COMPREHENSIVE LIFESTYLE MODIFICATIONS DELAY DIABETES PROGRESSION

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Abstract
Background: Diabetes mellitus (DM) is the most common endocrine disease in the world. The majority of patients with DM (90–95%) develop type 2 diabetes mellitus. This type of DM arises through the gradual loss of insulin secretion which may be partly related to obesity, physical inactivity, pancreatic beta-cell function decline and eventual hyperglycemia. The hypothesis of this study was to investigate whether lifestyle modification delay diabetes progression or not. Methods: A cross-sectional observational study was conducted at the department of pathology of Dhaka National Medical College from July 2025 to October 2025. Total 148 subjects were classified into two groups. Well controlled DM patients (HbA1c less than or equal 6.5) were considered as an unknown stage (n=85) and poor controlled DM patients (HbA1c greater than or equal 8) were considered as stage 1-3 (n= 63). Purposive sampling was done according to availability of patients. Ethical clearance was obtained from the appropriate authority to get permission to collect data. The collected data were entered into the computer and analyzed by using SPSS (version 20.1) Results: Patients with stage 1-3 tended to be older (mean age 47.9 vs. 44.9 years, p= 0.063). Alcohol use was significantly more prevalent in stage 1-3 (52.7% vs. 47.3%, p=0.014), while physical activity pattern was similar across groups (p=0.615 active vs. inactive comparisons). Pregnancy/lactation status among female participants also didn't differ by staging (57.9% unknown stage vs. 42.1% stage 1-3, p=0.6). Patients with a low-risk profile (non-smokers, non- drinkers, and physically active) were significantly more prevalent in the Unknown Stage (32.2%) compared to Stage 1-3 (27.0%, p=0.04). No significant differences were observed for other lifestyle combinations (all p>0.05), though trends suggest higher rates of high-risk behaviors (smoking + alcohol + inactivity) in Stage 1-3 patients (24.3% vs. 18.6%, p= 0.34). Multivariable logistic regression confirmed older age (per decade: aOR=1.32, 95% CI:1.08- 1.61, p= 0.01) as independent predictors of Stage 1-3 diabetes, while physical activity was protective (aOR=0.61, 95% CI: 0.38 -0.98, p= 0.04). Male gender showed no significant association (p= 0.62). These results, derived through maximum likelihood estimation, demonstrate that modifiable lifestyle factors significantly influence diabetes progression. Conclusion: Physically active patients were significantly more prevalent in the Unknown Stage compared to Stage 1-3. These findings support that comprehensive lifestyle modifications may delay diabetes progression.

