High HbA1c in diabetes patients propelled by the synergetic impact of the sedentary profession and family history

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ABSTRACT

Aims/hypothesis: We investigated associations between family history and active lifestyle, separately and in combination, to diabetes indicators HbA1c, fasting blood sugar (FBS) and resting blood sugar (RBS).
Subjects and methods: This cross-sectional study comprised 532 patients, aged 22–88 years, with 53.4% women and 28% having a family history in diabetes. Information on lifestyle factors was obtained by questionnaire, and diabetes indicators through case sheets.
Results: The cohort with family history in diabetes had higher values of diabetes indicators, similarly the patients who led a less-active lifestyle had significantly higher values. The factors attributed significantly to the values of HbA1c, FBS and RBS. Among the 3, HbA1c had a higher impact of lifestyle, and its synergy along with family history amplified the impact. HbA1c values ranged from 6.8% to 9%, for patients with no history and relatively active lifestyle, to ones with family history and sedentary lifestyle, respectively.
Conclusions/interpretation: Our analysis suggested a synergetic impact of lifestyle and family history on diabetes patients. While both family history of diabetes and lifestyle risk factors had effects on type 2 diabetes, irrespective of sex, lifestyle attributed to more pronounced impact. Among the 2, lifestyle is a more manageable factor and can be improved with regular counselling, motivation, education, and awareness.

Key words: family history of diabetes, synergy, lifestyle, physical activity, sedentary lifestyle, diabetes

1. INTRODUCTION

Diabetes is among the top 10 causes for global mortality, which contributed to 6.7 million deaths in 2021. As per International Diabetes Federation, 537 million people were suffering from diabetes globally, and the numbers are expected to reach 643 million by 2030 (growing at a CAGR of 2.02% during the period 2021-2030).[1] It incurred a global healthcare expenditure worth USD 966 billion in 2021 and is estimated to reach more than USD 1 trillion by 2030.[2]

After China (141 million), India (74 million) has the second-highest number of diabetics worldwide. In India, there are an additional 40 million persons who have impaired glucose tolerance, which puts them at a high risk of becoming type 2 diabetes. The country has more than half (53.1%) of diabetics who are undiagnosed. Diabetes can result in serious and sometimes fatal consequences such heart attack, stroke, kidney failure, blindness, and lower limb amputation if it is not recognized or treated properly. [3]

It is categorized under metabolic disorder and is primarily propelled by unhealthy lifestyles, obesity, and genetics. Amalgamation of these factors tend to have a much worse impact on patients – implying that patients who have a family history of diabetes and are leading a sedentary lifestyle are much more vulnerable than the ones who try to maintain an active lifestyle.

According to prior research, family history of diabetes (FHD) has been found as a strong risk factor leading to early onset of the disease and increased risk of comorbidities such as hypertension and dyslipidemia. It was also found that 40–80% of the risk related to FHD was reduced, due to increased awareness and motivation to change lifestyles for mitigating risk.[4] On the other hand sedentary and unhealthy lifestyle along with FHD can serve as a strong headwind for diabetes prevention or cure. Long periods of inactivity can alter the body's metabolism, including the development of insulin resistance, which can result in Type 2 diabetes. This fact is not only applicable on adults but also on adolescents – a study discovered that teenagers with low levels of physical activity and high levels of sedentary behavior had a 69% higher risk of acquiring diabetes than those with low levels of sedentary behavior.[5]

In order to investigate the relationship between family history and lifestyle on diabetic patients, we conducted a cross-sectional study based on the representative T2DM population in regions of Punjab.

2. METHOD

2.1. Study Design and Population

Using a standardized questionnaire, a survey (on T2DM patients) was undertaken in five regional hospitals of Punjab, including first referral units, district hospitals, and private hospitals serving patients from wide geographic areas. The study primarily aimed at exploring the impact of counselling on patients to control their diabetes level and severity.

All eligible T2DM patients who visited the hospital were included in our sample. It also included patients from neighboring states Himachal Pradesh, J&K, and Uttarakhand who had been referred. The World Health Organization (WHO) standards from 1999 were used to make the diabetes diagnosis.[6] Without sex or ethnic restrictions, a total of 532 patients were polled. Participants that didn't provide crucial details like age, height, weight, biomarker information, etc. were eliminated.

2.2. Data Collection

The questionnaire was filled by diabetes patients who visited the OPD, after thorough written consent. The basic questions revolved around their demographics, family history in diabetes, lifestyle and habits, and the biomarker data (FS, RBS, HbA1c, HDL, LDL and TG) was captured through their case sheets.

