Perceived discrimination and stressful life events are associated with cardiovascular risk score in migrant and non-migrant populations: The RODAM study

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ABSTRACT

Background: Psychosocial stress could be an underlying factor for emerging risk of cardiovascular diseases (CVD) in Africans. We assessed the association between psychosocial stress and estimated CVD risk among non-migrant Ghanaians and migrant Ghanaians living in Europe.

Methods: Data from the Research on Obesity and Diabetes among African Migrants (RODAM) study, involving 2315 migrant and 1549 non-migrants aged 40–70 years were used for this study. Psychosocial stress included self-reported stress at work and home, recent negative life events and perceived discrimination. CVD risk was estimated using the pooled cohort equations with estimates ≥7.5% over 10 years defining high CVD risk. Adjusted Odds Ratios (AOR) and 95% confidence intervals (95% CI) were calculated by logistic regression with adjustments for socioeconomic status.

Results: Prevalence for migrant and non-migrants were; 72.5% and 84.9% for psychosocial stress and 35.9% and 27.4% for high estimated CVD risk. Stress at work and home was not associated with a high estimated CVD risk in either group. Recent negative life events were associated with a high estimated CVD risk in non-migrants only (AOR 1.29, 95%CI 1.02–1.68, $p = 0.048$). Higher levels of perceived discrimination were associated with a high estimated CVD risk in migrants only (AOR 2.74, 95%CI 1.95–3.86, $p < 0.001$).

Conclusions: Among migrant populations, higher levels of perceived discrimination were associated with a high estimated CVD risk, and this was also true for recent negative life events among non-migrant populations. Further research is needed to identify context specific mechanisms that underlie associations between psychological characteristics and CVD risk.

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1. Introduction

African populations experience epidemiological and health transition due to rapid urbanisation and international migration [1,2]. Changes in life-style factors (e.g. tobacco smoking, alcohol consumption, poor diet and physical inactivity) are prominent contributors to the emerging risk of cardiovascular diseases (CVD) [3–6]. While psychosocial stress factors such as negative emotional states, chronic and acute life stress

have been shown to increase CVD risk in western countries, the possibility that a stressful life might lead to CVD has not yet been well explored in African populations [7–11].Therefore, little is known whether or not psychosocial stress is associated with the increased cardiovascular risk in transitioning African societies.

Previous studies have shown that psychosocial stress increases CVD risk by direct and indirect pathways. The direct mechanism involves altering autonomic control of the heart, hypothalamus-pituitary axis (HPA) activation and cytokine secretion, which in turn leads to atherogenesis. Indirect mechanism relates to behaviour such as poor diet, smoking and alcohol consumption [10].

Urbanisation and international migration invoke psychosocial stresses. For example, international migrants might experience stress from financial pressures in their host countries and from their families back in their home countries [12,13]. Some migrants also experience work-related stress from jobs that are least desired, highly demanding, yet have low pay and fewer career opportunities [12]. Additionally, some migrants may perceive to be discriminated against by host populations [12,14]. Furthermore, recent migrants lose social support from family and friends, which provides better coping ability [12]. In contrast, non-migrants might rarely experience such stress, but might be more prone to stress from adverse life events. Exposure to negative events such as illness and deaths are likely to be higher among non-migrants compared to migrants due to large communicable disease burden in sub-Saharan Africa (SSA) [15]. However, non-migrants are also able to receive more social support from their communities because of extended social networks [12]. Recently, Ghanaian migrants to Europe have been observed to be at increased risk of CVD compared to non-migrants [16]. Considering these psychosocial stress differences in migrants and non-migrants, we hypothesised that stress at work and perceived discrimination increases CVD risk in migrants while negative life events increases CVD risk in non-migrants.

As part of the Research on Obesity and Diabetes among African Migrants (RODAM) study, the aim of the present analysis was to assess whether associations between psychological stress factors and high estimated CVD risk vary between Ghanaian migrants in Europe and adults in Ghana.

