Journal of Health and Rehabilitation Research 2791-156X JHRR

For contributions to JHRR, contact at email: editor@jhrlmc.com

Original Article

Screening of Prediabetic Patients by using HbA1c in District Narowal Pakistan

Kashaf Fazal Kaream[1], Saima Ashraf[1]*, Muhammad Awais[1], Asad Shabbir[1], Faiqa Irshad[1], Hanna Ehsan[1]

[1]University of Sialkot.

*Corresponding Author: Saima Ashraf; Email: saima.ashraf@uskt.edu.pk

Conflict of Interest: None.

Kaream KF., et al. (2024). 4(1): DOI: https://doi.org/10.61919/jhrr.v4i1.291

ABSTRACT

Background: Background: The prevalence of prediabetes is on the rise globally, with lifestyle factors and obesity being key contributors to the development of the condition. Studies have consistently shown a link between higher Body Mass Index (BMI) and an increased risk of progressing from prediabetes to type 2 diabetes mellitus (T2DM).

Objective: This study aimed to determine the prevalence of prediabetes and its association with BMI and lifestyle factors in District Narowal, Pakistan.

Methods: A cross-sectional study was conducted with 200 participants from District Narowal. HbA1c levels were measured to classify participants into non-diabetic (4-7%), prediabetic (7-10%), and diabetic (10-13% and 13-16%) groups. BMI was calculated for each participant to assess weight status. Lifestyle factors were evaluated using a standardized questionnaire. Statistical analyses included the independent t-test for mean comparison and standard deviation assessment, with a significance level set at $P < 0.05$.

Results: Out of 200 participants, 81 (40.5%) were non-diabetic, 60 (30%) were prediabetic, and 16 (8%) were classified as diabetic. The mean HbA1c levels for non-diabetic, prediabetic, and diabetic individuals were 5.7%, 8.5%, and 14.5%, respectively. BMI assessment revealed that higher HbA1c levels were associated with higher BMI, and lifestyle analysis indicated a high consumption of ultra-processed foods among prediabetic individuals.

Conclusion: The study found a notable prevalence of prediabetes in District Narowal, with a significant association between higher BMI and poor dietary habits with elevated HbA1c levels. These findings suggest the necessity of public health strategies focusing on weight management, nutritional education, and lifestyle modification to prevent the progression of prediabetes to T2DM.

Keywords: Prediabetes, HbA1c, BMI, Lifestyle Factors, Public Health, Narowal, Type 2 Diabetes Mellitus, Obesity.

INTRODUCTION

Prediabetes, a significant health concern in Pakistan, is rapidly becoming more prevalent due to lifestyle changes and increasing rates of overweight and obesity. Recent estimates suggest that by 2020, one in three Pakistanis might be affected by prediabetes, a precursor to type 2 diabetes (T2D) (1). Currently, around one in four Pakistanis are believed to be prediabetic, a condition not without severe consequences, as it often leads to major microvascular and macrovascular complications like blindness, cardiovascular disease, myocardial infarction, and stroke (2,3). Notably, a substantial proportion of prediabetic patients—20-30%—already present with microvascular complications at the time of diagnosis, highlighting the urgency of addressing this condition proactively rather than reactively (3).

The global prevalence of prediabetes has been increasing alongside obesity and T2D. In 1994, approximately 1 million people were identified as prediabetic worldwide; this number increased to 382 million in 2013, with projections suggesting a rise to 592 million in the next 20 years (7). This increase is alarming, as a high incidence of prediabetes is associated with both a diminished quality of life for individuals and increased healthcare costs due to complications predominantly caused by persistent elevations in blood glucose levels (6,7). Traditionally associated with being "overweight and over forty," prediabetes is now increasingly affecting younger adults, adolescents, and even children, largely due to lifestyle changes that result in weight gain and increased adiposity (8).

