Prevalence and Risk Factors for Acute Coronary Syndrome Among Sudanese Individuals With Diabetes: A Population-Based Study

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Abstract

Background: Acute coronary syndrome (ACS) is common with diabetes. The aim of this study was to establish prevalence and risk factors for ACS among Sudanese individuals with diabetes mellitus (DM).

Methods: A descriptive cross-sectional study was conducted in Khartoum State and Atabra (North of Sudan). The data collection was performed through pretested questionnaire, in addition to measurement of lipid profile and HbA1c.

Results: Among the 496 respondents, 234 (48.4%) were males and only 15 of them had ACS, while 255 (51.6%) were females and 12 had ACS. Therefore, the prevalence of ACS was 5.44% (95% confidence interval (CI): 3.45-7.44%). The unadjusted risk factors for ACS were age (P = 0.0008864), duration of DM (P = 0.01105) and presence of hypertension (P = 0.0006021). The presence of albuminuria, gender, and body mass index (BMI) was not associated with ACS. In addition, parameters like HbA1c, high-density lipoprotein (HDL), triglyceride and low-density cholesterol (LDL) were also not associated with ACS. Logistic regression analysis showed that duration of diabetes (odds ratio (OR) for below 5 years' history of DM = 0.175 (95% CI for OR: 0.180 - 0.835), P = 0.04051) and hypertension (OR

= 2.462 (95% CI for OR: 1.007 - 6.500), P = 0.039) were absolute risk factors for ACS.

Conclusion: The prevalence of ACS is estimated to be 5.44%. ACS in Sudanese individuals with DM was associated with hypertension, increase in age and increase in duration of DM.

Keywords: Acute coronary syndrome; Sudan; Diabetes mellitus

Introduction

Sudan, as one of the largest countries in Africa, has also experienced an increase in the prevalence of the non-communicable disease in the same scale as other African countries [1]. For instance, Noor et al have shown that the burden of non-communicable diseases was found to exceed that of communicable diseases among patients admitted to medical wards at main teaching hospital in the north of Sudan [1]. This increase in non-communicable disease was also associated with an increase in the prevalence of diabetes. Elmadhoun et al showed that the prevalence of diabetes mellitus (DM) in urban areas in north of Sudan has increased to 19% in 2015, while the prevalence in 1995 was estimated to be around 7% [2]. Their study showed that increasing age, a family history of DM, central obesity, abnormal body mass index (BMI), and hypertension were significant risk factors for DM. Importantly, Noor et al showed that the prevalence of DM in rural areas in Sudan was estimated to be 2.5% in 2015 and this was similar to the prevalence in 1996 which was 2.5% [3]. This difference in prevalence of DM between rural and urban areas may be attributed in part to the increase in prevalence of obesity. Ahmed et al have shown in a large population study of 7,239 Sudanese individuals that the prevalence of obesity was 21.2%. Furthermore, obesity and central obesity have a higher prevalence among Sudanese women and are associated with DM and hypertension [4]. Importantly, the prevalence of obesity among Sudanese individuals with DM was estimated to be 24.5% and overweight was 39.9%, and the prevalence was more in women than in men and associated with hypertension [5]. Optimization of DM control will be a big challenge for health authorities in Sudan, as 85% of individuals with type 2 DM have Hb1Ac of more than 7% [6]. This can

also be attributed to the increase in prevalence of fatty liver and insulin resistance. For instance, Almobarak et al showed that the prevalence of fatty liver among Sudanese individuals with type 2 DM was around 50%, while the prevalence in population without DM was estimated to be around 20% [7, 8]. Another factor for poor DM control may be attributed to low physical activity, especially in women [9]. Therefore, it is plausible to suggest that Sudanese individuals with DM are likely to encounter DM complications. Awadalla et al showed that the prevalence of neuropathy, hypertension and high cholesterol was 68%, 39% and 59.9%, respectively. They attributed the presence of DM complications to duration of DM and living in urban areas [10]. Almobarak et al showed that the prevalence of DM foot ulcer was around 18% and duration of DM was an absolute risk factor [11]. Furthermore, retinopathy prevalence was around 86% and duration of DM and hypertension were absolute risk factors [12]. Ahmed et al showed that the presence of retinopathy can be associated with nephropathy in Sudanese individuals with DM and hypertension can be a risk factor [13]. In view of the increase in prevalence of DM, DM complications and obesity, the aim of this study was to assess prevalence and risk factors for acute coronary syndrome (ACS) among Sudanese individuals with DM.