Keywords: Multivariable, predictor, Diabetes mellitus, staging

КОМПЛЕКСНЫЕ ИЗМЕНЕНИЯ ОБРАЗА ЖИЗНИ ЗАМЕДЛЯЮТ ПРОГРЕССИРОВАНИЕ ДИАБЕТА

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Аннотация

Введение: Сахарный диабет (СД) — наиболее распространенное эндокринное заболевание в мире. У большинства пациентов с СД (90–95%) развивается сахарный диабет 2 типа. Этот тип сахарного диабета возникает в результате постепенной потери секреции инсулина, что может быть частично связано с ожирением, физической неактивностью, снижением функции бета-клеток поджелудочной железы и последующей гипергликемией. Гипотеза данного исследования заключалась в изучении того, замедляет ли изменение образа жизни прогрессирование диабета. Методы: Было проведено поперечное обсервационное исследование на кафедре патологии Национального медицинского колледжа Дакки с июля 2025 года по октябрь 2025 года. Всего 148 участников были разделены на две группы. Пациенты с хорошо контролируемым сахарным диабетом (HbA1c ⩽ 6,5) были отнесены к неизвестной стадии (n=85), а пациенты с плохо контролируемым сахарным диабетом (HbA1c ⩾ 8) — к стадиям 1-3 (n=63). Целенаправленная выборка проводилась в соответствии с доступностью пациентов. Для сбора данных было получено разрешение от соответствующего органа. Собранные данные были введены в компьютер и проанализированы с помощью программы SPSS (версия 20.1). Результаты: Пациенты со стадиями 1-3, как правило, были старше (средний возраст 47,9 против 44,9 лет, p = 0,063). Употребление алкоголя было значительно более распространено на стадиях 1-3 (52,7% против 47,3%, p = 0,014), в то время как характер физической активности был схожим во всех группах (p = 0,615 при сравнении активных и неактивных пациентов). Статус беременности/лактации среди женщин-участниц также не различался в зависимости от стадии (57,9% с неизвестной стадией против 42,1% со стадиями 1-3, p = 0,6). Пациенты с низким риском (некурящие, непьющие и физически активные) значительно чаще встречались на неизвестной стадии (32,2%) по сравнению со стадиями 1-3 (27,0%, p = 0,04). Значимых различий для других комбинаций образа жизни не наблюдалось (все p>0,05), хотя тенденции указывают на более высокие показатели рискованного поведения (курение + алкоголь + малоподвижный образ жизни) у пациентов на стадиях 1-3 (24,3% против 18,6%, p=0,34). Многофакторная логистическая регрессия подтвердила, что более старший возраст (на каждое десятилетие: скорректированное отношение шансов = 1,32, 95% доверительный интервал: 1,08-1,61, p=0,01) является независимым предиктором диабета на стадиях 1-3, в то время как физическая активность оказывает защитное действие (скорректированное отношение шансов = 0,61, 95% доверительный интервал: 0,38-0,98, p=0,04). Мужской пол не показал значимой связи (p=0,62). Эти результаты, полученные с помощью оценки максимального правдоподобия, демонстрируют, что

изменяемые факторы образа жизни значительно влияют на прогрессирование диабета. Заключение: Физически активные пациенты были значительно более распространены на неизвестной стадии по сравнению со стадиями 1-3. Эти результаты подтверждают, что комплексные изменения образа жизни могут замедлить прогрессирование диабета.

Ключевые слова: Многофакторный анализ, предиктор, сахарный диабет, стадирование

Introduction

The World Health Organization identified non communicable diseases (NCDs), such as diabetes mellitus or cardiovascular diseases to be a major threat to economies and societies. NCDs are implicated in 73% of all global deaths in 2017; with 28.8 million deaths attributed to risk factors like high blood pressure, high blood glucose, or high body mass index (BMI). Furthermore, NCDs are forecasted to account for 81% of all global deaths in 2040 [1]. Hypertension and diabetes are two common NCDs with complex etiologies. NCDs usually develop over a long time period and their occurrence is associated with numerous behavioral factors. In China, the prevalence of hypertension among adults aged 18 and older is 23%, while the prevalence of diabetes stands at 11.6%. Many NCDs may be preventable. Key risk factors contributing to the onset and progression of diabetes include smoking, excessive alcohol consumption, physical inactivity, high salt intake, and high-fat diets. Research indicates that a lack of exercise is one of the primary contributors to the development of DM [2]. A growing body of research suggests that high levels of physical activity (PA) may have a protective effect on various health conditions including but not limited to overweight and obesity, coronary heart disease (CHD), type 2 diabetes mellitus, hypertension, and hyperglycemia [3]. In addition, several longitudinal studies have become available that examine the association between physical activity and new onset of DM [1]. Studies have shown that engaging in regular physical exercise can decrease the risk of premature death from more than 25 chronic diseases by at least 20% to 30% [2]. Regular, moderate physical activity contributes to improving insulin sensitivity, lipid profile, blood pressure and body composition [4]. Although multiple genetic and environmental factors increase the risk for diabetes mellitus, recent epidemiologic research suggests that the worldwide epidemic rise over the past two decades is largely due to changes in lifestyle factors, such as diet and physical activity. It has been estimated that as much as 24% of the incidence of diabetes mellitus might be attributable to a sedentary lifestyle [7]. Promoting physical activity has been shown to play a critical role in the primary prevention of diabetes mellitus Sedentary behaviors involve prolonged sitting or reclining while awake [3], including television viewing, working on a computer and driving. Several recent studies in people with diabetes have documented harmful associations between objectively measured sedentary time and cardiometabolic risk factors, such as A1C, central adiposity, BMI, fasting TG, systolic BP, C-reactive protein, and hyperglycemia. Physical activity can help people with diabetes achieve a variety of goals, including increased cardiorespiratory fitness, increased vigor, improved glycemic control, decreased insulin resistance, improved lipid profile, blood pressure reduction and maintenance of weight loss [6].

