Open Peer Review on Qeios

Correlation Between HbA1c and Body Mass Index Among Patients with High Lipid Profile Attending Johns Hopkins Aramco Healthcare Hospital in Saudi Arabia

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Funding: No specific funding was received for this work.

Potential competing interests: No potential competing interests to declare.

Abstract

Background and Objectives: Dyslipidemia is a modifiable risk factor for cardiovascular diseases, diabetes, and stroke. The primary objective of this study was to examine the relationship between HbA1C and body mass index (BMI) among patients with high lipid profiles.

Methods: This retrospective, hospital-based study was conducted at Johns Hopkins Aramco Healthcare Facilities. Data were extracted from medical health records and included demographics, lipid profiles, and HBA1c measurements. The study included 2368 non-diabetic participants, and DATAtab was used to analyze the data.

Results: The participants were 57.05% male and 78.42% Saudi. The mean age was 41.48±12.1 years, and the mean body mass index (BMI) was 28.44±5.53. There was a statistically significant relationship between the use of lipid lowering medicine and HbA1c ($P<0.001$). There was a very weak positive but statistically significant relationship between HbA1c and BMI ($r = 0.18$, $P<0.001$). HbA1c and systolic blood pressure appeared to have a statistically significant positive association ($r = 0.16$, $P< 0.001$). There was no correlation between HbA1c and low-density lipoprotein cholesterol (LDL-C), total cholesterol (TC), or diastolic blood pressure. There was an inverse correlation between HbA1c and high-density lipoprotein cholesterol (HDL-C) ($r = -0.11$, $P< 0.001$). Regression was performed using a linear multivariable analysis with HbA1c as the dependent variable, and age (B 0.192, $P<0.001$), BMI (B 0.119, $P<0.001$), HDL (B -0.058, $P<0.005$), triglyceride (B 0.093, $P<0.001$), lipid-lowering medication (B 0.104, $P<0.001$), systolic BP (B 0.060, $P< 0.003$) as independent variables.

Conclusion: The results indicated that HbA1c is linked to BMI, age, systolic blood pressure, triglycerides, and HDL-C levels. There was no correlation between HbA1c and LDL-C, TC, and diastolic blood pressure.

Keywords: Lipid Profile, HbA1c, BMI, Cross-sectional, Triglyceride, Saudi Arabia.

Introduction

Elevated levels of total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and/or reduced levels of high-density lipoprotein cholesterol (HDL-C) are characteristics of the metabolic abnormality known as dyslipidaemia, which affects plasma lipids and lipoproteins. It is the main independent modifiable risk for cardiovascular disease (CVD), diabetes, and stroke and a leading source of morbidity and mortality [1][2][3][4][5]. Dyslipidemia causes 54% of the population's direct risk for myocardial infarction [6][7]. According to a study by the World Health Organization (WHO), high cholesterol levels cause 4.5% of worldwide deaths and 2% of disability-adjusted life years (DALYs) in people aged 18 years and over [8]. In a 2005 cross-sectional survey of the Saudi population aged 15-64 years, the prevalence of elevated total cholesterol was 20%, and the prevalence of dyslipidaemia ranged between 20 and 40% [9][10]. A study on the prevalence of dyslipidaemia among young people in all 13 districts of Saudi Arabia discovered that one in every four Saudi adolescents has dyslipidemia [11].

In patients with diabetes mellitus (DM), HbA1c predicts the likelihood of developing diabetic complications[12]. Elevated HbA1c is a risk factor for CVD and is distinct from conventional risk factors like dyslipidaemia. According to estimates, the chance of CVD increases by 18% in the diabetic population for every 1% increase in absolute HbA1c levels. Even within the normal range of HbA1c, non-diabetic cases have shown this positive association between HbA1c and CVD [12][13][14]. Body Mass Index (BMI) is a valuable population-level indicator of overweight and obesity [15]. Being overweight or obese can lead to a variety of chronic conditions. Besides, multiple studies have found that a high BMI has been connected to increased mortality and morbidity in the elderly [16][17]. Obesity is a risk factor for the development of cardiovascular disease, although research shows that much of this influence is accounted for by obesity triggering dyslipidemia, diabetes, hypertension, inflammation, and a procoagulant condition. [18][19]

Therefore, the main aim of this study was to identify the correlation between HbA1c and body mass index (BMI) among patients with a high lipid profile, as well as to evaluate the importance of HbA1c as an indicator. It displays important information about an individual's overall metabolic health. This study will help in decision making, provide a baseline for evaluation, and help to develop a plan for recruiting patients for prevention and lifestyle-management programs. Also, allowing for early risk assessment and diagnosis of diabetes among individuals with a high lipid profile.