Journal of Health and Rehabilitation Research 2791-156X JHRR

Over the past 40 to 50 years, changes in diet and physical activity in developed environments have significantly contributed to the rise in obesity and T2D (9). The prevalence of T2D has also escalated; from approximately 1 million cases globally in 1994, it reached 382 million by 2016 (10). Central adiposity and abdominal obesity are closely linked to changes in body composition, including lipid infiltration into key organs like the pancreas and liver, increasing the risk of developing T2D (11,12). It has been long established that weight loss can reduce the elevated blood sugar levels associated with T2D and obesity (13).

In this context, the use of HbA1c as a screening tool in clinical practice has gained rapid acceptance. If proven to have suitable sensitivity and specificity, HbA1c could be an excellent and cost-effective method for screening prediabetic patients. Typically, an HbA1c test costs less than an OGTT (14). HbA1c levels are directly correlated with the risk of developing prediabetes, making it a reliable long-term biomarker of glycemic control (14). It's crucial to note that HbA1c readings reflect an average of blood glucose over the lifespan of a red blood cell, usually 2-3 months, with the final month contributing approximately 50% to the outcome (15). The HbA1c molecule undergoes non-enzymatic glycation in high blood sugar environments, particularly at the N-terminal valine residue of the beta chain, forming HbA1c (16).

Despite the advantages of HbA1c measurements, there have been challenges in efficiently comparing published data sets due to various methodological issues. One significant challenge is the ongoing debate among expert committees regarding the diagnostic criteria for prediabetes (17,18,19). In the absence of data determining optimal diagnostic HbA1c cut points for prediabetes, expert committees have relied on the understanding of risk curves for complications like retinopathy, despite established thresholds for increased retinopathy prevalence (20,21).

The objectives of this study are to assess the prevalence of prediabetic patients in District Narowal and to explore the relationship between lifestyle factors and prediabetes.

MATERIAL AND METHODS

The study was conducted at Usman Surgical Hospital, Zafarwal, in the District Narowal over a six-month period, focusing on the prevalence and associated lifestyle factors of prediabetes. The research involved 200 volunteers from the general population, all aged 40 and older. These individuals were selected from a specific section of Zafarwal to represent a cross-section of the District Narowal community. The primary methodology for determining the prevalence of prediabetes involved the use of the HbA1c test, a widely recognized diagnostic tool for assessing blood glucose levels over a prolonged period.

To evaluate the lifestyle factors potentially contributing to prediabetes, participants were asked to complete a detailed questionnaire. This questionnaire was designed to gather comprehensive information about their daily routines, dietary habits, and physical activity levels. Specific attention was given to the amount of time each participant dedicated weekly to various forms of exercise, including walking, jogging, running, bicycling, and swimming. This approach aimed to establish a clear link between lifestyle choices and the risk of developing prediabetes.

The diagnostic process for prediabetes was carried out through the collection and analysis of blood samples. These samples were tested for HbA1c levels in a laboratory setting, providing a reliable means of diagnosing prediabetes among the participants.

For the statistical analysis of the collected data, the study utilized SPSS version 25. This choice of software reflects an update from the initial plan to use SPSS version 16.00, aligning the research with more current data analysis methodologies. The analysis involved the use of t-tests and standard deviation calculations to assess the data rigorously. A significance level of $P < 0.05$ was set for the statistical tests, ensuring a robust evaluation of the findings. The prevalence of prediabetic patients in District Narowal, specifically the Shakargarh area, was calculated by determining the percentage of individuals with elevated HbA1c levels.

An ethical statement was integral to the study, ensuring all participants provided informed consent and that the research adhered to ethical standards for medical research. This included considerations for privacy, voluntary participation, and the ethical handling of personal health information. The research thus not only aimed to shed light on the prevalence of prediabetes in District Narowal but also sought to uphold the highest standards of research ethics and participant care.

