

https://dspace.org/

Associations of psychosocial stress with type 2 diabetes and glycaemic control among Ghanaians: the RODAM study

Chilunga, Felix P.; Schwerzel, Pleun S.; Meeks, Karlijn A. C.; Beune, Erik; Bahendeka, Silver ...

2022
Wiley
https://hdl.handle.net/10539/49550
Chilunga, F. P., Schwerzel, P. S., Meeks, K. A. C., Beune, E., Bahendeka, S., Mockenhaupt, F., Klipstein-Grobusch, K., & Agyemang, C. (2023). Associations of psychosocial stress with type 2 diabetes and glycaemic control among Ghanaians: The RODAM study. Diabetic medicine : a journal of the British Diabetic Association, 40(1), e15006. https://doi.org/10.1111/dme.15006

Downloaded from a DSpace repository. https://dspace.org/

Received: 7 June 2022 | Accepted: 9 November 2022

DOI: 10.1111/dme.15006

DIABETIC Medicine

RESEARCH: EPIDEMIOLOGY

Associations of psychosocial stress with type 2 diabetes and glycaemic control among Ghanaians: The RODAM study

Felix P. Chilunga[1] | **Pleun S. Schwerzel**[1] | **Karlijn A. C. Meeks**[2] | **Erik Beune**[1] | **Silver Bahendeka**[3] | **Frank Mockenhaupt**[4] | **Kerstin Klipstein-Grobusch**[5,6] | **Charles Agyemang**[1]

[1]Department of Public and Occupational Health, Amsterdam Public Health Research Institute, Amsterdam UMC, University of Amsterdam, Amsterdam, The Netherlands

[2]Center for Research on Genomics and Global Health, National Human Genome Research Institute, National Institutes of Health, Bethesda, Maryland, USA

[3]MKPGMS-Uganda Martyrs University, Kampala, Uganda

[4]Charité - Universitätsmedizin Berlin, Corporate Member of Freie Universität Berlin, Humboldt-Universitaet, Berlin, Germany

[5]Julius Global Health, Julius Center for Health Sciences and Primary Care, University Medical Center Utrecht, Utrecht University, Utrecht, The Netherlands

[6]Division of Epidemiology and Biostatistics, School of Public Health, Faculty of Health Sciences, University of the Witwatersrand, Johannesburg, South Africa

Correspondence
Felix P Chilunga and Pleun S. Schwerzel, Department of Public and Occupational Health, Amsterdam Public Health Research Institute, Amsterdam UMC, University of Amsterdam, Amsterdam 1012 WX, The Netherlands.
Email: f.p.chilunga@amsterdamumc.nl and p.s.schwerzel@gmail.com

Funding information
European Commission under the Framework Programme (Grant Number: 278901)

Abstract

Background: The extent to which psychosocial stress relates to type 2 diabetes among sub-Saharan Africans is not well understood. We assessed associations of psychosocial stresses with type 2 diabetes status and glycaemic control among Ghanaians.

Methods: We used data from Research on Obesity and Diabetes among African Migrants (RODAM) study. We performed logistic and linear regression models to assess association of psychosocial stresses with type 2 diabetes and HbA1c respectively with adjustments for age, sex, education and other stresses. We also assessed moderation effects of migration status (migrant Ghanaians vs. non-migrant Ghanaians), age, sex and education by adding interaction terms in models.

Results: Four thousand eight hundred and forty one Ghanaians were included with 44% resident in Ghana, 62% women, mean age of 46 years and 10% having type 2 diabetes. Psychosocial stress at home and at work were not associated with type 2 diabetes or HbA1c levels. Negative life events in past 12 months were negatively associated with type 2 diabetes (adjusted odds ratio = 0.93, 95% CI 0.87–0.99). Perceived discrimination was positively associated with type 2 diabetes (aOR = 1.01, 95% CI 1.004–1.03). Both associations were more pronounced

Felix P. Chilunga and Pleun S. Schwerzel are shared first authors.

This is an open access article under the terms of the Creative Commons Attribution-NonCommercial-NoDerivs License, which permits use and distribution in any medium, provided the original work is properly cited, the use is non-commercial and no modifications or adaptations are made.
© 2022 The Authors. *Diabetic Medicine* published by John Wiley & Sons Ltd on behalf of Diabetes UK.

in men. Perceived discrimination was also positively associated with HbA1c levels, especially among those with type 2 diabetes (adjusted β = 0.01, 95% CI 0.007–0.02).

Conclusions: Perceived discrimination and negative life events are associated with type 2 diabetes and glycaemic control among Ghanaians, especially in men. Further studies are needed to identify context-specific mechanisms underlying these associations.