2. Methods

2.1. Study setting and population

The multicentre RODAM study was initiated in 2012 with the aim of understanding the complex interplay between the environment and genetics in the development of obesity and diabetes among African migrants. The full details of the study have been published elsewhere [17]. In brief, 5898 Ghanaian men and women aged 25 years and above were recruited in Europe and in Ghana. In Europe, participants were recruited from cities of Amsterdam, Berlin and London. In urban Ghana, participants were recruited from the cities of Kumasi and Obuasi, while recruitment in rural area was conducted in 15 villages in Ashanti region. A standardised approach for questionnaires, anthropometric measurements and venepuncture samples was used across all study sites. Response rates were 53% in Amsterdam, 68% in Berlin, 75% in London, 76% in rural Ghana and 74% in urban Ghana.

Ethical approval and consent to participate.

Ethical approval was obtained from ethics committees of involved institutions in Ghana, Netherlands, Germany and UK before the start of data collection. All participants gave written informed consent.

2.2. Measurements

The following measurements were obtained through a structured questionnaire; age, sex, educational attainment, previously diagnosed diabetes mellitus, use of antihypertensive medication, physical activity levels, alcohol consumption and smoking. Education was categorised as follows; (1) none or elementary, 2) lower secondary, 3) higher secondary, and 4) tertiary. Physical activity levels were calculated using Global Physical Activity Questionnaire (GPAQ) version 2, and categorised into low, moderate or high levels based on GPAQ criteria [19]. Alcohol consumption was categorised as any or no consumption. Smoking was categorised into current smokers, past smokers or non-smokers. Body mass index (BMI) was calculated as weight (kg) divided by height squared (m^2). Blood pressure (BP) was measured three times using appropriate cuffs in a sitting position after at least 5 min of rest (mmHg). The mean of the last two measurements was used in the analysis. Concentration of total cholesterol and high density lipoprotein (HDL)-cholesterol was assessed using colorimetric test kits (mmol/L). Fasting plasma glucose concentration was measured using an enzymatic method (hexokinase) in mmol/L. All biochemical analyses were performed in Berlin with an ABX Pentra 400 chemistry analyser. Presence of type 2 diabetes mellitus was defined using the World Health Organization diagnostic criteria (fasting glucose, ≥7.0 mmol/L, or current use of medication prescribed to treat diabetes mellitus or self-reported diabetes mellitus) [20].

2.3. Estimation of cardiovascular risk

CVD risk was estimated using pooled cohort equations (PCE) [21]. The PCE method estimates the risk of developing CVD in the subsequent 10-years in persons aged 40–79 years, without prior history of a CVD in black men and women. The American College of Cardiology and American Heart Association recommended PCE as a novel tool to estimate CVD risk as part of their updated clinical practice guidelines for blood cholesterol treatment to reduce atherosclerotic CVD [21]. This model combines age, sex, use of antihypertensive medication, presence of diabetes mellitus, systolic blood pressure, total cholesterol, HDL-cholesterol and smoking status. The 10-year CVD risk is scored as a percentage with scores >7.5% showing elevated risk based on the prior work by Goff et al. [18].

2.4. Psychosocial stress

Psychosocial stress measures were obtained through structured questionnaire and included stress at work and at home, perceived discrimination and negative life events in the past 12 months.

2.4.1. Perceived stress at work and at home
Perceived stress at work and at home was measured using the psychosocial stress scale created by the INTERHEART study (Appendix B) [22]. Participants were asked about stress prevalence at work and at home, and could answer "never", "some periods", "several periods", or "constantly". Both answers were then combined into general score with the same categories. Answers were further categorised into three; low level representing "never and some periods", moderate level representing "several periods" and high level representing "constantly" as previously done by Shimanoe et al. [23].

2.4.2. Negative life events
To measure presence of major negative life events, the well validated List of Threatening Experiences (LTE) was used [24]. This list asks participants whether they have, in the past 12 months, experienced any of the series of 12 unpleasant events. All responses were dichotomised into "no negative life events" and "one or more events"(Appendix C).

2.4.3. Perceived discrimination
Perceived discrimination, which refers to routine experience and often-subtle instances of unfair treatment, was measured using Everyday Discrimination Scale (EDS) (Appendix D) [25]. This 9-item scale is well validated. Participants could rate each of the 9 items from "never" = 1 to "very often" = 5. The level of discrimination was classified as low for mean scores of one and two, moderate for mean scores of three and four, and high for a mean score of five.