RESULTS

Along with the bar graphs, the scatter plot titled "BMI vs HbA1c" illustrates the relationship between Body Mass Index (BMI) and HbA1c levels, with each point representing an individual's measured values.

Kaream KF., et al. (2024). 4(1): DOI: https://doi.org/10.61919/jhrr.v4i1.291
Journal of Health and Rehabilitation Research 2791-156X JHRR

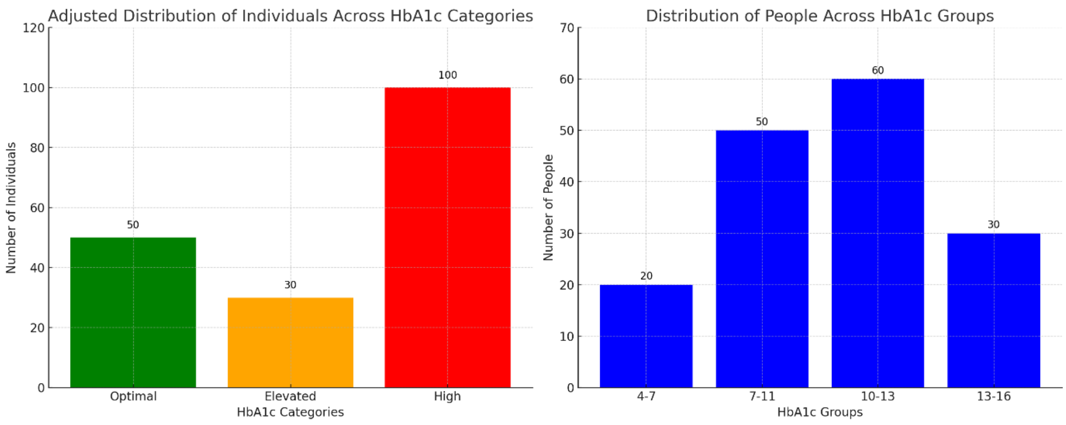

Figure 1 HbA1c Level based Classification

The plot reveals a positive correlation between BMI and HbA1c levels, as indicated by the ascending trend line. This correlation is quantified by the coefficient of determination (R-squared value) of 0.3967, suggesting that approximately 39.67% of the variation in HbA1c levels can be explained by BMI.

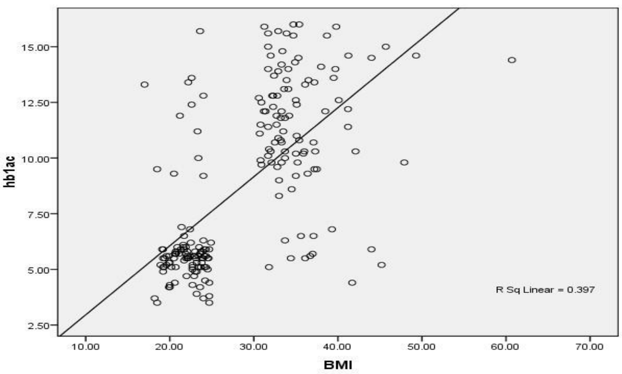

Figure 2 Dot plot showing the correlation between body mass index and risk of developing prediabetes.

This graphical analysis underscores the association between increased body weight and higher HbA1c levels, which is significant for identifying individuals at risk for prediabetes or diabetes. Integrating this with the earlier described bar graphs provides a multifaceted view of the health status of the population, combining categorical HbA1c distributions with the continuous relationship of HbA1c to BMI, thus enriching the narrative on the impact of weight on blood glucose levels.