The data for 532 patients (53.4% female and 46.6% male) was collected (January 2021- June 2021), with majority (~77%) of the patients falling under the age of 60 years, 12% under the age of 40 years and 7.2% patients above 70 years. Average age of sample was 51.85 years (M =51.85, SD = 11.23). No significant difference was reported in the age or weight of the two genders. The patients who did not give consent, minors (<18 years of age), pregnant/lactating mothers, and mentally unfit patients were not included in the study.

According to a standard protocol, body weight was measured in kilograms, FBS and RBS was measured in mg/dl, and HbA1c in mmol/mol and percent (percentage of total haemoglobin).

2.3. Assessments of physical activity and sedentary behavior

The survey tool (questionnaire) had questions related to occupation type and duration of physical activity. Based on the inputs, the patients were categorized into sedentary, moderate, or physically active lifestyle. We used qualitative assessment to classify the patients into these 3 categories – patients with desk jobs such as banker, office person, shopkeeper, etc. who exercised < 15 minutes a day fell under sedentary lifestyle; patients with desk jobs or with moderate movement and <30 minutes of exercise into moderate category; and patients such as laborers, farmers, gardeners etc. as heavy workers, who typically had an active routine for >1 hour. Adults are advised to engage in at least 150-300 minutes per week of moderate-intensity physical activity, at least 75-150 minutes per week of vigorous intensity physical activity, or at least 150 minutes per week of MVPA (moderate-to-vigorous-intensity physical activity) according to the WHO 2020 guidelines on physical activity.[6]

2.4. Dependent Variables

The biomarkers data related to diabetes – fasting blood sugar, resting blood sugar and HbA1c were assessed relative to the factors – FHD and lifestyle. The idea was to analyze any causal relationship among the dependent and independent variables (FHD and lifestyle). According to the Standards of diabetes for type 2 diabetes as per American Diabetes Association 2022, the control targets for these three indicators are as follows: HbA1c <6.5% (48 mmol/mol); FBS <126 mg/dL; RBS <200 mg/dL.[8]

2.5. Statistical Analysis

The characteristics of the study sample are presented as the means ± standard deviations (SDs). Normality of the sample for analyzed using Kolmogorov- Smirnov and Shapiro-Wilk. The confidence interval for the study was set at 95%. For group comparisons, an independent sample t test (FHD) and one-way analysis of variance (ANOVA for lifestyle) were used for normally distributed continuous variables. Univariate analysis was conducted (to expand on one way ANOVA) to determine the impact (partial eta squared) of independent variable on dependent one. Conducted regression analysis using categorial independent variable to determine the causal impact on dependent variables (such as Hb1AC). SPSS version 26.0 was used for the statistical analysis (SPSS Inc., USA). Statistical significance was defined as two-sided P values less than 0.05.

3. RESULTS

3.1. Baseline Characteristics

The baseline characteristics of the study sample are provided in Table 1,2,3. Overall, the participants had a mean ± SD age of (51.85 ± 11.23) years; mean ± SD weight of (78.14 ± 10.5); 53.4% were women.

Table 1. Baseline characteristics of age

	N	Minimum	Maximum	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Age of the patient	532	22	88	51.85	11.232	.296	.106	.244	.211

Table 2. Baseline Characteristics of weight

	N	Mean	Std. Deviation	Skewness		Kurtosis	
	Statistic	Statistic	Statistic	Statistic	Std. Error	Statistic	Std. Error
Weight of the patient	532	78.14	10.508	.195	.106	.047	.211

Table 3. Group Characteristics

	Gender of the patient	N	Mean	Std. Deviation	Std. Error Mean
Age of the patient	Male	248	51.35	11.251	.714
	Female	284	52.29	11.216	.666
Weight of the patient	Male	248	78.35	9.844	.625
	Female	284	77.96	11.070	.657

3.2. Associations between FHD and diabetes parameters

Average HbA1c of patients who did not have any family history of diabetes was 1.2% less (7% compared to 8.24%) than the ones who had history. There was a significant difference in HbA1c for the patient samples having and not having FHD ($p<0.05$). Likewise, the difference in the 2 cohorts was applicable both for FBS and RBS. In the former there was a significant ($p<0.05$) mean difference of 4.8 mg/dl, wherein patients with FHD had a higher average FBS of 278.2 mg/dl. In the latter, the significant mean difference was 5.6 mg/dl, wherein FHD patients reported average RBS of 322 mg/dl. (Table 4)

Table 4. **Difference in HbA1c, FBS and RBS for patients with FHD and without FHD**