Methods

Study design

A descriptive cross-sectional, hospital-based study was carried out in Khartoum and Atbara, Sudan, between September and December 2015.

Study population and sampling

A total of 496 individuals with DM were enrolled in this study.

Data collection

The WHO stepwise approach for non-communicable diseases surveillance was used for data collection. The approach had three levels: a questionnaire to gather demographic and behavioral information; physical measurements including anthropometric and blood pressure; and biochemical tests. The variables collected were: demographic and background factors including age, gender, smoking, alcohol intake, DM duration and medications, and other co-morbidities, such as heart failure. Height and weight were assessed to calculate BMI. Blood indices estimated were: HbA1c, cholesterol and triglycerides levels.

Laboratory measures

Blood sample and urine sample were collected from each participant, who was willing to participate in the study and gave their verbal consent. The collection was done by a skilled laboratorist in sterilized condition. Blood samples were separated in two vacuum tubes: ethylenediaminetetraacetic acid (EDTA) reagent for HbA1c and lithium reagent for renal function test (RFT) and lipid profile. The laboratory tests were carried out using Cobas c 111 analyzer for sample analysis.

Data analysis

Data were cleaned, organized, coded and entered in master sheet and analysed using R-statistical software version 3.4.1.. The main variables analyzed were age, sex, BMI, blood glucose level, retinopathy, neuropathy, albuminuria, blood pressure, a family history of DM, duration of DM, cholesterol, triglyceride and HbA1c. Chi-squared test was used to test for significance between proportions. P-value < 0.05 was considered statistically significant. Logistic regression analysis was used to establish absolute risk factors.

Ethical approval

Verbal consent was obtained from each participant prior to enrolment. The following information was given during data collection to ensure they had the information needed to make the informed consent: participation was optional; there would be no penalty for refusal. A complete description of the aims and procedures of the study was clarified; potential benefits and risks were explained, and assurance of confidentiality of any information was guaranteed. Any other additional information requested by participants was provided during data collection. All individuals found to have a high blood pressure, or any other medical condition were referred, according to their will, to a physician for further management. All information obtained was kept confidential. All patients attending the physicians clinic at the time of study were offered free of charge investigations and medications, and no additional financial burdens were added to participants. An ethical clearance of the research was obtained from the Ethical Committee of the Faculty of Medicine, University of Medical Science and Technology, Khartoum, Sudan (IRB No. 00008867).

Results

Sociodemographic variables

The study is a retrospective observational analysis of 496 Sudanese patients with an established diagnosis of DM. There were 27 patients who developed ACS. Therefore, the prevalence of ACS was 5.44% (95% confidence interval (CI): 3.45-7.44%). Of the participants in the study, 257 (51.8%) were females, whereas 239 (48.2%) were males. Among the 27 participants with ACS, 12 were females (ACS prevalence = 4.7%) and 15 were males (ACS prevalence = 6.3%). However, this association between males and increased risk of ischemic heart disease (IHD) was not statistically significant (X-squared

Table 1. Characteristics of the Respondents According to Diagnosis of ACS

Factor/covariate	ACS, no. (%)	No ACS, no. (%)	Total, no. (%)	P value
Gender				0.5692
Men	15 (63.6)	224 (48)	239 (48.4)	
Women	12 (44.4)	243 (52)	255 (51.6)	
Age (mean), years	61.6	55.1	55.4	0.0008864
BMI (mean)	27.7	26.7	26.5	0.07137
Duration of DM				0.01105
Up to 5 years	1 (3.7)	98 (21)	100 (20.2)	
6 - 10 years	6 (22.2)	113 (24.2)	119 (24.1)	
11 - 20 years	7 (25.9)	149 (31.9)	157 (31.8)	
More than 20 years	13 (48.1)	105 (22.5)	118 (23.9)	
Hypertension				0.0006021
No	19 (70.4)	166 (35.5)	185 (37.3)	
Yes	8 (29.6)	301 (64.5)	309 (62.7)	
Cholesterol (mean)	161.7	172.4	171.9	0.2391
HbA1c (mean)	9.44	9.67	9.66	0.501
Triglycerides (mean)	125.8	135.2	134.8	0.5159
HDL (mean)	41.3	44.0	43.9	0.4412
LDL (mean)	112.8	115.7	115.6	0.804
Albuminuria				0.5068
Negative	97 (92.4)	324 (94.7)	421 (94.2)	
Positive	8 (7.6)	18 (5.3)	26 (5.8)	
Smoking				0.09711
No	15 (57.7)	313 (66.6)	328 (73.5)	
Yes	11 (42.3)	107 (33.4)	118 (26.5)	

P values < 0.05 are considered significant; Pearson Chi-squared and *t*-tests were used to check for significance between variables.