KEYWORDS

glycaemic control, psychosocial stress, sub-Saharan Africans; migration, type 2 diabetes

1 | INTRODUCTION

Over the last few decades, the prevalence of type 2 diabetes has increased considerably among sub-Saharan Africa (SSA) populations residing in Africa and in high-income countries.[1,2] Demographic changes, rapid urbanization, and accompanying lifestyle changes related to diet, tobacco smoking, and physical activity are thought to be the major driving forces.[1,2] Despite interventions based on these conventional risk factors, the burden of diabetes continues to rise.[3] Moreover, good glycaemic control has also been difficult to achieve among SSA populations with type 2 diabetes due to multiple factors such as limited access to treatment and poor self management resulting in increased morbidity and mortality from the disease.[4,5]

Emerging literature from high-income countries suggests that psychosocial stress is a risk factor for type 2 diabetes onset and progression, as well as for poor glycaemic control.[6] Psychosocial stress can influence type 2 diabetes onset and glycaemic control through biological and behavioural pathways.[7] Biologically, psychosocial stress can result in chronic activation of the physiologic stress response, consequently leading to the development of abdominal obesity.[7] Psychosocial stress can also activate the hypothalamic–pituitary–adrenal axis, leading to the release of glucose and lipids into the circulation, activation of the immune system, and an increase in blood pressure.[7] These biological changes are often accompanied by adverse effects of lifestyle behaviours, such as an unhealthy diet, tobacco smoking, and physical inactivity which are also linked to type 2 diabetes.[7] Additionally, psychosocial stress can negatively affect type 2 diabetes self care, resulting in poor glycaemic control.[6]

While the link between psychosocial stress and type 2 diabetes status has been well studied in populations from high-income countries,[8,9] little is known about this relationship among SSA populations. Critically, we hypothesize that factors such as cultural perception of stresses,[10] underlying sources of stresses, social support systems,[11] genetic predispositions,[12] etc. may differentially affect the relationship between psychosocial stress and type 2 diabetes status among SSA populations as opposed to populations originating from high-income countries. For example, community and religious social support might be higher in SSA populations than in high-income countries' origin populations.[13] Moreover, factors such as migration status (i.e. whether residing in Africa or abroad in Europe), age, sex and education might also distinctively moderate the relationship between psychosocial stress and type 2 diabetes among SSA populations. For instance, SSA populations residing in Europe might perceive more racial discrimination than SSA populations residing in Africa,[14]

We, therefore, assessed associations of psychosocial stress with type 2 diabetes status and glycaemic control among Ghanaians, as well as the moderation effects of migration status, age, sex and education on this relationship.

What's New?

- Psychosocial stress at home and at work are not associated with type 2 diabetes or HbA1c levels among Ghanaians.
- Negative life events in past 12 months are negatively associated with type 2 diabetes among Ghanaians, especially in men.
- Perceived discrimination is positively associated with type 2 diabetes among Ghanaians, especially in men and with HbA1c levels, especially among those with type 2 diabetes.
- Our findings could open avenues for diabetes prevention/management among sub-Saharan African populations via psychosocial interventions (e.g. behavioural, and cognitive strategies).

2 | METHODOLOGY

2.1 | Study participants

This study is part of the Research on Obesity and Diabetes among African Migrants (RODAM) study.[15] 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 and non-migrants.[15] The full details of the study have been published elsewhere. In brief, RODAM enrolled 5659 Ghanaians 25–70 years living in rural (Ashanti region) and urban Ghana (Kumasi and Obuasi), the Netherlands (Amsterdam), Germany (Berlin) and the United Kingdom (London). Participation rates across the five sites were: 76% in rural Ghana, 74% in urban Ghana, 53% in Amsterdam, 68% in Berlin and 75% in London. For this study we included participants without missing data on any of the relevant indicators. After exclusions, 4841 participants were included in our analysis (Appendix A).

2.2 | Ethical approval

Ethics approval was obtained from the ethics committees of the relevant institutions in Ghana (Kwame Nkrumah University of Science and Technology, Kumasi; CHRPE/AP/200/12), the Netherlands (Amsterdam University Medical Centre, Amsterdam; W12–062#12.17.0086), Germany (Charité University Berlin, Berlin; EA1/307/12) and the United Kingdom (London School of Hygiene & Tropical Medicine, London; 6208) before the start of data collection. All participants gave written informed consent.

2.3 | Measurements

Data were collected via structured questionnaires, physical examination and venous blood samples. A standardized approach was used across all study sites. Questionnaires were available in English and were also translated into the local languages by the study team including interviewers. The questionnaire contained information on demographics, education level, socio-economic status, migration history, health status and psychosocial stress. A physical examination assessed a series of anthropometric measurements. Measurements were performed twice. Body weight was measured in light clothing and without shoes to the nearest 0.1 kg. Body height was measured to the nearest 0.1 cm. At all sites, trained research assistants were responsible for collecting fasting venous blood samples. These were processed and aliquoted immediately after collection. All stored blood samples from the research centres were transported in dry shippers to Berlin for biochemical analysis. Fasting plasma glucose concentration was measured with an enzymatic method (hexokinase) in mmol/L. HbA1c was measured using high-performance liquid chromatography in mmol/mol. All biochemical analyses were performed using an ABX Pentra 400 chemistry analyser (ABX Pentra; Horiba ABX, Montpellier, France).