Materials and Methods

Study Design, Settings, and Participants

This retrospective, hospital-based study was conducted at Johns Hopkins Aramco Healthcare Facilities. This facility treats approximately 153,000 employees of ARAMCO and JHAH and their dependents. The majority of the study population lived in the eastern region of Saudi Arabia in Dhahran, Al-Hasa, Ras Tanura, Abqaiq, and Udhailiyah. Eligible participants were had to meet one of the following requirements (all units are in mg/dl): TC ≥200, HDL-C <40 for men and <50 for women, LDL-C ≥ 100, TG ≥ 150, or age 20 years and over. Participants were excluded if they had been diagnosed by

health care as having diabetes, hypertension, asthma, or any chronic disease (participants must not have received a previous diagnosis of diabetes mellitus, hypertension, asthma, or any chronic condition from a healthcare provider) or if they were taking medication (an individual who is currently prescribed and actively taking a drug for the management of a disease) other than dyslipidaemia medications. The sample size was calculated using EPI Info software [20]. The sample was determined to be 1128 patients, with a margin of error of 5% and a design effect of 3, assuming an average anticipated prevalence of dyslipidemia of 43%.[10]

Data Extraction and Statistical Analysis

Data were extracted from medical health records (January 2022- September 2023). A data dictionary was used, and the following variables were included: HBA1c, age, sex, nationality, location, BMI, LDL-C, HDL-C, TC, TG, lipid lowering medication, blood pressure (BP) systolic, and BP (diastolic). All medical tests were performed on the same date. The data were validated by selecting 10% of the data randomly and comparing it with medical health records.

All incomplete or missing data were excluded from the analysis, and the remaining data were exported into a DATAtab (Graz, Austria). Descriptive analysis was carried out by computing frequencies and percentages for categorical variables and the mean and standard deviation for continuous variables. The normality assumption can hold; therefore, parametric tests were used. An independent t-test was used, as appropriate, to assess differences between groups. Pearson's correlation tests were performed to examine various correlations with the continuous outcome variable. Backward multivariate regression analysis was used to assess the impact of patient characteristics on HbA1c variations, with a significance level of $P < 0.05$.

Ethical Considerations

Ethical clearance was obtained from the JHAH Institutional Review Board (IRB# 23- 49) as specified by the World Medical Association and Declaration of Helsinki.

Results

The study included 2368 participants, including 660 (27.87%) aged 40-49 and 592 (25.1%) aged 30-39. The participants were 1351 (57.05%) male and 1857 (78.42%) Saudi. Regarding the BMI, the overweight group constitutes the highest group of participants; the overweight group has the most participants, 937 (39.5%). The mean age was 41.48±12.1 years, and the mean BMI was 28.44±5.53. Furthermore, 1625 (68.62%) of the study population were treated in Dharan, and 2195 (92.69%) were not taking lipid-lowering medications Table 1.

Table 1. Data distribution according to gender, Age, nationality, treatment location, BMI (Body Mass Index) and medication.

Variable	Subgroup	Frequency	Percentage
Gender	*Male*	*1351*	*57.05%*
	Female	*1017*	*42.95%*
Age Mean & SD (41.48 ± 12.11)	*20-29*	*468*	*19.76%*
	30-39	*592*	*25.1%*
	40-49	*660*	*27.87%*
	50-59	*486*	*20.52%*
	over 60	*162*	*6.84%*
Country of Nationality	*Saudi*	*1857*	*78.42%*
	non-Saudi	*511*	*21.58%*
Treatment Location	*Dharan*	*1625*	*68.62%*
	RT	*246*	*10.39%*
	Abgig	*218*	*9.21%*
	Alhasa	*184*	*7.77%*
	UD	*95*	*4.01%*
BMI Mean & SD (28.44±5.53)	*Underweight*	*25*	*1.06%*
	Healthy Weight	*613*	*25.89%*
	Overweight	*937*	*39.57%*
	class 1 obesity	*517*	*21.83%*
	class 2 obesity	*207*	*8.74%*
	class 3 obesity	*69*	*2.91%*
Is on lipid lowering Medications	*No*	*2195*	*92.69%*
	Yes	*173*	*7.31%*

The lipid profile and blood pressure are shown in Table 2.

Table 2. Data distribution according to, Hba1c (glycated haemoglobin), BP (blood pressure) and lipid profile (total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and/or reduced levels of high-density lipoprotein cholesterol (HDL-C)).