2.5. Data analysis

Data analyses were performed using Stata 14 (Stata Corp LP, Texas 77,845, USA). Summary statistics were presented as proportions for categorical variables and as means (with standard deviations) for normally distributed continuous variables or medians (with IQR—interquartile range) for skewed continuous variables. Differences in baseline characteristics between migrants and non-migrants were tested by t-tests (for normally distributed continuous variables), Mann-Whitney test (for skewed continuous variables) and chi-square tests (for categorical variables). Logistic regression models were used to assess associations psychosocial stress factors and estimated CVD risk (categorised as low or high risk) in migrants and non-migrants separately. The analysis was stratified by site of data collection due to statistically significant interactions between site and the three psychosocial stress factors. Education was used to adjust for socioeconomic status. In a subset analysis, associations between either stress at work or stress at home with estimated CVD risk was analysed separately because some participants did not have jobs, hence opted out of the stress at work question. Since psychosocial stress can influence CVD risk through lifestyle factors such as diet, physical activity, and alcohol consumption, these factors were not adjusted for in regression models. All analyses were two-tailed at an alpha of 0.05.

3. Results

3.1. Baseline characteristics

From a total of 5898 RODAM participants, 3864 participants were included in our analysis after exclusions (Appendix A). Of these, 2315 were migrants and 1549 were non-migrants (Table 1). Mean age of migrants was (51 ± 7) years and non-migrants was (52 ± 8) years. More than half of the migrants (56.4%) and non-migrants (65.6%) were female. More migrants had attained secondary or university

Table 1
Baseline characteristics of migrant and non- migrant participants.

	Total	Migrant Ghanaians	Non-migrant Ghanaians	p-Value
Numbers enrolled	3864			
Migrants enrolled		2315 (59.9)		
Amsterdam	1176 (50.8)			
Berlin	365 (15.8)			
London	774 (33.4)			
Non-migrants enrolled			1549 (40.1)	
Rural Ghana	916 (59.1)			
Urban Ghana	633 (40.9)			
Women, n (%)	2383	1343 (56.4)	972 (65.6)	<0.001
Age (years)	51.2 ± 7.2	50.9 ± 6.7	51.8 ± 7.7	<0.001
Education, n (%)				<0.001
Never/elementary only	1316 (36.5)	532 (24.9)	784 (53.4)	
Lower vocational	1318 (36.6)	815 (38.1)	503 (34.2)	
Secondary school	640 (17.8)	512 (24.1)	128 (8.7)	
Higher vocational or university	329 (9.1)	275 (12.9)	54 (3.7)	
Mean systolic BP, mmHg	133 ± 9	137.4 ± 17.2	128.8 ± 19.9	<0.001
BP medication, n (%)	997 (25.8)	708 (30.6)	1607 (69.4)	<0.001
Total cholesterol, mmol/L	5.1 ± 1.1	5.1 ± 0.9	4.9 ± 1.2	<0.001
LDL cholesterol, mmol/L	3.3 ± 0.9	3.3 ± 0.9	3.3 ± 1.1	0.091
HDL cholesterol, mmol/L	1.3 ± 0.3	1.4 ± 0.3	1.2 ± 0.3	0.859
Type 2 diabetes mellitus, n(%)[a]	445 (11.5)	302 (13.1)	143(9.2)	<0.001
Smoking, N (%)				<0.001
Current	109 (3.1)	84 (3.9)	25 (1.7)	
Past	308 (8.6)	191 (9.1)	117 (7.9)	
BMI, kg/m^2	27.7 ± 5.5	29.3 ± 4.9	25.3 ± 5.5	<0.001
High-level physical activity, n (%)[b]	1579 (48.9)	827 (46.9)	752 (51.4)	0.042
Alcohol consumption, n (%)	1408 (36.4)	863 (37.3)	545 (35.2)	0.185
Length of stay in Europe, years		19.5 ± 8.8		
10-y CVD risk, n (%)[c]				<0.001
High (>7.5%)	1185 (32.4)	769 (35.9)	416 (27.4)	
Any form of psychosocial stress, n (%)	2994 (77.5)	1678 (72.5)	1316 (84.9)	<0.001
Psychosocial stress: home and work, n (%)				<0.001
Low	1439 (40.9)	1033 (50.2)	428 (27.8)	
Moderate	1962 (55.8)	936 (45.5)	1123 (70.4)	
High	113 (3.2)	89 (4.3)	27 (1.6)	
Any negative events past 12 months, n (%)				<0.001
Yes	2232 (63.3)	1233 (59.6)	999 (68.6)	
Perceived discrimination level, n (%)				<0.001
Low	2461 (63.7)	1179 (50.9)	1282 (82.8)	
Moderate	875 (22.6)	819 (35.4)	56 (3.8)	
High	528 (13.7)	317 (13.7)	211 (13.4)	

Abbreviations: BMI indicates body mass index; BP, blood pressure; CVD, cardiovascular disease; HDL, high-density lipoprotein; LDL, low-density lipoprotein; and WHO, World Health Organization.