2.4 | Type 2 diabetes and glycaemic control

Type 2 diabetes was defined using the diagnostic criteria from the World Health Organization (WHO), which include fasting glucose ≥7.0 mmol/L, current use of medication prescribed to treat diabetes mellitus, or self-reported physician-diagnosed diabetes mellitus. Participants were then categorised into type 2 diabetes present or absent. HbA1c levels were used as a measure of glycaemic control as they reflect average levels of blood glucose over the previous 2–3-months.

2.5 | Psychosocial stress factors

Measures of psychosocial stress were obtained through structured validated questionnaires. This included perceived discrimination in daily life, perceived stress at work in the past 12 months, perceived stress at home in the last 12 months and negative life events in the past 12 months.

2.5.1 | Perceived discrimination

Perceived discrimination refers to routinely experienced and often subtle instances of unfair treatment. This was measured using the validated everyday discrimination scale (EDS; Appendix B).[16] The EDS comprises of nine-item scale, which asked participants to rate the frequency with which they experience daily mistreatment such as being treated with less courtesy or less respect, receiving poorer service than other people, or being called names or insulted. This validated nine-item scale lets participants rate each item from 'never' = 1 to 'very often' = 5. Scores on each item were summed to provide a total score (range = 9 to 45).

2.5.2 | Perceived stress at home and perceived stress at work

Perceived stress at home or at work was defined as 'feeling irritable, filled with anxiety, or as having sleeping

difficulties as a result of conditions at home or at work'. These were measured using the validated psychosocial stress scale created by the INTERHEART study (Appendix C).[17] Participants were asked about stress prevalence at work or at home in the past 12 months, and they answered: 'never' = 1, 'some periods' = 2, 'several periods' = 3 or 'constantly' = 4.

2.5.3 | Negative life events

To measure the presence of major negative/adverse life events, the validated and widely used list of threatening experiences (LTEs) was used. This list asks participants 12 major stressful life events in the preceding 12 months (Appendix D).[18] Participants can in turn answer 'no' = 0 or 'yes' =1. Scores on each item/major stressful life event were summed to provide a total score (range = 0 to 12).

2.6 | Statistical analysis

All statistical analyses were performed using R (*Version 4.0.3*). Summary statistics for categorical variables were presented as proportions, as means (with standard deviations) for normally distributed continuous variables, and as medians with interquartile range for skewed continuous variables. Logistic regression analyses were used to examine associations between psychosocial stress and type 2 diabetes status (outcome variable). Analyses were adjusted for age, sex, education and other stress factors. Odds ratios (ORs) were reported together with their corresponding 95% confidence intervals. For psychosocial stress factors that were significantly associated with type 2 diabetes in adjusted models, effect modification by migration status, age, sex and education was additionally assessed by including interaction terms in the logistic models. A p-value of <0.1 was considered a statistically significant interaction effect due to lower power for interactions than for main effects.[19] In instances where the interaction effects were statistically significant, analyses were further stratified by relevant effect modifier (i.e. migration, age, sex and education). All analyses (except assessment of interaction effects) were performed at an alpha of 0.05.

Linear regression models were used to examine associations between psychosocial stress and HbA1c levels (outcome variable). Model adjustments, interaction tests and analysis stratifications were performed similarly to the logistic regression analyses. However, type 2 diabetes status (present or absent) was additionally assessed as an effect modifier in linear regression models.

3 | RESULTS

3.1 | Participant characteristics

A total of 4841 Ghanaians were included in the current analysis (Table 1). Of these, 2698 (56%) resided in Europe, while 2143 (44%) resided in Ghana. The mean age was 46 years (standard deviation = 11 years). The majority (63%) were female. Only 30% had completed secondary/tertiary education. At least 49% had higher levels of physical activity and the majority had never smoked (93%). The mean BMI was 27.4 kg/m^2 (SD = 5.4 kg/m^2) and 47% had hypertension.

3.2 | Levels of psychosocial stress, type 2 diabetes and HbA1c

About 52% of participants had experienced any stress at home in the past 12 months. On the other hand, 48% experienced any stress at work in the past 12 months. The median negative life events score was nine (interquartile range; IQR = 8–10) while that of perceived discrimination was 12 (IQR = 9–18). The prevalence of type 2 diabetes was 10% while the mean HbA1c was 38.7 mmol/mol (5.7%) with an SD of 12.2 mmol/mol (1.13%; Table 1).

3.3 | Association of psychosocial stress factors with type 2 diabetes

Both psychosocial stress at home and at work in the past 12 months were not associated with type 2 diabetes status in adjusted models (Table 2). However, negative life events in the past 12 months were negatively associated with type 2 diabetes (adjusted odds ratio = 0.93, 95% CI 0.87–0.99) while perceived discrimination was positively associated with type 2 diabetes (aOR = 1.01, 95% CI 1.004–1.03). Moreover, sex modified the effects of both negative life events in the past 12 months and perceived discrimination on type 2 diabetes status (Table 3).