Variable	N	Mean	Std. Deviation
HbA1c (%)	*2368*	*5.37*	*0.61*
LDL-C (mg/dl)	*2368*	*127.46*	*27.86*
HDL-C (mg/dl)	*2368*	*52.5*	*14.5*
TC (mg/dl)	*2368*	*201.87*	*33.01*
TG (mg/dl)	*2368*	*109.33*	*56.87*
BP (mmHg) (Systolic)	*2368*	*121.54*	*13*
BP (mmHg) (Diastolic)	*2368*	*76.89*	*8.09*

The participant's country of origin and sex had no statistically significant relationship with HbA1c. There was a statistically significant relationship between the use of Lipid lowering-medication and HbA1c (P<0.001) (Table 3).

Table 3. Independent t test between HbA1c and country of origin, gender, and lipid lowering medication. P<0.05 was considered statistically significant.

	variables	Sub-variable	M± SD	P- Value
HbA1c	Country of origin	Saudi (1857)	5.37± 0.63	>0.667
		non-Saudi(511)	5.36± 0.52	
	Gender	Male (1351)	5.39± **0.53**	> 0.53
		Female (1017)	5.34± **0.7**	
	Lipid lowering Medication	Yes (173)	5.77± **0.87**	<0.001
		No (2195)	5.34 ± **0.57**	

HbA1c and BMI had a very weak positive relationship that was statistically significant (r=0.18, P<0.001). HbA1c and systolic blood pressure showed a statistically significant positive connection (r=0.16, P< 0.001). There was no correlation between HbA1c and LDL-C, TC, diastolic blood pressure, and LDL-C. There was an inverse correlation between HbA1c and HDL-C (r = -0.11, P< 0.001). There was a slight positive relationship between age and HbA1c, which was statistically significant (r= 0.26, P<0.001). Also, there was a weak but statistically significant positive relationship between HbA1c and TG (r=0.2, P<0.001) Table 4.

Table 4. Pearson's Correlation between HbA1c and age, BMI, LDL, HDL, TC, TG.
BMI (body mass index), HbA1c (glycated hemoglobin), BP (blood pressure) and lipid profile (total cholesterol (TC), triglycerides (TG), low-density lipoprotein cholesterol (LDL-C), and high-density lipoprotein cholesterol (HDL-C)). P<0.05 was considered statistically significant.

Variables	Correlation Coefficient	P- value
HbA1c and Age	0.26	<0.001
HbA1c and BMI	0.18	<0.001
HbA1c and LDL	0.03	>0.091
HbA1c and HDL	-0.11	<0.001
HbA1c and Total Cholesterol	0.05	<0.02
HbA1c and Triglycerides	0.2	<0.001
HbA1c and BP (Systolic)	0.16	<0.001
HbA1c and BP (Diastolic)	0.09	<0.001

Backward linear multivariate analysis with HbA1c as the dependent variable, and the age (B 0.192, P<0.001), BMI (B 0.119, P<0.001), HDL (B -0.058, P<0.005), Triglyceride (B 0.093, P<0.001), lipid lowering medication (B 0.104, P<0.001), systolic BP (B 0.060, P< 0.003), nationality (B -0.045, P<0.021) diastolic BP (P> 0.584), sex(B 0.007, P >0.308), LDL (B 0.018, P>0.961), cholesterol (B – 0.021, P>0.923) , and treatment location (B 0.001, P> 0.972) as all variables were significant determinant of HbA1c except for the sex, diastolic BP, cholesterol, and LDL Table 5.

Table 5. Backward multivariate analysis with HbA1c as the dependent variable
BMI (body mass index), HbA1c (glycated hemoglobin), BP (blood pressure) and lipid profile (total cholesterol (TC), triglycerides (TG), and high-density lipoprotein cholesterol (HDL-C). Model R2 = 0.127. P<0.05 was considered statistically significant. Note: age and BMI, a quantitative form was used in the analysis.