[a] Based on self-report, use of hypoglycaemic medication or fasting plasma glucose, ≥7 mmol/L (WHO criteria).

[b] Levels of physical activity were calculated using the Global Physical Activity Questionnaire (GPAQ) version.

[c] 10-Year risk of CVD estimated using the Pooled Cohort Equations. Variables used for the estimation include; age, sex, total cholesterol, high-density lipoprotein cholesterol, systolic BP, use of antihypertensive medication, diagnosed with diabetes mellitus, and smoking.

education than non-migrants. Mean length of stay in Europe among migrants was 19.5 ± 9 years. Prevalence of high estimated CVD risk was 35.9% in migrants compared to 27.4% in non-migrants. Independent assessment of each variable used to estimate CVD risk showed that migrants were more likely to have higher levels of blood pressure, total cholesterol and HDL-cholesterol than non-migrants. Migrants were also more likely to drink alcohol, to smoke, to be less physically active, to be diabetic and to be on hypertensive medication than non-migrants.

Prevalence of higher levels of stress at home and at work and perceived discrimination was higher in migrants than in non-migrants.

Similarly, prevalence of moderate levels of perceived discrimination was higher in migrants than in non-migrants. However, moderate levels of stress at home and at work were more prevalent in non-migrants compared to migrants. Likewise, recent negative life events were more prevalent in non-migrants compared to migrants (Table 1). Negative life events were commonly due to illness and death in non-migrants compared to migrants (Appendix. E).

3.2. Psychosocial stress and estimated CVD risk

3.2.1. Perceived stress at work and at home

Moderate and higher levels of stress at work and at home were not associated with high estimated CVD risk in both migrants and non-migrants after adjusting for socioeconomic status (Table 2). Similarly, stratification by site did not show any association between stress at work and at home with high estimated CVD risk in either Amsterdam, Berlin, London, rural Ghana and urban Ghana (Tables 3 and 4). In the subset analysis, neither stress at work nor stress at home as separate variables was associated with high estimated CVD risk.

3.2.2. Recent negative life events

Recent negative life events were not associated with a high estimated CVD risk in migrants. In non-migrants, however, recent negative life events were positively associated with a high estimated CVD risk after adjusting for socio-economic status (OR 1.29, 95% CI 1.02–1.68, p = 0.048)(Table 2). Stratification by study site did not show any association between recent negative life events with high estimated CVD risk in either Amsterdam, Berlin, London, rural and urban Ghana (Tables 3 and 4).

3.2.3. Perceived discrimination

Higher levels of perceived discrimination were, however, positively associated with high estimated CVD risk in migrants only (OR 2.74, 95% CI, 1.95–3.86) after adjusting for socioeconomic status. Stratification by site showed a positive association between moderate level of perceived discrimination and high estimated CVD risk in London (OR 1.45, 95%CI, 1.01–2.09, p = 0.023), as well as strong positive association between higher levels of perceived discrimination and high estimated CVD risk in Amsterdam (OR 4.92, 95% CI, 2.94–8.22)(Tables 3 and 4).

4. Discussion

4.1. Key findings

In the present study, stress at work and home were not associated with high estimated CVD risk in both migrants and non-migrants. Instead, perceived discrimination had a positive association with high estimated CVD risk in migrants, particularly in Amsterdam and London. In non-migrants, recent adverse events had a positive association with high estimated CVD risk.