When stratified by sex (Table 4), associations between negative life events in the past 12 months with type 2 diabetes were statistically significant in men (aOR 0.88, 95% CI 0.81–0.95) but not in women (aOR 0.99, 95% CI 0.90–1.08). Similarly, perceived discrimination events were associated with type 2 diabetes in men (aOR 1.07, 95% CI 1.06–1.09) but not in women (aOR 1.04, 95% CI 0.90–1.20).

TABLE 1 Baseline characteristics of participants

	N or mean	% or SD
Numbers enrolled	4841	
Resident in Europe, *n* (%)	2698	55.7
Resident in Ghana, *n* (%)	2143	44.3
Demographics		
Women, *n* (%)	3037	62.7
Age (years), mean (SD)	46.3	10.9
Education level, *n* (%)		
None or elementary	1619	33.4
Lower vocational	1791	37.0
Secondary school	878	18.1
Higher vocational or university	526	10.9
Lifestyle factors		
Physical activity, *n* (%)[a]		
Low	1225	27.6
Moderate	871	19.6
High	2182	49.1
BMI, kg/m^2, mean (SD)	27.4	5.4
Smoking, *n* (%)		
Past	356	7.4
Current	143	3.0
Hypertension, *n* (%)[b]	2282	47.1
Type 2 Diabetes Mellitus, *n* (%)[c]	480	9.9
HbA1c (mmol/mol), mean (SD)[d]	38.7	12.2
HbA1c (%), mean (SD)[e]	5.7	1.13
Psychosocial stress factors		
Psychosocial stress at home past 12 months		
Never	2327	48.2
Some	2088	43.3
Several period	334	6.9
Constantly	77	1.6
Psychosocial stress at work past 12 months		
Does not apply (do not work)	363	7.5
Never	2123	44.0
Some	1803	37.4
Several period	443	9.2
Constantly	89	1.8
Negative events past 12 months (sum score), median (IQR)	9	8–10
Perceived discrimination (sum score), median (IQR)	12	9–18

Abbreviations: BMI, body mass index; HbA1c, glycosylated haemoglobin; SD, standard deviation; WHO, World Health Organization.

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

[b]Hypertension based on self-report, use of anti-hypertensives or mean SBP ≥ 140 mmHg or mean DBP ≥ 90 mmHg. This is also based on WHO criteria.

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

[d]Glycated haemoglobin in International Federation of Clinical Chemistry; IFCC units (mmol/mol).

[e]Glycated haemoglobin in Diabetes Control and Complications Trial; DCCT units (%).

3.4 | Association of psychosocial stress factors with glycaemic control

Psychosocial stress at work or at home in the past 12 months and negative events in the past 12 months were not associated with HbA1c levels in adjusted models (Table 5). On the other hand, perceived discrimination was positively associated with HbA1c levels (adjusted β coefficient = 0.01, 95% CI 0.004–0.01). Moreover, type 2 diabetes status modified the effects of perceived discrimination on HbA1c levels (Table 6). When stratified by type 2 diabetes status, associations between perceived discrimination with HbA1c levels were more pronounced in those with type 2 diabetes (adjusted β coefficient 0.01, 95% CI 0.007–0.02) than in those without type 2 diabetes (adjusted β coefficient − 0.03, 95% CI -0.06-0.003; Table 7).

4 | DISCUSSION

4.1 | Key findings

In our study, we assessed associations of psychosocial stress with type 2 diabetes prevalence and glycaemic control among Ghanaian migrants and non-migrant Ghanaians, as well as the moderation effects of migration status, age, sex and education on this relationship. We found that psychosocial stress at work or at home in the past 12 months was not associated with type 2 diabetes or HbA1c levels. However, negative life events in the past 12 months were negatively associated with type 2 diabetes while perceived discrimination was positively associated with type 2 diabetes. Both associations were more pronounced in men. Perceived discrimination was also associated with HbA1c levels, especially among those with type 2 diabetes.

4.2 | Interpretation of results

4.2.1 | Psychosocial stress and type 2 diabetes

To date, results from various meta-analyses on the relationship between psychosocial stress at work or at home

TABLE 2 Association between psychosocial stress factors and type 2 diabetes

Variable	Univariate Model OR (95% CI)	Adjusted model OR (95% CI)
Psychosocial stress at home past 12 months	1.04 (0.90–1.19)	1.04 (0.87–1.23)
Psychosocial stress at work past 12 months	0.89 (0.76–1.01)	0.85 (0.72–1.01)
Negative events in the past 12 months	0.91 (0.86–0.97)	0.93 (0.87–0.99)[a]
Perceived discrimination	1.02 (1.003–1.03)	1.01 (1.004–1.03)[a]

Note: Qdds ratio and their 95% confidence intervals (CIs) obtained via logistic regression models. Adjusted models, adjusted for age, sex, education and the other stress factors.