= 0.3241, degrees of freedom (df) = 1, P = 0.5692). The mean age was 55.4 years (standard deviation (SD) = 12.5 years, range between 20 and 90 years). The median age was 55.5 years. The mean age for ACS group was 61.6 years, whereas the mean age for those with no ACS was 55.1 years. This 6.5-year difference was statistically significant (t = 3.657, df = 32.78, P = 0.0008864). The mean BMI was 26.8 (SD = 6.73, range between 14.06 and 96). The median BMI was 26.5. The mean BMI for IHD group was 27.7, whereas the mean BMI for those with no IHD was 26.7. This 1-unit difference was not statistically significant (W = 4278.5, P = 0.07137). In addition, albuminuria and gender were not associated with ACS. Furthermore, parameters like HbA1c, high-density lipoprotein (HDL), triglyceride and low-density cholesterol (LDL) were also not associated with ACS (Table 1).

Duration of DM

Out of the total 27 participants with ACS, 13 (prevalence = 11%) were living with DM for more than 20 years, seven (prevalence = 4.5%) were living with DM for 11 - 20 year, and

six (prevalence = 5%) were living with DM for 6 - 10 years, with one (prevalence = 1%) from the under 5 years' duration group getting the ACS. This association between the duration of DM and increased risk of ACS was statistically significant (X-squared = 11.129, df = 3, P = 0.01105).

Hypertension

Among the 27 participants with ACS, there were 19 with hypertension diagnosis (prevalence = 10.3%) and eight without (prevalence = 2.6%). This unadjusted association between hypertension diagnosis and increased risk of IHD was statistically significant (X-squared = 11.7694, df = 1, P = 0.0006021).

Smoking

Out of the total 27 participants with IHD, there were 11 with history of smoking (prevalence = 9.3%) and 15 without (prevalence = 4.6%). However, this association between history of smoking and increased risk of ACS was not statistically sig-

Table 2. Logistic Regression Analysis for Risk Factors of ACS

Factor/covariate	OR	Lower 95% CI	Upper 95% CI	P value
Male gender	0.5166922	0.1375752	1.6081059	0.25065
Age	1.0299497	0.9837644	1.0805835	0.18085
BMI	1.0320679	0.9500168	1.0827273	0.24934
Duration of DM	0.1751397	0.1802962	0.8354782	0.04051
Hypertension	2.4620328	1.006920	6.5000341	0.03916
Cholesterol	1.0037601	0.9932443	1.0114327	0.36075
HbA1c	0.9397261	0.7582192	1.1143376	0.47802
Triglycerides	0.9987686	0.9918043	1.0041398	0.65345
HDL	1.0041865	0.9737831	1.0289004	0.74243
LDL	1.0012480	0.9927317	1.0099615	0.75116
Smoking	2.4882621	0.7201396	9.6310948	0.13486
Albuminuria	1.0368389	0.3540358	2.7341348	0.94096

P values < 0.05 are considered significant; duration of DM and hypertension were absolute risk factors for ACS.

nificant (X-squared = 2.7523, df = 1, P = 0.09711).

Logistic regression analysis

Utilizing the full logistic regression model that adjusts for all risk factors for ACS simultaneously, this was significant for the variables of duration of DM (OR for below 5 years' history of DM = 0.175 (95% CI for OR: 0.180 - 0.835), P = 0.04051) and hypertension (OR = 2.462 (95% CI for OR: 1.007 - 6.500), P = 0.039) (Table 2).