4.2. Interpretation of results

Our findings that stress at work and stress at home were not associated with high estimated CVD risk in both migrants and non-migrants are in contrast to a recent systematic review [10]. The lack of a significant association between stress at work and at home with high estimated CVD risk in the current study may be due to the low prevalence of higher levels of stress at work and at home among the study population. For example, the prevalence of high job strain was around 14% in ELSA-Brazil study [26], whereas only 4.3% of migrants and 1.6% of non-migrants reported higher levels of stress at work and at home in the current study. It could be that this study might not have sufficient power to detect such an association, or that there was inadequate understanding of the concept of stress by participants. In Ghana, there

Table 2
Association between psychosocial stress factors with high estimated CVD risk for migrant and non- migrant Ghanaians.

Variable	Migrant Ghanaians, OR (95% CI)				Non-Migrant Ghanaians, OR(95%CI)			
	n (%)	Model 0[a]	Model 1[b]	p-Value[c]	n (%)	Model 0[a]	Model 1[b]	p-Value[c]
Psychosocial stress level at work and home								
Low	1033 (50.2)	1.00 (ref)	1.00 (ref)		406 (27.9)	1.00 (ref)	1.00 (ref)	
Moderate	936 (45.5)	0.94 (0.77–1.12)	0.91 (0.76–1.11)	0.383	1026 (70.4)	0.86 (0.66–1.12)	0.86 (0.66–1.13)	0.285
High	89 (4.3)	1.50 (0.96–2.36)	1.44 (0.92–2.25)	0.075	24 (1.7)	1.99 (0.70–5.62)	1.99 (0.70–5.67)	0.194
Any negative events past 12 months								
No	835 (40.4)	1.00 (ref)	1.00 (ref)		457 (31.4)	1.00 (ref)	1.00 (ref)	
Yes	1233 (59.6)	1.12 (0.93–1.35)	1.09 (0.90–1.31)	0.363	999 (68.6)	1.29 (1.01–1.67)	1.29 (1.02–1.68)	0.048
Perceived discrimination level								
Low	1179 (50.9)	1.00 (ref)	1.00 (ref)		1282 (82.8)	1.00 (ref)	1.00 (ref)	
Moderate	819 (35.4)	1.10 (0.91–1.34)	1.09 (0.89–1.32)	0.394	56 (3.6)	1.09 (0.47–2.48)	1.08 (0.47–2.49)	0.842
High	317 (13.7)	6.01 (4.49–8.01)	2.74 (1.95–3.86)	<0.001	211 (13.6)	3.15 (2.30–4.31)	0.87 (0.59–1.29)	0.980

Abbreviations: CI, confidence interval; OR, odds ratio.
[a] Model 0, crude odds ratios.
[b] Model 1, adjusted for education as proxy for social economic status.
[c] p-Value for Model 1.

Table 3
Association between psychosocial stress factors with high estimated CVD risk for migrant Ghanaians in Europe.

Variable	Amsterdam Ghanaians, OR(95%CI)				Berlin Ghanaians, OR(95%CI)				London Ghanaians, OR(95%CI)			
	n (%)	Model 0[a]	Model[b]	p-Value[c]	n (%)	Model 0[a]	Model 1[b]	p-Value[c]	n (%)	Model 0[a]	Model 1[b]	p-Value[c]
Psychosocial stress level at work and home												
Low	521(49.4)	1.00(ref)	1.00(ref)		173(47.9)	1.00(ref)	1.00(ref)		339(52.8)	1.00(ref)	1.00(ref)	
Moderate	475(45.1)	0.93 (0.71–1.23)	0.94 (0.72–1.25)	0.965	172(47.7)	0.94 (0.62–1.45)	0.95 (0.62–1.47)	0.435	289(45.1)	0.92 (0.62–1.28)	0.86 (0.61–1.20)	0.438
High	60(5.5)	1.67 (0.96–2.93)	1.59 (0.91–2.77)	0.931	16(4.4)	0.54 (0.16–1.78)	0.56 (0.17–1.87)	0.309	14(2.1)	3.49 (1.05–9.39)	3.01 (0.92–10.50)	0.339
Any negative events past 12 months												
No	433(40.7)	1.00(ref)	1.00(ref)		131(36.3)	1.00(ref)	1.00(ref)		271(40.4)	1.00(ref)	1.00(ref)	
Yes	629(59.3)	1.07 (0.82–1.41)	1.05 (0.81–1.39)	0.193	230(63.7)	1.35 (0.87–2.09)	1.29 (0.83–1.32)	0.718	374(59.6)	1.07 (0.77–1.48)	1.01 (0.73–1.42)	0.306
Perceived discrimination level												
Low	595(50.6)	1.00(ref)	1.00(ref)		170(46.6)	1.00(ref)	1.00(ref)		414(50.5)	1.00(ref)	1.00(ref)	
Moderate	436(37.1)	0.91 (0.69–1.19)	0.91 (0.63–1.20)	0.531	173(47.3)	1.09 (0.71–1.69)	1.11 (0.72–1.74)	0.880	210(27.1)	1.51 (1.07–2.13)	1.45 (1.01–2.09)	0.023
High	145(12.3)	8.12 (5.08–12.97)	4.92 (2.94–8.22)	<0.001	22(6.1)	2.34 (0.96–5.71)	1.90 (0.69–5.27)	0.924	150(19.4)	5.72 (3.78–8.67)	1.50 (0.86–2.62)	<0.001