Abbreviations: CI, confidence interval; OR, odds ratio.

[a]Considered as statistically significant result at *p*-values <0.05.

TABLE 3 Moderation of various factors on the associations between psychosocial stress factors and type 2 diabetes

Variable	Categories	Adjusted Models OR (95% CI)	*p*-Value
Negative events in the past 12 months			
Migration status	Non-Migrants	1.00 (ref)	ref
	Migrants	0.99 (0.86–1.14)	0.955
Age (years)		0.99 (0.98–1.01)	0.767
Sex	Men	1.00 (ref)	ref
	Women	1.12 (0.99–1.26)	0.069*
Education		0.99 (0.93–1.05)	0.829
Perceived discrimination in the past 12 months			
Migration status	Non-Migrants	1.00 (ref)	ref
	Migrants	1.01 (0.97–1.05)	0.541
Age (years)		1.00 (0.99–1.01)	0.709
Sex	Men	1.00 (ref)	ref
	Women	0.97 (0.95–1.00)	0.068*
Education		0.99 (0.97–1.01)	0.158

Note: Interaction effects between psychosocial stress factor and (migration, age, sex, education) used to assess moderation in the logistic regression models. Adjusted models, adjusted for age, sex, education and the other stress factors. Odds ratio obtained via logistic regression analysis and their 95% confidence intervals (CIs).

Abbreviations: CI, confidence interval; OR, odds ratio.

**p*-Values considered as significant at <0.1 in these moderation analyses due to lower power for interactions than for main effects.[19]

TABLE 4 Association between perceived discrimination, negative life events and type 2 diabetes for men and women

Variable	Total N (%)	Univariate model OR (95% CI)	Adjusted model OR (95% CI)
Negative events in the past 12 months			
Men	1804 (37.3)	0.87 (0.81–0.95)*	0.88 (0.81–0.95)*
Women	3037 (62.7)	0.96 (0.88–1.05)	0.99 (0.90–1.08)
Perceived discrimination in the past 12 months			
Men	1804 (37.3)	1.03 (1.01–1.05)*	1.07 (1.06–1.09)*
Women	3037 (62.7)	0.99 (0.98–1.02)	1.04 (0.90–1.20)

Abbreviations: Adjusted models, adjusted for age, and education; CI, confidence interval; OR, odds ratios and their 95% CIs.

*Considered as statistically significant result at *p*-values < 0.05.

TABLE 5 Association between psychosocial stress factors and HbA1c

Variable	Univariate model β (95% CI)	Adjusted model β (95% CI)
Psychosocial stress at home past 12 months	−0.03 (−0.08–0.02)	−0.02 (−0.08–0.04)
Psychosocial stress at work past 12 months	−0.06 (−0.10—0.01)*	−0.04 (−0.09–0.01)
Negative events in the past 12 months	−0.01 (−0.03–0.01)	−0.003 (−0.03–0.02)
Perceived discrimination	0.01 (0.01–0.02)*	0.01 (0.004–0.01)*

Note: Adjusted models, adjusted for age, sex, education and the other stress factors.

Abbreviation: β, Beta Coefficients and their 95% confidence intervals (CIs) obtained via linear regression models.

*Considered as statistically significant result at *p*-values <0.05.

TABLE 6 Moderation of various factors on the associations between perceived discrimination and HbA1c

Variable	Categories	Adjusted models β (95% CI)	*p*-value
Perceived discrimination in the past 12 months			
Migration status	Non-migrants	1.00 (ref)	ref
	Migrants	0.01 (−0.001–0.02)	0.107
Age (years)		0.004 (−0.001–0.01)	0.849
Sex	Men	1.00 (ref)	ref
	Women	−0.01 (−0.02–0.01)	0.273
Education		−0.004 (−0.01–0.001)	0.117
Type 2 diabetes status	Not present	1.00 (ref)	ref
	Present	−0.04 (−0.05—0.03)[a]	<0.001[a]

Note: *p*-Values considered as significant at <0.1 in these moderation analyses due to lower power for interactions than for main effects.[19] Interaction effects between perceived discrimination and (migration, age, sex, education) used to assess moderation in the linear regression models. Adjusted models, adjusted for age, sex, education and the other stress factors.

Abbreviation: β, beta coefficients and their 95% confidence intervals (CIs).

[a]Statistically significant result.

TABLE 7 Association between perceived discrimination and HbA1c by type 2 diabetes status

Variable	Total *N* (%)	Univariate model β (95% CI)	Adjusted model β (95% CI)
Perceived discrimination in the past 12 months			
Type 2 diabetes present	480 (9.9)	0.01 (0.008–0.02)*	0.01 (0.007–0.02)*
Type 2 diabetes not present	4361 (90.1)	−0.03 (−0.06—0.005)*	−0.03 (−0.06–0.003)

Note: Adjusted models, adjusted for age, sex, and education.