Table 1 Distribution of HbA1c Levels

Number of Samples	HbA1c Range (%)	Percentage of Total Samples	Valid Percentage
81	4-7	35.2%	40.5%
60	7-10	26.1%	30.0%
43	10-13	18.7%	21.5%
16	13-16	7.0%	8.0%
Total	200	87.0%	100.0%

The dataset encapsulates a comprehensive analysis of HbA1c levels and BMI across a sample of 200 individuals. In Table 1, the distribution of HbA1c levels is segmented into four ranges: 81 participants (40.5% valid percentage) fell into the '4-7%' category, which accounted for 35.2% of the total samples; the '7-10%' range encompassed 60 individuals (30.0% valid percentage) representing 26.1% of the total; the '10-13%' bracket included 43 subjects (21.5% valid percentage) with 18.7% of the total; and finally, the '13-16%' category comprised 16 people (8.0% valid percentage), making up 7.0% of the samples. Collectively, these HbA1c ranges encompass an 87.0% cumulative percentage of the total samples, with the remainder likely falling outside the specified ranges.

The interplay between BMI and weight status, as outlined in Table 2, categorizes the population into four distinct groups: 'Underweight' with BMIs below 18.5, 'Healthy Weight' ranging from 18.5 to 24.9, 'Overweight' spanning BMIs of 25 to 29.9, and 'Obese' for BMIs of 30 or greater. This classification aids in understanding the prevalence of various weight statuses within the cohort and their potential link to HbA1c levels.

Table 2 BMI Categories and Weight Status

Weight Status Category	BMI Range
Underweight	Below 18.5
Healthy Weight	18.5 to 24.9
Overweight	25 to 29.9
Obese	30 or greater

Table 3 Correlation of HbA1c with BMI

Sample Number	HbA1c Range (%)	BMI Range
81	4-7	25 to 26
60	7-10	26 to 27.9
43	10-13	27.9 to 28
16	13-16	29

Further probing into the relationship between HbA1c levels and BMI in Table 3 reveals a correlation where higher BMI ranges are associated with elevated HbA1c percentages. Specifically, individuals with HbA1c levels in the '4-7%' range predominantly had BMIs between 25 to 26. The '7-10%' HbA1c group had BMI ranges of 26 to 27.9, and the '10-13%' HbA1c category was associated with BMIs of 27.9 to 28. The highest HbA1c group ('13-16%') corresponded to the highest BMI observed at 29. These correlations underscore a trend where increased HbA1c levels align with higher BMI values, suggesting a potential link between body weight and glycemic control within this population.

DISCUSSION

The burgeoning prevalence of prediabetes, as demonstrated by the study in District Narowal, echoes a global health concern corroborated by various international studies. The low prevalence of prediabetes among Lebanese university students, as reported by Younes et al. (2019), underlines the protective role of a healthy BMI and active lifestyle against the dysregulation of glucose levels (22). This is consistent with the findings in Narowal, where lifestyle choices, particularly dietary habits, have emerged as significant determinants of glycemic control (23).

The research by Bennasar-Veny et al. (2020) further reinforces the narrative that an interplay of diet, physical activity, and BMI influences the progression from prediabetes to T2DM (24). Their work, in synergy with the Narowal study, suggests that lifestyle modification is not only a cornerstone of diabetes prevention but also a critical component of managing prediabetes.

Drawing parallels from the study in the Karimnagar district by Saibhavani et al. (2020), the strong link between elevated BMI and the incidence of prediabetes is evident (25). This association is critical for risk stratification and targeted interventions, emphasizing the need for BMI management as a pivotal strategy in prediabetes control, as also reflected in the Narowal study findings.

In the context of public health interventions, the study by Andes et al. (2019) on American adolescents and young adults presents a striking statistic: the significant presence of prediabetes in youth calls for urgent public health strategies (24). This reinforces the Narowal study's recommendation for early intervention and lifestyle education to stem the tide of an impending diabetes epidemic.

Moreover, the advent of digital health interventions, such as the "Changing Health" program studied by Cassidy et al. (2019), offers a promising avenue for supporting lifestyle behavior changes (26). This aligns with the Narowal study's suggested preventive measures, highlighting the potential for leveraging technology to facilitate widespread and personalized health interventions.