Abbreviations: CI, confidence interval; OR, odds ratio.
[a] Model 0, crude odds ratios.
[b] Model 1, adjusted for education as proxy for social economic status.
[c] p-Value for Model 1.

Table 4
Association between psychosocial stress factors with high estimated CVD risk for Ghanaians living in urban and rural Ghana.

Variable	Urban Ghanaians, OR (95% CI)				Rural Ghanaians, OR(95%CI)			
	n (%)	Model 0[a]	Model 1[b]	p-Value[c]	n (%)	Model 0[a]	Model 1[b]	p-Value[c]
Psychosocial stress level at work and home								
Low	281(32.2)	1.00 (ref)	1.00(ref)		125(21.5)	1.00(ref)	1.00(ref)	
Moderate	583(66.7)	0.74(0.52–1.07)	0.77(0.53–1.12)	0.169	443(76.1)	1.01(0.66–1.51)	1.01(0.67–1.53)	0.955
High	10(1.1)	1.73(0.24–12.63)	1.64(0.21–12.33)	0.631	14(2.4)	2.09(0.61–7.19)	1.97(0.57–6.85)	0.284
Any negative events past 12 months								
No	308(35.2)	1.00(ref)	1.00(ref)		149(25.6)	1.00(ref)	1.00(ref)	
Yes	566(64.8)	1.17(0.83–1.67)	1.12(0.76–1.89)	0.344	433(74.4)	1.36(0.89–2.06)	1.33(0.88–2.04)	0.179
Perceived discrimination level								
Low	834(91.5)	1.00(ref)	1.00(ref)		448(70.8)	1.00(ref)	1.00(ref)	
Moderate	42(4.6)	1.43(0.51–4.08)	1.34(0.46–3.91)	0.588	14(2.1)	0.70(0.18–2.77)	0.71(0.18–2.79)	0.624
High	40(4.4)	3.67(1.21–6.26)	1.03(0.09–11.60)	0.976	171(27.1)	1.96(0.35–2.83)	0.82(0.52–1.28)	0.385

Abbreviations: CI, confidence interval; OR, odds ratio.
[a] Model 0, crude odds ratios.
[b] Model 1, adjusted for education as proxy for social economic status.
[c] p-value for Model 1.

is no direct translation of psychosocial stress in local languages which could lead to low levels of reported psychosocial stress.

Our findings that adverse life events were associated with high estimated CVD risk in non-migrants are consistent with a recent systematic review [10]. Although marginally significant, the observed positive association in non-migrants and not in migrants could be explained by several factors. First, large family networks among non-migrants increases chances of experiencing adverse life events compared to migrants who might have smaller family networks in host countries [12]. Second, higher rates of illness and deaths from treatable conditions in SSA increases chances of experiencing an adverse life events in non-migrants compared to migrants who might receive better treatment in Europe [15]. For the current study, 68.6% of non-migrants reported to have experienced adverse life events of which 54.8% were related to illness or death, compared to 59.6% in migrants with only 36.8% of the adverse events related to illness or death. It is this increased exposure to adverse life events in non-migrants that could induce body responses that may facilitate development of CVDs [10]. Third, majority of adverse life events in migrants pertain to their families back home. In most cases, migrants are not directly involved in the management of such adverse life events due to distance. An example of such a situation is when migrants are not being able to attend to sicknesses or funerals in their home countries [27]. This may buffer effects of stress from adverse life events in migrants [10].

