participants (eg demographic, clinical, social) and information on exposures and potential confounders	Pg. 7 lines 269-357	We have also referred to RODAM methods paper
		(b) Indicate number of participants with missing data for each variable of interest	Pg. 7 lines 260-264	We have also referred to RODAM methods paper
		(c) *Cohort study*—Summarise follow-up time (eg, average and total amount)	NA	
Outcome data	15*	*Cohort study*—Report numbers of outcome events or summary measures over time	*NA*	
		Case-control study—Report numbers in each exposure category, or summary measures of exposure	*NA*	

		Cross-sectional study—Report numbers of outcome events or summary measures	Pg. 11-13	Summary measures are given in the results section and in tables and figures
Main results	16	(*a*) Give unadjusted estimates and, if applicable, confounder-adjusted estimates and their precision (eg, 95% confidence interval). Make clear which confounders were adjusted for and why they were included	*Pg. 11-23 lines 406-521*	Unadjusted and adjusted estimates are given in the results section and in figures
		(*b*) Report category boundaries when continuous variables were categorized	*Pg. 11-23 lines 389-521*	We have provided mean and corresponding standard deviations for the continuous variables.
		(*c*) If relevant, consider translating estimates of relative risk into absolute risk for a meaningful time	NA	

Continued on next page

Other analyses	17	Report other analyses done—eg analyses of subgroups and interactions, and sensitivity analyses	NA	
Discussion				
Key results	18	Summarise key results with reference to study objectives	Pg. 24 lines 524--531	
Limitations	19	Discuss limitations of the study, taking into account sources of potential bias or imprecision. Discuss both direction and magnitude of any potential bias	Pg. 25 lines 584-596	Key limitations regarding study methods including differential response rates and sampling methods in the various study sites have been provided
Interpretation	20	Give a cautious overall interpretation of results considering objectives, limitations, multiplicity of analyses, results from similar studies, and other relevant evidence	Pg. 24-26 lines 522-603	Cautious overall interpretation of the key findings have been provided.
Generalisability	21	Discuss the generalisability (external validity) of the study results	Pg. 25 lines 584-596	
Other information				
Funding	22	Give the source of funding and the role of the funders for the present study and, if applicable, for the original study on which the present article is based	Pg. 26 lines 624-630	The funders had no role in study design, data collection and analysis, decision to publish, or preparation of the manuscript

*Give information separately for cases and controls in case-control studies and, if applicable, for exposed and unexposed groups in cohort and cross-sectional studies.

Note: An Explanation and Elaboration article discusses each checklist item and gives methodological background and published examples of transparent reporting. The STROBE checklist is best used in conjunction with this article (freely available on the Web sites of PLoS Medicine at http://www.plosmedicine.org/, Annals of Internal Medicine at http://www.annals.org/, and Epidemiology at http://www.epidem.com/). Information on the STROBE Initiative is available at www.strobe-statement.org.