

The Impact of High BMI on Cholesterol Levels and Type-2 Diabetes Control. A Cross-Sectional Study

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ABSTRACT

Background: Higher levels of BMI have closed relationship with hypercholesterolemia and glycated hemoglobin (HbA1c) in the population with type 2 diabetes.

Study Design: Present research was a Cross-Sectional Study.

Methodology: Current study was conducted at Lahore General Hospital, Jinnah hospital Lahore and Diabetes Endocrine Metabolic Centre (DEMC) from March 2023 to February 2024. A retrospective Cross-Sectional analysis of 800 patients was considered and correlation between BMI, HbA1c and hypercholesterolemia was noted. The Underweight, Normal, Overweight, Obesity Class 1, Obesity Class 2, and Obesity Class 3 were the six categories based on BMI. One could classify HbA1c as controlled or uncontrolled. One could take cholesterol as controlled or uncontrolled.

Results: For above 500 patients, 25 percent had normal weight, 30.1% were overweight, and 35 percent were obese. Class 1 had a 25.8% obesity rate, Class 2 had a 40% obesity rate, and Class 3 had a 42 % obesity rate. Both sexes showed similar levels of obesity, HbA1c, and cholesterol control. Whereas 32.26% of patients had a controlled HbA1c. Of them, 7.8% had normal weight, 11.8% were overweight, and 0.98% were underweight. In this class, 11.8% of the patients were obese. Class 1 obesity rates were 6.2%, Class 2 obesity rates were 4.3%, and Class 3 obesity rates were 1.2%. 1.9% of patients with uncontrolled HbA1c levels were underweight, 18.2% were of normal weight, 22.1% were overweight, and 26.3% were obese out of 67.74% of patients. Class 1 obesity rates were 18.7%, Class 2 obesity rates were 6.3%, and Class 3 obesity rates were 1.4%.

Conclusion: The findings of present study were showed that BMI has close relationship with HbA1c. And hypercholesterolemia. High levels of BMI had poor glycemic and Cholesterol control.

Keywords: Glycosylated hemoglobin, Hypercholesterolemia, Body mass index, Glycemic Index. Diabetes Type-2.



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INTRODUCTION

The incidence of diabetes mellitus in Pakistan has surged significantly from 15% in 2020 to over 38% in recent times, primarily due to alterations in lifestyle. One

extremely common metabolic illness is diabetes mellitus[5]. It was first believed to be an illness associated with wealth[8]. The existence in developing nations, however, runs counter to this theory. It is now known that lifestyle changes are crucial to controlling it, and that it can

affect both the rich and the poor equally. About 12 million people in Pakistan are thought to be pre-diabetic, and about 29 million people have diabetes. The number of people with obesity-related diabetes is rising as a result of the adoption of Western diets heavy in fat and refined carbohydrates, as well as the spread of sedentary lifestyles[9].

The Patients with Type 2 diabetes are frequently noted to be overweight or obese. According to the pathology of Type 2, an increase in weight causes a corresponding increase in endogenous insulin resistance[12]. While there are many other variables at play, one of the most significant ones is an elevated Body Mass Index (BMI). In Pakistan, diabetes is the most prevalent non-communicable disease. As a result, its effects on rates of morbidity, risk of atherosclerosis, hypertension, and dyslipidemia are growing. Diabetes is harder to manage when a person is obese. Glycosylated hemoglobin can provide an accurate measure of control (HbA1c). For the life of a red blood cell, high blood sugar levels cause hemoglobin to become irreversibly glycosylated[14].

The American Diabetes Association (ADA) states that pre-diabetic patients may be diagnosed with glycated hemoglobin (HbA1c) levels between 6.7% and 8.4%, but a level of $\geq 7.5\%$ is advised for the diagnosis of diabetes[8]. The small intra-individual variability of the HbA1c level, which is a reflection of the average plasma glucose for the preceding two to three months, as well as the assessment's feasibility without the requirement for fasting, are factors that support its use in the diagnosis and monitoring of diabetes mellitus[17]. However, because the HbA1c test has a lower sensitivity in some patient groups (like sickle cell anemia) or in some populations (like the Asian population), it should be used cautiously[19].