Abbreviation: β, beta coefficients and their 95% confidence intervals (CIs) obtained via linear regression models.

*Considered as statistically significant result at *p*-values <0.05.

with type 2 diabetes have been conflicting.[8,20] For instance, a meta-analysis of 13 European cohorts reported a positive relationship between psychosocial stress at work with type 2 diabetes,[8] while another meta-analysis incorporating data from the United States, Canada, Japan and some European countries did not detect any relationship at all.[20] These conflicting observations suggest that the relationship between psychosocial stress at work or at home with type 2 diabetes is dependent upon the populations under study. In our case, the lack of

statistically significant association between psychosocial stress at work or at home in the past 12 months with type 2 diabetes could be partly attributed to the extended family system.[21] Ghanaian culture is still largely based on an extended family system.[21] This social structure provides emotional support to families in times of need or family problems and may therefore be a buffer to psychosocial stress at home. In addition, good job opportunities are difficult to come by for Ghanaians residing in Ghana,[22] as well as for Ghanaians resident in Europe when compared to European origin populations.[23] As such, we postulate that having the job itself might be more important than any stresses that might be encountered at the workplace thereby acting as a buffer, leading to the lack of associations.

Our findings on negative life events contrast with previous studies, which found an inverse relationship with type 2 diabetes.[24] The explanation for this observation is unclear. However, we believe it could be related to lifestyle modifications. Since 60% of negative life events among Ghanaians in this study derived from illness and deaths, it is possible that experiencing sickness and death among family members and close friends instils positive behavioural change in those around these events. As such, unfortunate circumstances relating to illness and death could lead to the adoption of healthier lifestyles, which decreases their risk of type 2 diabetes. Since data on lifestyle modifications in response to adverse life events are lacking, further studies should explore this avenue. Additionally, the larger effect of negative life events in men as compared to women could be related to levels of gender norms. In Ghana, men in the immediate/extended family are more likely to lead the management (decision makers) of adverse events than women.[25] As a result, the effects of negative life events are likely to be more pronounced in men as compared to women.

The positive association between perceived discrimination and type 2 diabetes is in line with previous studies.[26] Perceived discrimination can alter the hypothalamic–pituitary–adrenal axis, leading to the release of glucose and lipids into the circulation, and activation of the immune system.[26] It can also lead to or aggravate the effects of unhealthy behavioural factors such as unhealthy diet, tobacco smoking and physical inactivity, which are linked to type 2 diabetes.[26] The larger effect in men as compared to women could be related to levels of social support. In Ghana, women are more likely to receive social support from the church (religious institutions) and women groups than men.[13] Eventually, this could act as a buffer of perceived discrimination in women than in men.

4.2.2 | Psychosocial stress and glycaemic control

The lack of associations between psychosocial stress at work or at home in the past 12 months with HbA1c levels contrasts with previous studies.[27] Like with type 2 diabetes, we postulate that the extended family support system for psychosocial stresses at home,[21] and having a job acting like a buffer for psychosocial stress at work may also explain the lack of association between these stresses with HbA1c levels. On the other hand, it is unclear why negative life events in the past 12 months (which are associated with type 2 diabetes in this study) were not similarly associated with HbA1c levels. With the same negative direction of associations for both type 2 diabetes and HbA1c levels, it is possible that the effects of negative life events on glycaemic control were present in this study but were masked by self-efficacy and self-care behaviours that are already present among participants previously diagnosed with type 2 diabetes. These self-efficacy and self-care behaviours include the adoption of healthy lifestyles, taking anti-diabetic medication, attending type 2 diabetes support groups, going to church for social support, etc.[28]

The positive association between perceived discrimination and HbA1c levels is in line with previous studies.[29] Perceived discrimination could negatively alter self-efficacy and self-care behaviours leading to a positive association with HbA1c levels.[29] This is further evidenced by the strong association observed in participants with type 2 diabetes (who are likely to be on self-efficacy and self-care behaviours that can be altered) than those without.[28]

4.3 | Strengths and limitations

The main strength of this study is that it was based on a large homogenous population of Ghanaians living in different locations, from which data were collected using standardized protocols. This enabled us to study the moderating role of migration status (a least studied factor) on psychosocial stresses and type 2 diabetes on top other well studied moderation factors such as age, sex and education. The other strength is that four different psychosocial stress measures were included in this study to account for different aspects of psychosocial stress. However, several limitations should be considered as well. First, due to the cross-sectional design of the study, reverse causation cannot be ruled out. Second, the duration of stressors was not considered. Therefore, the effects of chronic and acute stress were not differentiated, which might have affected our results. Third, the measurement of psychosocial stress factors relied on self-reported