	Levene's Test for Equality of Variances		t-test for Equality of Means						
								95% Confidence Interval of the Difference	
	F	Sig.	t	df	Sig. (2-tailed)	Mean Difference	Std. Error Difference	Lower	Upper
HbA1c	27.634	.000	-14.247	530	.000	-1.20393	.08451	-1.36994	-1.03792
Fasting Blood Sugar	7.563	.006	-3.460	530	.001	-4.83929	1.39880	-7.58717	-2.09140
Resting Blood Sugar	7.342	.007	-3.441	530	.001	-5.60357	1.62859	-8.80285	-2.40429

3.3. Associations between lifestyle and diabetes parameters

Among the 3 categories of participants (ones having sedentary lifestyle, moderate and heavy) the values of HbA1c, FBS and RBS were measurably higher than moderate worker followed by heavy worker. (Figure 1,2,3)

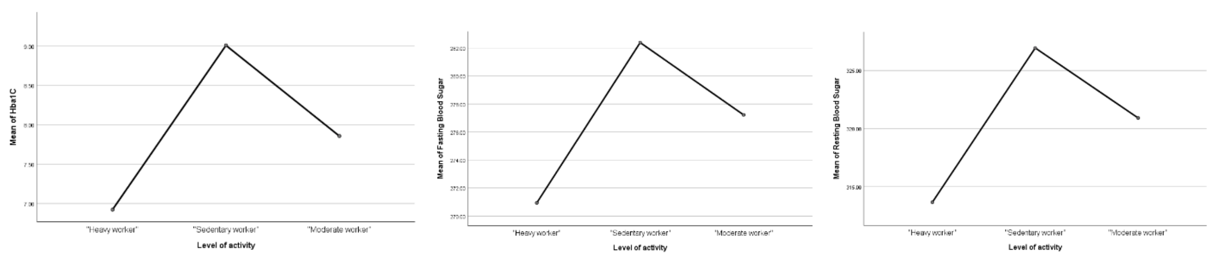


Figure 1,2,3 (Mean of HbA1c, FBS and RBS respectively vs level of activity)

The mean difference for HbA1c, FBS and RBS was significant among the 3 groups ($p<0.005$). For the 3-diabetes metrics, lifestyle had a significant impact on HbA1c – attribution of 86.2% (based on partial eta squared). For FBS and RBS the attribution of lifestyle was 12.6%, lesser than HbA1c but significant enough to drive the difference.

Table 5. **Attribution of Lifestyle on HbA1c**

HbA1c ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	399.099	2	199.549	1656.431	.000

Dependent Variable: HbA1c

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	399.099[a]	2	199.549	1656.431	.000	.862
Intercept	33204.731	1	33204.731	275627.567	.000	.998
Lifestyle	399.099	2	199.549	1656.431	.000	**.862**
Error	63.728	529	.120			
Total	34469.240	532				
Corrected Total	462.827	531				

a. R Squared = .862 (Adjusted R Squared = .862)

Table 6. **Attribution of Lifestyle on FBS**

FBS ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	11859.712	2	5929.856	38.299	.000

Dependent Variable: Fasting Blood Sugar (FBS)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	11859.712[a]	2	5929.856	38.299	.000	.126
Intercept	40488958.408	1	40488958.408	261503.068	.000	.998
Lifestyle	11859.712	2	5929.856	38.299	.000	.126
Error	81905.957	529	154.832			
Total	40971230.000	532				
Corrected Total	93765.669	531				

a. R Squared = .126 (Adjusted R Squared = .123)

Table 7. **Attribution of Lifestyle on RBS**

RBS ANOVA	Sum of Squares	df	Mean Square	F	Sig.
Between Groups	15954.090	2	7977.045	37.977	.000

Dependent Variable: Resting Blood Sugar (RBS)

Source	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Corrected Model	15954.090[a]	2	7977.045	37.977	.000	.126
Intercept	54264513.169	1	54264513.169	258339.164	.000	.998
Lifestyle	15954.090	2	7977.045	37.977	.000	**.126**
Error	111117.211	529	210.051			
Total	54912788.000	532				
Corrected Total	127071.301	531				

a. R Squared = .126 (Adjusted R Squared = .122)

3.4. Regression analysis

The regression model for determining mean HbA1c (which is highly impacted) with the independent variables of FHD and lifestyle is:

Eq.1. *HbA1c = 0.179*(FHD) + 1.994*(Sedentary lifestyle) + 0.861*(Moderate lifestyle) + 6.837*

This implies for a person without FHD, and healthy lifestyle has average HbA1c at ~6.8%; with FHD and sedentary lifestyle it is ~9%, with FHD and moderate lifestyle it is ~7.9%; and with FHD and healthy lifestyle it is ~7%.
The model clearly depicts the impact of lifestyle and FHD on HbA1c.