Patients with diabetes have an increased risk of developing dyslipidemia, also known as atherogenic dyslipidemia, which is linked to microvascular disorders like neuropathy and nephropathy as well as macrovascular disorders like heart disease and stroke[20]. These conflicting results underlined the need for additional research on the relationship between diabetic patients' lipid profiles and HbA1c. In order to better understand the relationship between HbA1c and the lipid profile in a sizable group of type-2 diabetes mellitus patients, present study was conducted[21]. Diabetes raises the possibility of numerous problems that can lower one's quality of life. They all lead to an increase in atherogenicity[22].

In this study, we sought to determine how BMI related to hypercholesterolemia and glycated hemoglobin (HbA1c) in our institution.

MATERIALS AND METHODS

Monitor the association between BMI hypercholesterolemia and glycated hemoglobin (HbA1c)

in the population with type 2 diabetes. Current research was a Cross-Sectional Study. Age limit was in between 25 to 60 years. All patients were type-2 with high levels of diabetes mellitus and hypercholesterolemia. BMI used to classify someone as overweight or obese, usually 25 kg/m^2 and above, in order to investigate the effects of high BMI. Individuals who have been taking Type-2 diabetes medications steadily for a predetermined amount of time. To concentrate the study on Type-2 diabetes, people with Type-1 diabetes are not included. Individuals who have had major surgery recently for example, within the last six months may have different medication regimens or metabolic states. Because pregnancy alters metabolic and hormonal profiles that may impact cholesterol and diabetes management, pregnant women are not allowed to participate. Individuals who, in order to prevent confounding effects, changed their cholesterol or diabetes medication within a certain time frame prior to the study. Those who have a history of alcohol or drug misuse, as this may affect the study's guidelines or adherence. Current study was conducted at Lahore General Hospital, Jinnah hospital Lahore and Diabetes Endocrine Metabolic Centre (DEMC) from March 2023 to February 2024. A retrospective Cross-Sectional analysis of 800 patients was considered and correlation between BMI, HbA1c and hypercholesterolemia was noted. The Underweight, Normal, Overweight, Obesity Class 1, Obesity Class 2, and Obesity Class 3 were the six categories based on BMI. One could classify HbA1c as controlled or uncontrolled. One could take cholesterol as controlled or uncontrolled. Dependent and Variables Independent Variables were presented through various statistical techniques, such as mixed models, survival analysis, and regression analysis, can be used, depending on the study design and the type of data. Means Standard deviation (Mean $\pm$ SD) and Significant ($p < 0.05$) were considered respectively.

RESULTS

For above 500 patients, 25 percent had normal weight, 30.1% were overweight, and 35 percent were obese. Class 1 had a 25.8% obesity rate, Class 2 had a 40% obesity rate, and Class 3 had a 42 % obesity rate. Both sexes showed similar levels of obesity, HbA1c, and cholesterol control. Whereas 32.26% of patients had a controlled HbA1c. Of them, 7.8% had normal weight, 11.8% were overweight, and 0.98% were underweight. In this class, 11.8% of the patients were obese. Class 1 obesity rates were 6.2%, Class 2 obesity rates were 4.3%, and Class 3 obesity rates were 1.2%. 1.9% of patients with uncontrolled HbA1c levels were underweight, 18.2% were of normal weight, 22.1% were overweight, and 26.3% were obese out of 67.74% of patients. Class 1 obesity rates were 18.7%, Class 2 obesity rates were 6.3%, and Class 3 obesity rates were 1.4%.