measures. Therefore, the possibility of recall bias cannot be excluded. Fourth, psychosocial stress factors cannot be readily translated into some Ghanaian languages (e.g. Twi), hence it is possible that our translations were affected by response bias. However, majority of Ghanaian participants in Europe responded in English, and the lack of moderation effect of migration status on the relationship between psychosocial stresses and type 2 diabetes could suggest that these biases were minimal. Fifth, the data were collected between 2012 and 2015, which is almost an average of 8 years time lag. However, data on psychosocial stress and cardiometabolic health are lacking in Ghana and SSA in general. These results are therefore still important in this context to shed light on the role of psychosocial stress in type 2 diabetes among these populations and help kick-start mechanistic studies, or prevention and control programmes (e.g. behavioural, and cognitive strategies for psychosocial stress). Essentially, professional treatment of psychosocial stress is not part of the type 2 diabetes prevention and control strategies among SSA populations.[30] Lastly, due to large missing values, we are unable to comment on contributions of occupation and household income on our results.

5 | CONCLUSIONS

Our findings show that perceived discrimination and negative life events in the past 12 months but not psychological stress at work or at home in the past 12 months are associated with T2DM and glycaemic control among Ghanaians. These associations are more pronounced in men. With the increasing burden of type 2 diabetes among Ghanaians, further studies are needed to identify the context-specific mechanisms linking psychosocial stresses to type 2 diabetes and glycaemic control to develop prevention and management strategies that target these stresses.

AUTHOR CONTRIBUTION

Pleun S. Schwerzel, Felix P. Chilunga and Charles Agyemang conceived and designed the study. Pleun S. Schwerzel analysed the data. Felix P. Chilunga and Pleun S. Schwerzel wrote the paper with Charles Agyemang. All authors Pleun S. Schwerzel, Felix P. Chilunga, Karlijn A.C. Meeks, Erik Beune, Silver Bahendeka, Frank Mockenhaupt, Kerstin Klipstein-Grobusch and Charles Agyemang participated in drafting the article or revising it critically for content.

ACKNOWLEDGMENTS

The authors are very grateful to the advisory board members for their valuable support in shaping the methods, to the research assistants, interviewers and other staff of the five research sites, who have taken part in gathering the data, and, most of all, to the Ghanaian volunteers participating in this project. We gratefully acknowledge Jan van Straalen from the Academic Medical Centre for his valuable support with standardization of the laboratory procedures and the AMC Biobank for support in biobank management and storage of collected samples.

FUNDING INFORMATION

This work was supported by the European Commission under the Framework Programme (Grant Number: 278901) and European Research Council Consolidation (Grant Number: 772244).

CONFLICT OF INTEREST

The authors declare that they have no competing interests.

DATA AVAILABILITY STATEMENT

Data used for the study are available upon request.

ORCID

Felix P. Chilunga https://orcid.org/0000-0003-4083-001X

REFERENCES

1. Atun R, Davies JI, Gale EA, et al. Diabetes in sub-Saharan Africa: from clinical care to health policy. *Lancet Diabetes Endocrinol*. 2017;5(8):622-667.
2. Agyemang C, Meeks K, Beune E, et al. Obesity and type 2 diabetes in sub-Saharan Africans-is the burden inβ today's Africa similar to African migrants in Europe? The RODAM study. *BMC Med*. 2016;14(1):1-12.
3. Gouda HN, Charlson F, Sorsdahl K, et al. Burden of non-communicable diseases in sub-Saharan Africa, 1990-2017: results from the global burden of disease study 2017. *Lancet Glob Health*. 2019;7(10):e1375-e1387.
4. Manne-Goehler J, Atun R, Stokes A, et al. Diabetes diagnosis and care in sub-Saharan Africa: pooled analysis of individual data from 12 countries. *Lancet Diabetes Endocrinol*. 2016;4(11):903-912.
5. Bijlholt M, Meeks KA, Beune E, et al. Type 2 diabetes mellitus management among Ghanaian migrants resident in three European countries and their compatriots in rural and urban Ghana: the RODAM study. *Diabetes Res Clin Pract*. 2018;136:32-38.
6. Hackett RA, Steptoe A. Type 2 diabetes mellitus and psychological stress - a modifiable risk factor. *Nat Rev Endocrinol*. 2017;13(9):547-560. doi:10.1038/nrendo.2017.64
7. Kelly SJ, Ismail M. Stress and type 2 diabetes: a review of how stress contributes to the development of type 2 diabetes. *Annu Rev Public Health*. 2015;36:441-462. doi:10.1146/annurev-publhealth-031914-122921
8. Nyberg ST, Fransson EI, Heikkilä K, et al. Job strain as a risk factor for type 2 diabetes: a pooled analysis of 124,808 men and women. *Diabetes Care*. 2014;37(8):2268-2275. doi:10.2337/dc13-2936