Finally, the position statement from Australia on the screening and management of prediabetes by Bell et al. (2020) underpins the global consensus on the efficacy of intensive lifestyle interventions (27). It suggests that primary care settings can be instrumental in reversing prediabetes, a sentiment that resonates with the findings from Narowal, advocating for a proactive healthcare approach.

Integrating these studies, it becomes evident that a multifaceted strategy encompassing early screening, lifestyle interventions, and the harnessing of digital health platforms may be the most effective approach to addressing the prediabetes challenge. The collective insights from global research accentuate the need for a concerted effort to prevent the transition to T2DM, offering a beacon of hope for reversing prediabetes trends not only in District Narowal but also on a global scale.

CONCLUSION

The collective insights from international research and the current study in District Narowal converge to a pressing conclusion: prediabetes is a global public health challenge with a significant prevalence, influenced heavily by BMI and lifestyle factors such as diet and physical activity. The implication is clear; there is an urgent need for early, proactive interventions, including lifestyle education, regular screening, and the utilization of digital tools for health promotion and disease prevention. Such strategies are imperative not only for individual health but also for easing the future burden on healthcare systems. The Narowal study, alongside global research, underscores the potential of intensive lifestyle interventions in reversing the course of prediabetes, thereby reducing the risk of progression to type 2 diabetes. This highlights a critical opportunity for healthcare systems worldwide to implement comprehensive preventive measures, tailored to local contexts, to curb the rising tide of diabetes and its associated health complications.

REFERENCES

1. American Diabetes Association. Classification and Diagnosis of Diabetes: Standards of Medical Care in Diabetes-2021. Diabetes Care. 2021;43(Suppl 1):S15-S33.
2. Siu AL. Screening for abnormal blood glucose and type 2 diabetes mellitus: U.S. preventive services task force recommendation statement. Ann Intern Med. 2015;163(11):861-868.
3. Rosenzweig JL, Bakris GL, Berglund LF, et al. Primary Prevention of ASCVD and T2DM in Patients at Metabolic Risk: An Endocrine Society* Clinical Practice Guideline. J Clin Endocrinol Metab. 2019. doi: 10.1210/jc.2019-01338.
4. Echouffo-Tcheugui JB, Selvin E. Prediabetes and What It Means: The Epidemiological Evidence. Annu Rev Public Health. 2021;42:59-77.
5. Karve A, Hayward RA. Prevalence, diagnosis, and treatment of impaired fasting glucose and impaired glucose tolerance in nondiabetic U.S. adults. Diabetes Care. 2010;33(11):2355-2359.
6. Centers for Disease Control and Prevention. National Diabetes Statistics Report, 2020. Estimates of Diabetes and Its Burden in the United States. Available from: https://www.cdc.gov/diabetes/pdfs/data/statistics/national-diabetes-statistics-report.pdf. Published 2020.
7. Saeedi P, Petersohn I, Salpea P, et al. Global and regional diabetes prevalence estimates for 2019 and projections for 2030 and 2045: Results from the International Diabetes Federation Diabetes Atlas, 9th edition. Diabetes Res Clin Pract. 2019;157:107843.
8. Gu K, Cowie CC, Harris MI. Mortality in adults with and without diabetes in a national cohort of the U.S. Population, 1971-1993. Diabetes Care. 1998;21(7):1138-1145.
9. Gregg EW, Cheng YJ, Srinivasan M, et al. Trends in cause-specific mortality among adults with and without diagnosed diabetes in the USA: an epidemiological analysis of linked national survey and vital statistics data. Lancet. 2018;391(10138):2430-2440.
10. Vaidya V, Gangan N, Sheehan J. Impact of cardiovascular complications among patients with Type 2 diabetes mellitus: A systematic review. Expert Rev Pharmacoecon Outcomes Res. 2015;15(3):487-497.
11. Bailey RA, Wang Y, Zhu V, Rupnow MF. Chronic kidney disease in US adults with type 2 diabetes: An updated national estimate of prevalence based on Kidney Disease: Improving Global Outcomes (KDIGO) staging. BMC Res Notes. 2014;7:415.
12. US Renal Data System. 2018 UKRDS Annual Data Report | Volume 2: ESRD in the United States- Chapter 1: Incidence, Prevalence, Patient Characteristics, and Treatment Modalities. Am J Kidney Dis. 2019;73(3):S291-S332.
13. Yau JWY, Rogers SL, Kawasaki R, et al. Global prevalence and major risk factors of diabetic retinopathy. Diabetes Care. 2012;35(3):556-564.
14. Gregg EW, Gu Q, Williams D, et al. Prevalence of lower extremity diseases associated with normal glucose levels, impaired fasting glucose, and diabetes among U.S. adults aged 40 or older. Diabetes Res Clin Pract. 2007;77(3):485-488.
15. Cai X, Zhang Y, Li M, et al. Association between prediabetes and risk of all cause mortality and cardiovascular disease: updated meta-analysis. BMJ. 2020;370:m2297.
16. Yang W, Dall TM, Beronjia K, et al. Economic costs of diabetes in the U.S. in 2017. Diabetes Care. 2018;41(5):917-928.
17. Dall TM, Yang W, Gillespie K, et al. The economic burden of elevated blood glucose levels in 2017: Diagnosed and undiagnosed diabetes, gestational diabetes mellitus, and prediabetes. Diabetes Care. 2019;42(9):1661-1668.
18. Zhuo X, Zhang P, Barker L, Albright A, Thompson TJ, Gregg E. The lifetime cost of diabetes and its implications for diabetes prevention. Diabetes Care. 2014;37(9):2557-2564.
19. Bommer C, Heesemann E, Sagalova V, et al. The global economic burden of diabetes in adults aged 20-79 years: a cost-of-illness study. Lancet Diabetes Endocrinol. 2017;5(6):423-430.
20. Bertram MY, Vos T. Quantifying the duration of pre-diabetes. Aust N Z J Public Health. 2010;34(3):311-314.
21. Harris MI, Klein R, Welborn TA, Knuiman MW. Onset of NIDDM occurs at least 4-7 yr before clinical diagnosis. Diabetes Care. 1992;15(7):815-819.