Discussion

Khalil et al showed that coronary event rate for men and women was 112/100,000 in Khartoum in 1989 [14]. Khalil et al used the diagnostic and classification criteria of the World Health Organization Monitoring of Trends and Determinants in Cardiovascular Disease (MONICA) project. In Egypt, the overall prevalence of coronary heart disease was estimated to be 8.3% and this prevalence was thought to be higher in women (8.9%) relative to men (8.0%) [15]. The prevalence of ACS in Saudi Arabia was thought to be around 6% [16], while in Lebanon, this was estimated to be 13% [17]. Our study showed that the prevalence of ACS was 5.44% among individuals with DM. Hertz et al have summarized finding of studies (including a total of 92,378 in five different countries) in prevalence of ACS in sub-Saharan Africa (SSA), and their data showed that the prevalence of acute myocardial infarction ranged from 0.1% to 10.4% [18]. Despite such low prevalence of ACS in sub-Saharan Africa, Onen predicted an increase in prevalence of ACS by 2030 due to the rising prevalence of risk factors, especially hypertension, DM, overweight, obesity, physical inactivity, increased tobacco use and dyslipidemia. The possible estimation that age-standardized mortality rates for IHD will rise by 70% in African men and 74% in women by 2030 [19]. In Sudan, diagnosis of ACS among individuals with DM can

be associated with high risk of morbidity and mortality. For instance, among 67 individuals with DM who died in Hospital in Khartoum, 10% of death was attributed to myocardial infarction [20]. Onen and Hertz et al in their systematic reviews described the problem of insufficient population-based data and the need to establish registries for ACS using common diagnostic criteria. This is urgently needed in sub-Saharan Africa as this will help not only with establishing surveillance studies that capture the broad and diverse population with acute myocardial infarction, but also guiding prevention and treatment strategies for ACS [18, 19]. Therefore, one limitation of this study was that the diagnosis of ACS was reported by the patients during interview. This is unlikely to represent recall bias as diagnosis of ACS is major one and is unlikely to be forgotten or mixed with other condition.

The unadjusted risk factors for ACS in this study were age (P = 0.0008864), duration of DM (P = 0.01105) and presence of hypertension (P = 0.0006021). However, logistic regression analysis showed hypertension and duration of DM are absolute risk factors. Data from the Sudan Household Survey (SHHS) 2006 showed that the prevalence of heart disease in Sudan is around 2.5% (hypertensive heart disease (HHD), rheumatic heart disease (RHD), IHD and cardiomyopathy constitute more than 80% of cardiovascular disease (CVD) in Sudan). High prevalence of risk factors for CVD was also recorded. For instance, physical activity, obesity, hypertension, hypercholesterolemia, DM and smoking were estimated to be around 86.8%, 53.9%, 23.6%, 19.8%, 19.2% and 12%, respectively in the SHHS. Hypertension was associated with poor control and a high prevalence of target-organ damage [21]. High prevalence of hypertension in different regions and ethnic groups in Sudan was found to be high. For instance, in urban population in North of Sudan, the prevalence of hypertension was estimated to be more than 30% [22]. While in rural population, the prevalence was estimated to be 15-38% in Sudan [23, 24]. Importantly, the prevalence of hypertension in Nubia ethnic population in South of Sudan living in the North of Sudan was estimated to be around 50% [25].

Importantly, several studies indicated that DM emerged as a strikingly common correlate to hypertension [26-28]. In rural and urban areas in Sudan, hypertension was found to be significantly associated with diabetes [22, 23]. Hypertension will be a big challenge for health authorities, not only in Sudan but also in all countries in SSA [29, 30]. This is likely due to high prevalence of hypertension and the shared metabolic risk factors with DM. Therefore, it is important not to underestimate socio-economic implications. Strategies are urgently needed in Sudan to tackle the problems of under-diagnosis, low levels of control and need for tight blood pressure control, especially in individuals with DM.

In this study, duration of DM was also found to be an absolute risk factor for ACS. Awadalla et al have shown that majority of DM complications are associated with duration of DM and living in urban area [10]. Almobarak et al have shown duration of DM is also an absolute risk factor for DM foot ulceration [11]. Furthermore, duration of DM and hypertension were absolute risk factors for retinopathy in Sudan [12].

This study is not without limitations. The cross-sectional design may not allow for generalization of the results to the whole population. The role of genetic and nutritional factors and link with ACS were not investigated. Despite these limitations, this study is novel, important and pioneer in drawing attention of health professions and health policy makers to consider strategies to prevent mange and treat risk factors that lead to ACS.

Conclusion

The prevalence of ACS is estimated to be 5.44%. ACS in Sudanese individuals with DM was associated with hypertension, increase in age and increase in duration of DM. Treatment of hypertension and optimization of DM control are important and cost-effective ways for reducing the prevalence of ACS in individuals with DM and should be advocated by the health authorities and the public in Sudan.

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Conflict of Interest

There is no conflict of interest.

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