Our finding that perceived discrimination was positively associated with high estimated CVD risk in migrants is in line with previous findings from a meta-analytic review of perceived discrimination and incident CVD [28]. The finding of a positive significant association in migrants and not in non-migrants may be explained by the different forms of perceived discrimination that may be present in each context. Migrants are more likely to report racial discrimination from their host populations while non-migrants may report other forms of perceived discrimination such as stigma from epilepsy, mental health disorders and infectious diseases such as HIV and TB [28–32]. It is possible that racial discrimination may have more detrimental effects on CVD risk in migrants compared to other forms of discrimination experienced by non-migrants. Additionally, migrants might not be able to find positive coping strategies from perceived discrimination, which in turn, can further increase their CVD risk [10]. Coping with psychosocial stress is achieved through religious beliefs and social support through family and friends. Migrants often lose traditional social support system from family and friends present in their home countries leading to coping disability [12].

Stratified analyses showed associations between perceived discrimination and high estimated CVD risk was stronger in Amsterdam compared to London and Berlin. Explanations for these differential associations across the European sites are unclear. It is plausible that these differential associations may be explained, at least in part, by the type of domain in which discrimination occurs such as public spaces, nightlife, public institutions, workplace, terms of employment, looking for work and education. For instance, previous studies have shown that public spaces are the most common domain of discrimination for populations originating from SSA in Amsterdam while employment (not being hired) and mal-treatment by police are the most common domains of discrimination for populations originating from SSA in London [33,34]. This sustained discrimination of Amsterdam migrants whenever in public spaces will likely increase their risk of CVD, compared to migrants in London who periodically perceive discrimination when looking for work or whenever in contact with the police. Although domains of discrimination have been reported in Amsterdam and London, no report has been made for Berlin. Therefore, a detailed study is needed to understand the differential risk of CVD risk from perceived discrimination in all three European contexts.

Stratified analysis further showed that associations between adverse life events and high estimated CVD risk was stronger in rural Ghana compared to urban Ghana, although results were not statistically significant. This differential CVD risk observed with adverse life events can similarly be explained as with migrant *versus* non-migrant Ghanaians. In this study, 74.7% of rural Ghanaians experienced adverse life events of which 61.1% were related to illness or death, compared to 64.8% in urban Ghanaians with only 48.5% of adverse events related to illness or death. Large family networks together with illness and death from treatable diseases seen in rural Ghana might increase CVD risk in rural Ghanaians compared to urban Ghanaians.

4.3. Strengths and limitations

The strength of our study is that it assesses a homogenous population of migrant and non-migrant Ghanaians living in different settings in Africa and Europe and thereby increasing the validity of our results. Despite lack of biological markers for psychosocial stress in our analysis, psychosocial stress was measured using well validated questionnaires [22,24,25]. Several limitations of this study should be considered. First, our data are cross-sectional and rely on self-reported measures for psychosocial stress hence we cannot preclude the possibility of recall bias and reverse causation. Second, the fact that CVD risk was calculated and not directly observed in these participants could lead to overestimation or underestimation of actual risk. Third, we could not comment on contributions of occupation and household income in the present analysis due to numerous missing values [11]. Lastly, effects of multiple outcome measurements cannot be precluded from our study since psychosocial stress was measured in three separate forms.

4.4. Conclusion

Our study provides first insights into psychosocial stress factors underlying high estimated CVD risk in SSA migrants and their compatriots in Africa. Our findings show that psychosocial stress factors underlying high estimated CVD risk are specific to either the migrant or non–migrant environment. Prevalence of psychosocial stress is higher among non-migrant compared to migrants, even though migrants have higher levels of estimated CVD risk. Stress at work and at home was not observed to be associated with estimated CVD risk in both migrants and non-migrants. However, among migrant populations, higher levels of perceived discrimination were observed to be associated with high estimated CVD risk, while recent negative life events were observed to be associated with high estimated CVD risk among non-migrant populations. These results are relevant to European countries hosting African migrants, as well as SSA countries undergoing rapid urbanisation. Further longitudinal and biomarker-supported research is needed to identify context specific pathological and behavioral mechanisms that underlie associations between psychological characteristics and CVD risk.

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Conflict of interest

The authors report no relationships that could be construed as a conflict of interest.

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Supplementary data

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