Table 1: Gender variations regarding their BMI

Parameters	U. W	19->25 control	26-30 O.W	31-35 C-1 Ob	35.1-40 C-2 Ob	>40 C-3 Ob	Collective
Men	10	50	100	50	60	30	300
Women	10	50	50	41	34	15	200

Table 2: Individuals with Controlled HbA1c levels

Parameters	Women	Men	Mean $\pm$ SD
U.W	3.9	4	7.9 $\pm$ 0.01
Control	50	50	100.01 $\pm$ 0.01
O.W	100	50	150.01 $\pm$ 0.03
C-1 Ob	50	41	91.01 $\pm$ 0.01
C-2 Ob	60	34	94.01 $\pm$ 0.02
C-3 Ob	30	15	45.01 $\pm$ 0.01

(p<0.05)

Table 5: Patients with Uncontrolled Cholesterol levels

Parameters	Women	Men	Mean $\pm$ SD
U.W	2	7	9.01 $\pm$ 0.01
Control	40	48	88.01 $\pm$ 0.03
O.W	40	89	139.01 $\pm$ 0.01
C-1 Ob	30	49	79.01 $\pm$ 0.01
C-2 Ob	30	48	78.01 $\pm$ 0.02
C-3 Ob	10	20	30.01 $\pm$ 0.01

(p<0.05)

Table 3: Patients with uncontrolled HbA1c

Parameters	Women	Men	Mean $\pm$ SD
U.W	8	8	16.01 $\pm$ 0.01
Control	40	48	88.01 $\pm$ 0.03
O.W	50	99	149.01 $\pm$ 0.04
C-1 Ob	40	50	90.01 $\pm$ 0.01
C-2 Ob	33	58	88.01 $\pm$ 0.02
C-3 Ob	15	30	45.01 $\pm$ 0.01

(p<0.05)

Table 4: Patients with Controlled Cholesterol levels

Parameters	Women	Men	Mean $\pm$ SD
U.W	9	10	19.01 $\pm$ 0.01
Control	47	48	95.01 $\pm$ 0.03
O.W	48	89	137.01 $\pm$ 0.04
C-1 Ob	40	40	80.01 $\pm$ 0.01
C-2 Ob	32	50	82.01 $\pm$ 0.02
C-3 Ob	14	27	41.01 $\pm$ 0.01

(p<0.05)

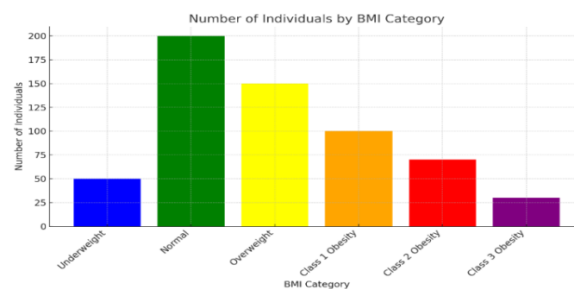


Figure 1: This graph showing the number of individuals by BMI category, ranging from Underweight to Class 3 Obesity. Each category is represented with a different color, illustrating a hypothetical distribution of individuals across various BMI classifications. This visualization could be analogous to categorizing participants in a study related to weight status and its impact on health outcomes, such as cholesterol levels and Type-2 diabetes control.

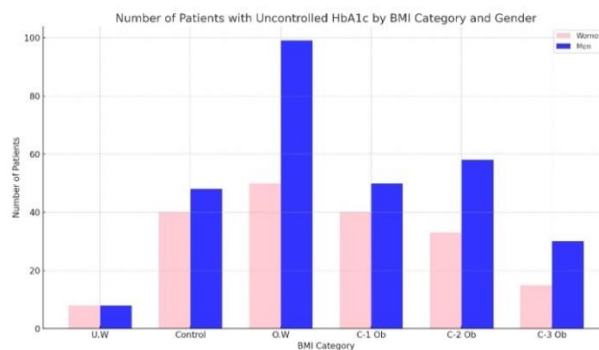


Figure 2: The graph illustrating the number of patients with uncontrolled HbA1c, broken down by BMI category and gender. The categories range from Underweight (U.W) to Class 3 Obesity (C-3 Ob), with separate bars for women (in pink) and men (in blue). This visualization helps highlight differences in the distribution of uncontrolled HbA1c across both BMI categories and genders