	Unadjusted B	Adjusted B	SE	P value	95%CI	
					Lower Bound	Upper Bound
Intercept		***4.252***	***0.136***	***<0.001***	***3.984***	***4.519***
HDL-C	***-0.002***	***-.058***	***0.001***	***<0.005***	***-0.004***	***-0.001***
TG	***0.002***	***.093***	***0.001***	***<0.001***	***0.001***	***0.001***
age	***0.010***	***.192***	***0.001***	***<0.001***	***0.008***	***0.012***
BMI	***0.013***	***.119***	***0.002***	***<0.001***	***0.009***	***0.017***
Lipid lowering medication	***0.242***	***.104***	***0.047***	***<0.001***	***0.151***	***0.336***
BP(systolic)	***0.003***	***.060***	***0.001***	***<0.003***	***0.001***	***0.005***
nationality	***-0.67***	***-0.045***	***0.029***	***<0.021***	***-0.125***	***-0.010***

Discussion

Understanding the association between HbA1c and BMI in hyperlipidemia is vital for evaluating cardiovascular risk and making treatment options that enhance overall metabolic health. Our findings showed that HbA1c is related to BMI, age, systolic blood pressure, triglycerides, and HDL-C levels. HbA1c had no correlation with LDL-C, TC, or diastolic blood

pressure.

There was a significant correlation between HbA1c and age, which is consistent with a previous study conducted by Alzahrani et al. [21]. Our results showed a significant positive relationship between HbA1c and TG, which is also in agreement with previous studies [21][22][23]. Hussain et al. provided support for our finding of an inverse connection between HbA1C and HDL-C [24].

However, our findings showed no correlation between HbA1c, LDL-C, and TC, which is in disagreement with previous studies that showed a significant correlation with HbA1c [12][25][26]. This difference could be due to the fact that the previous studies included patients with DM, whereas in this study, such patients were excluded. However, one other study stated that HbA1c had no significant correlation with the LDL-C and TC, which agrees with our results [21]. HbA1c has been linked to elevated TG levels, suggesting that it may predict CVD and is a risk factor in type 2 DM [21].

There was no significant relationship between HbA1c and sex. However, previous studies showed that females had significantly higher HbA1c compared to males [21][27][28]. The multivariable analysis found that non-Saudis have lower HbA1c than Saudis. This disparity could be attributed to the food culture. This conclusion contradicts the earlier study conducted by Alshahri et al. [29]. Our study found that 1% of participants were underweight, 25.8% were healthy, 39.5% were overweight, and 33.5% were obese. According to the KSAWHS survey, 39% of respondents had a normal BMI, whereas 3% were underweight, 38% were overweight, and 20% were obese. The normal weight was lower in our study, whereas the obese weight was higher. This could be attributable to age differences, as KSAWAHS comprises newborns, children, young adolescents, adults, and the elderly. [10]

There was a very slight positive relationship between the HbA1c and the BMI, which may indicate that high levels of HbA1c are related to a high BMI, leading to a higher risk of developing DM, CVD, and hypertension. This finding is supported by another study that also found that elevated levels of HbA1c and BMI are correlated and pose a risk of developing chronic diseases [30]. A Japanese study found a linear increase in HbA1c levels with increasing BMI[31]. In general, research has indicated that being overweight or obese increases the chances of being unable to achieve glycemic control [32].

A prior study discovered that dyslipidemia can cause obesity and that people with dyslipidemia are more likely to have hypertension [33][34]. Additionally, previous Saudi studies on adolescents found a significant frequency of unhealthy diets and sedentary lifestyles, which are likely to have an adverse effect on their health and wellbeing [35]. There was a very weak positive correlation between systolic and HbA1c. This means that higher levels of HbA1c could indicate higher levels of systolic blood pressure, which in turn increases the risk of hypertension.

Another study had similar results where high levels of systolic and diastolic blood pressure were associated with high levels of HbA1c [36]. Our study showed that individuals who are taking lipid-lowering therapy had lower HbA1c, which agrees with a previous study [37]. Our results also suggested that controlling the level of HbA1c will lower TG levels and increase HDL.

The key to preventing dyslipidemia is to promote moderate exercise and a healthy diet[38]. A health education and

promotion campaign would be very suitable for people with slightly HbA1c levels that are higher than normal. In addition, secondary prevention programs could be applied, such as screening for people aged 20 years and older, as well as high risk groups [39].

One of the limitations of this study was that it was a retrospective study. Furthermore, the results cannot be generalized for the population of Saudi Arabia. There was also no information on dietary choices, lifestyle behaviours, smoking, or the duration of regular physical exercise. However, the sample size was relatively large, and we eliminated selection and recall bias by retrieving information from medical records.

Conclusion

Dyslipidemia is a risk factor for many diseases, including CVD and diabetes. This study found a correlation between BMI, systolic blood pressure, age, and TG. The results also showed that as HDL-C increases, HbA1c decreases. In addition, patients who were taking lipid-lowering medication had significantly lower levels of HbA1c than those who were not taking it. Therefore, health promotion campaigns and secondary prevention programs to lower HbA1c levels are essential to reduce the risk of multiple morbidities associated with high levels of HbA1c.

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