9. Cosgrove MP, Sargeant LA, Caleyachetty R, Griffin SJ. Work-related stress and type 2 diabetes: systematic review and meta-analysis. *Occup Med (Lond)*. 2012;62(3):167-173. doi:10.1093/occmed/kqs002
10. Hashim IH, Zhiliang Y. Cultural and gender differences in perceiving stressors: a cross-cultural investigation of African and Western students in Chinese colleges. *Stress Health*. 2003;19(4):217-225.
11. Amoah PA. The relationship between functional health literacy, self-rated health, and social support between younger and older adults in Ghana. *Int J Environ Res Public Health*. 2019;16(17):3188.
12. Feodorova YN, Sarafian VS. Psychological stress--cellular and molecular mechanisms. *Folia Med (Plovdiv)*. 2012;54(3):5-13. doi:10.2478/v10153-011-0091-9
13. Michgelsen J, Boateng D, Meeks KA, et al. Association between Practising religion and cardiovascular disease risk among Ghanaian non-migrants and migrants in Europe: the RODAM study. *Int J Environ Res Public Health*. 2021;18(5):2451.
14. Chilunga FP, Boateng D, Henneman P, et al. Perceived discrimination and stressful life events are associated with cardiovascular risk score in migrant and non-migrant populations: the RODAM study. *Int J Cardiol*. 2019;286:169-174.
15. Agyemang C, Beune E, Meeks K, et al. Rationale and cross-sectional study design of the research on obesity and type 2 diabetes among African migrants: the RODAM study. *BMJ Open*. 2015;4(3):e004877.
16. Williams DR, Yu Y, Jackson JS, Anderson NB. Racial differences in physical and mental health: socio-economic status, stress and discrimination. *J Health Psychol*. 1997;2(3):335-351.
17. Rosengren A, Hawken S, Ôunpuu S, et al. Association of psychosocial risk factors with risk of acute myocardial infarction in 11 119 cases and 13 648 controls from 52 countries (the INTERHEART study): case-control study. *Lancet*. 2004;364(9438):953-962.
18. Brugha TS, Cragg D. The list of threatening experiences: the reliability and validity of a brief life events questionnaire. *Acta Psychiatr Scand*. 1990;82(1):77-81.
19. Aguinis H, Beaty JC, Boik RJ, Pierce CA. Effect size and power in assessing moderating effects of categorical variables using multiple regression: a 30-year review. *J Appl Psychol*. 2005;90(1):94-107.
20. Sui H, Sun N, Zhan L, Lu X, Chen T, Mao X. Association between work-related stress and risk for type 2 diabetes: a systematic review and meta-analysis of prospective cohort studies. *PloS One*. 2016;11(8):e0159978.
21. Kumado K, Gockel AF. A Study on Social Security in Ghana. University of Ghana Legon; 2003. https://library.fes.de/pdf-files/bueros/ghana/50022.pdf
22. Honorati M, De Silva SJ. Expanding Job Opportunities in Ghana. World Bank Publications; 2016. https://openknowledge.worldbank.org/handle/10986/25208
23. Ronda Perez E, Benavides FG, Levecque K, Love JG, Felt E, Van Rossem R. Differences in working conditions and employment arrangements among migrant and non-migrant workers in Europe. *Ethn Health*. 2012;17(6):563-577.
24. Mooy JM, De Vries H, Grootenhuis PA, Bouter LM, Heine RJ. Major stressful life events in relation to prevalence of undetected type 2 diabetes: the Hoorn study. *Diabetes Care*. 2000;23(2):197-201.
25. Brown CK. Gender roles and household allocation of resources and decision-making in Ghana. *The Changing Family in Ghana*. Vol 2; Ghana Universities Press; 1996: 21-41.
26. Pascoe EA, Smart RL. Perceived discrimination and health: a meta-analytic review. *Psychol Bull*. 2009;135(4):531-554.
27. Hilliard ME, Yi-Frazier JP, Hessler D, Butler AM, Anderson BJ, Jaser S. Stress and A1c among people with diabetes across the lifespan. *Curr Diab Rep*. 2016;16(8):1-10.
28. Shrivastava SR, Shrivastava PS, Ramasamy J. Role of self-care in management of diabetes mellitus. *J Diabetes Metab Disord*. 2013;12(1):1-5.
29. Ryan AM, Gee GC, Griffith D. The effects of perceived discrimination on diabetes management. *J Health Care Poor Underserved*. 2008;19(1):149-163.
30. Nyarko KM, Ameme DK, Ocansey D, Commeh E, Markwei MT, Ohene S-A. Capacity assessment of selected health care facilities for the pilot implementation of package for essential non-communicable diseases (PEN) intervention in Ghana. *Pan Afr Med J*. 2016;25(Suppl 1):16.

SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

How to cite this article: Chilunga FP, Schwerzel PS, Meeks KAC, et al. Associations of psychosocial stress with type 2 diabetes and glycaemic control among Ghanaians: The RODAM study. *Diabet Med*. 2023;40:e15006. doi:10.1111/dme.15006