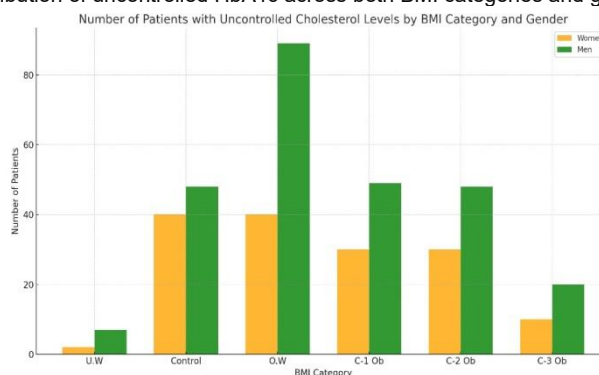


Figure 3: The color scheme for the graph depicting the number of patients with uncontrolled cholesterol levels by BMI category and gender. Women are now represented in orange, and men in green. This change in color scheme helps to differentiate the data visually while maintaining the same informative layout

DISCUSSION

A study that combined data from five Spanish observational studies was published. The goal was to determine the cardiovascular risk factors in patients with varying BMI groups, as well as how the patient's age and HbA1c sugar control correlated[1, 2]. They provided evidence that diabetes control is not influenced by BMI. For other cardiovascular risk factors, such as hypertension and hypertriglyceridemia, it was not the case. They recommended strict management of obesity, dyslipidemia, and hypertension in young diabetic patients. These outcomes differed from what our investigation revealed[3, 4]. Regarding the various BMI classes, controlled and uncontrolled HbA1c, and total cholesterol levels, there was no discernible sex difference. Nonetheless, the bulk of patients had high BM and were in the obesity group[6, 7].

Patients with Type 1 obesity made up the majority of these. Patients who were overweight came after it. The majority had uncontrolled cholesterol and an uncontrolled HbA1c[10, 11]. It implies that poor control of HbA1c and cholesterol in our population is directly correlated with high BMI. A review article by several researchers provided evidence that lowering cholesterol led to a decline in cardiovascular events[13]. They also found a significant level of cholesterol and showed that the

risk of developing cardiovascular disease increased as levels rose over time. Both primary and secondary prevention have documented the effect of reduction. There were several ways in which this study differed from ours. First, the associated cardiovascular risks were not calculated[15, 16].

Secondly, our study was retrospective in nature and did not evaluate the relationship between elevated cholesterol and an increase in cardiac events[18].

Secondly, our study was retrospective in nature and did not evaluate the relationship between elevated cholesterol and an increase in cardiac events [18]. We did, however, record a clear correlation between poor cholesterol and both high body mass index and inadequate diabetic control. There were numerous ways in which this study differed from ours. We measured total cholesterol levels only (not fragments) in 500 patients with dyslipidemia. We computed the cholesterol control using the ATP III recommendation [23]. It was found that the majority of patients in the overweight group had low cholesterol. Patients who were obese came after it. There were more patients in the Class 1 group of obesity than in the Class 2 and 3 groups. Additionally, it was noted that a sizable portion of patients with uncontrolled cholesterol had normal BMIs. The HbA1c control showed comparable findings.

CONCLUSION

The study concludes that high BMI is closely associated with poor control of HbA1c and cholesterol levels, highlighting the need for integrated management strategies for patients with Type-2 diabetes and high BMI to mitigate cardiovascular risk factors.

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Authors Contribution: Every author contributed equally and sincerely in the current research.