22. Younes N, Atallah M, Alam R, Chehade NH, Gannagé-Yared M-H. HBA1C AND BLOOD PRESSURE MEASUREMENTS: RELATION WITH GENDER, BODY MASS INDEX, STUDY FIELD AND LIFESTYLE IN LEBANESE STUDENTS. Endocr Pract. 2019.

23. Saibhavani G, Kamalaja T, Aparna K, Sreedevi PA. Nutritional status assessment in Prediabetic subjects of Karimnagar District. J Pharmacogn Phytochem. 2020;9:683-6.

24. Bennasar-Veny M, Fresneda S, López-González A, Busquets-Cortés C, Aguiló A, Yáñez AM. Lifestyle and Progression to Type 2 Diabetes in a Cohort of Workers with Prediabetes. Nutrients. 2020;12.

25. Andes LJ, Cheng YJ, Rolka DB, Gregg EW, Imperatore G. Prevalence of Prediabetes Among Adolescents and Young Adults in the United States, 2005-2016. JAMA Pediatr. 2019:e194498.

26. Cassidy S, Okwose NC, Scragg J, Houghton D, Ashley K, Trenell MI, et al. Assessing the feasibility and acceptability of Changing Health for the management of prediabetes: protocol for a pilot study of a digital behavioural intervention. Pilot Feasibility Stud. 2019;5.

27. Bell KL, Shaw JE, Maple-Brown LJ, Ferris W, Gray S, Murfet GO, et al. A Position Statement on Screening and Management of Prediabetes in Adults in Primary Care in Australia. Diabetes Res Clin Pract. 2020:108188.