Table 8. **Regression model**

Model	R	R Square	Adjusted R Square	Std. Error of the Estimate
	.931[a]	.867	.866	.34197

a. Predictors: (Constant), Lifestyle=""Moderate worker"", History=""Yes"", Lifestyle=""Sedentary worker""

Model		Unstandardized Coefficients		Standardized Coefficients		
		B	Std. Error	Beta	t	Sig.
1	(Constant)	6.837	.033		205.102	.000
	History="Yes"	.179	.043	.078	4.117	.000
	Lifestyle="Sedentary worker"	1.994	.042	1.035	46.933	.000
	Lifestyle="Moderate worker"	.861	.042	.429	20.691	.000

a. Dependent Variable: HbA1c

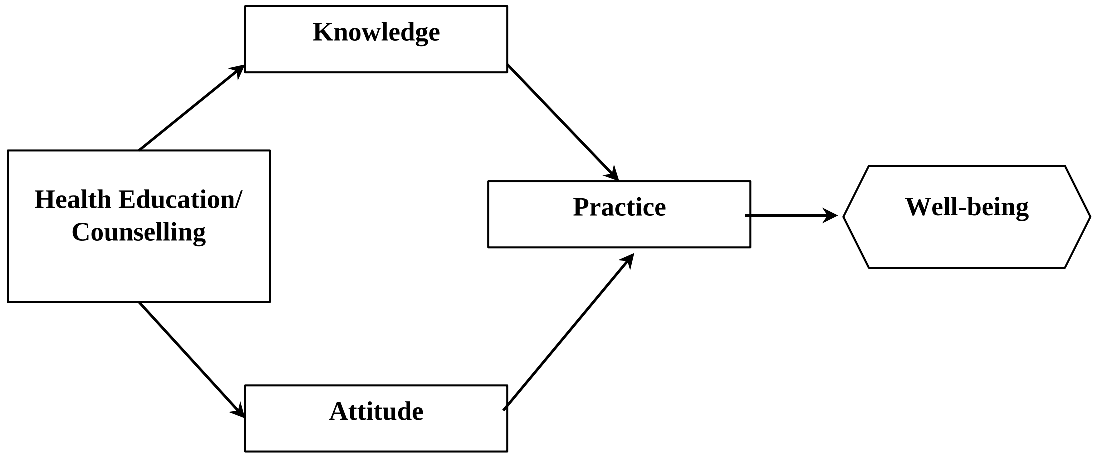
4. DISCUSSIONS

The aim of the study was to investigate the relationship between family history and lifestyle on diabetic patients. Based on the statistical results it was validated that patients with family history and/or less active lifestyle had higher values for HbA1c, FBS and RBS, compared to others. Patients who had a family history in diabetes reported higher HbA1c, FBS and RBS with a difference of 1.2%, 4.8 mg/dl and 5.6 mg/dl, respectively.

Similarly, the patients who had a less active lifestyle reported higher values of diabetes indicators. Attribution of lifestyle on HbA1c, FBS and RBS was 86.2%, 12.6% and 12.6%, respectively. Although the difference in mean HbA1c, FBS and RBS was significant among the 3 categories (sedentary lifestyle, moderate lifestyle and active lifestyle), the level of elasticity was highest in HbA1c. HbA1c had a synergistic impact of FHD and lifestyle. The robust regression model (with 86.6% fit) for HbA1c presented a range of [6.8%, 9%], for patients without FHD and active lifestyle, to ones with FHD and sedentary lifestyle.

5. CONCLUSION

The analysis clearly defined the ill impact of family history and inactive lifestyle on diabetes patients. While, the parameter of family history is not modifiable, the lifestyle factor, which has high attribution, can be managed, and controlled. The ‘type of lifestyle’ attributed ~86% to HbA1c, implying that even slow yet consistent change in lifestyle (level of physical activity) can bring a huge impact. One of the key roles to play will be of the healthcare authority and HCP to educate patients on this aspect and motivate them to lead to a physically active lifestyle. As witnessed, a simple change in lifestyle can prevent and protect people from life threatening disease, a robust approach to aware the patients and persuade them to work on their physical well-being can bring a large change in population. Patients need to be counselled on 3 aspects knowledge, attitude, and practice to alleviate the impact of diabetes.



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