REFERENCES

1. Bener A, Zirir M, Al-Rikabi A. Genetics, obesity and environmental risk factors associated with type 2 diabetes. *Croat Med J*. 2005;46(2):302–7.
2. Liu H, Liu J, Liu J, Xin S, Lyu Z, Fu X. Triglyceride to high-density lipoprotein cholesterol ratio as predictor of type 2 diabetes in older adults. *Front Endocrinol*. 2022;13:828581.
3. Khil J, Kim SM, Chang J, Choi S, Lee G, Son JS, et al. Changes in total cholesterol and cardiovascular risk in type 2 diabetes patients. *Sci Rep*. 2023;13:8342.
4. Riaz M, Qazi AMQ, Syed SA, Chaudhary AK. Hepatoprotective effects of Glycyrrhiz glabra and Cicorium intybus in paracetamol toxicity. *Dev Med Life Sci*. 2024;1(1).
5. Gutierrez MJ, Rosenberg NL, MacDougall DE, Hanselman JC, Margulies JR, Strange P, et al. Efficacy and safety of ETC-1002 in hypercholesterolemia and type 2 diabetes. *Arterioscler Thromb Vasc Biol*. 2014;34(3):676–83.
6. Kim MK, Han K, Joung HN, Baek KH, Song KH, Kwon HS. Cholesterol and cardiovascular disease in Koreans with type 2 diabetes. *Cardiovasc Diabetol*. 2019;18:1–11.
7. Hussain R, Umar M, Shuja M, Khowaja S, Jabeen S, Shah SSA. Effect of ibuprofen on muscle hypertrophy and soreness. *Pak J Med Health Sci*. 2023;17(5):471.
8. Wang JS, Lo SH, Yeh YP, Hwu CM, Huang CN, Hsieh CH, et al. Self-monitoring of blood glucose in early vs. long-term type 2 diabetes. *Int J Clin Pract*. 2021;75(9):e14410.
9. Rahmy AF, Afifi WM, Ghorab AA, Mostafa HA. Aerobic exercise and kidney function in CKD patients. *J Egypt Soc Nephrol Transplant*. 2016;16(3):97–105.
10. Jende JM, Groener JB, Rother C, Kender Z, Hahn A, Hilgenfeld T, et al. Serum cholesterol and peripheral nerve damage in type 2 diabetes. *JAMA Netw Open*. 2019;2(5):e194798.
11. Rashid M, Shahbaz MN, Akram A, Anwar A, Umar M, Ali MS, et al. Treatment of inflammatory breast disease in tertiary units. *Dev Med Life Sci*. 2024;1(1).
12. Adediji TA. Risk factors for overweight and obesity in college students. *Howard Univ*; 2017.
13. Russo G, Pintaudi B, Giorda C, Lucisano G, Nicolucci A, Cristofaro MR, et al. LDL-cholesterol management differences in type 2 diabetes. *Int J Endocrinol*. 2015;2015.
14. Jaber AAF. Physical activity and cognitive function in early Alzheimer's disease. *Univ Kansas*; 2010.
15. Fu Q, Zhang Z, Hu W, Yang Y. TG/HDL-C ratio and muscle mass in type 2 diabetes. *BMC Endocr Disord*. 2023;23:93.
16. Chen L, Pei JH, Kuang J, Chen HM, Chen Z, Li ZW, et al. Lifestyle intervention in type 2 diabetes: meta-analysis. *Metabolism*. 2015;64(2):338–47.
17. Praveen EP, Kulshreshtha B, Khurana ML, Sahoo J, Gupta N, Kumar G, et al. Low HDL in offspring of type 2 diabetes patients. *Hormones (Athens)*. 2011;10:57–66.
18. Lotta LA, Sharp SJ, Burgess S, Perry JR, Stewart ID, Willems SM, et al. LDL-lowering variants and type 2 diabetes risk. *JAMA*. 2016;316(13):1383–91.
19. Li K, Cao B, Wang X, Chai T, Ke J, Zhao D. Sex differences in BMI–LDL-C association in type 2 diabetes. *Front Endocrinol*. 2023;14:1180012.
20. Liu H, Yan S, Chen G, Li B, Zhao L, Wang Y, et al. TG/HDL-C ratio and type 2 diabetes risk. *J Diabetes Res*. 2021;2021.
21. Youk TM, Kang MJ, Song SO, Park EC. BMI and LDL-cholesterol change patterns and cardiovascular disease. *BMJ Open Diabetes Res Care*. 2020;8(2):e001340.
22. Cheng C, Liu Y, Sun X, Yin Z, Li H, Zhang M, et al. TG/HDL-C ratio and type 2 diabetes risk. *J Diabetes*. 2019;11(3):183–92.
23. Franz MJ, Boucher JL, Rutten-Ramos S, VanWormer JJ. Lifestyle weight-loss interventions in type 2 diabetes. *J Acad Nutr Diet*. 2015;115(9):1447–63.

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