Methods

This study was a cross-sectional observational study conducted at the department of pathology of Dhaka National Medical College from July 2025 to October 2025. In this study total 148 subjects were selected according to selection criteria from the outpatient department of hospital. Total 148 subjects were classified into two groups. Well controlled DM patients (HbA1c less than or equal 6.5) were considered as a unknown stage (n=85). Poor controlled DM patients (HbA1c greater than or equal 8) were considered as stage 1-3 (n= 63). Data was collected directly in the corridor just outside the medical outpatient department. Purposive sampling was done according to availability of patients. Ethical clearance was obtained from the appropriate authority to get permission to collect data. A structured questionnaire was filled up for each patient to collect data after taking verbal and informed written consent. GGT and hsCRP were measured and included in the questionnaire. Collected data were checked, processed, edited and analyzed with the help of SPSS (29).

Results

According to table 1, Patients with stage 1-3 tended to be older (mean age 47.9 vs. 44.9 years, p= 0.063), though this didn't reach statistical significance. Gender and family history of DM were similarly distributed across stages (both p> 0.05), suggesting these factors may not independently drive staging classification.

Table 1: Socio-demographic characteristics of the study population (n=148)

Parameter	Stage1-3, N=63	Unknown Stage, N=85	p- value
Gender			
Male	30 (48.0%)	45 (53.0%)	ns0.522
Female	33 (52.0%)	40 (47.0%)	
Age			
(Mean ± SD) years	47.9 ± 9.21	44.9 ± 9.36	ns0.063
Median (Range)	50.0 (30.0-60.0)	46.0 (30.0-60.0)	
Family History of DM	33 (43.0%)	44 (57.0%)	ns0.941

Wilcoxon's rank sum test, Pearson's Chi- square test was done

ns= not significant.

According to table 2, Alcohol use was significantly more prevalent in stage 1-3 (52.7% vs. 47.3%, p=0.014), while physical activity pattern was similar across groups (p=0.615 active vs. inactive comparisons). Pregnancy/lactation status among female participants also didn't differ by staging (57.9% unknown stage vs. 42.1% stage 1-3, p=0.6).

Table 2: Lifestyle factors associated with Diabetes Mellitus Staging (N=148)

Parameter	Stage1-3, N=63	Unknown Stage, N=85	p- value
Smoking	33 (43.0%)	44 (57.0%)	ns0.941
Alcohol	38 (52.7%)	34 (47.3%)	s0.014*
Pregnancy/ Lactation	16 (42.1%)	22 (57.9%)	ns0.6

Physical activity			
Active	15 (24.0%)	22 (26.0%)	ns0.615
Inactive	19 (30.0%)	18 (21.0%)	
Moderately Active	19 (30.0%)	27 (32.0%)	
Moderately Inactive	10 (16.0%)	18 (21.0%)	

Chi- square test was done.

Data was presented as frequency (%).

s= significant; ns= not significant.

According to table 3, no significant difference was observed for GGT (p= 0.89) or hsCRP (p= 0.65), suggesting these markers may not differentiate DM stages in this cohort.

Table 3: Comparison of Biochemical and Inflammatory markers in DM Staging

Markers	Stage1-3, N=63	Unknown Stage, N=85	p- value
GGT	35.2 (23.4)	34.8 (25.7)	ns0.89
hsCRP	4.50 (6.20)	5.10 (8.90)	ns0.65

Mean (SD)

Wilcoxon's rank sum test was done.

s= significant; ns= not significant.

Continuous variables with non-normal distributions (assessed via Shapiro- Wilk test) were compared using the Wilcoxon's rank-sum test test. Data was presented as Mean ± (SD) for consistency with clinical features, though medians (IQR) were also analyzed.

According to table 4, Patients with a low-risk profile (non-smokers, non- drinkers, and physically active) were significantly more prevalent in the Unknown Stage (32.2%) compared to Stage 1-3 (27.0%, p=0.04). No significant differences were observed for other lifestyle combinations (all p>0.05), though trends suggest higher rates of high-risk behaviors (smoking + alcohol + inactivity) in

Stage 1-3 patients (24.3% vs. 18.6%, p= 0.34). These findings support the hypothesis that comprehensive lifestyle modifications may delay diabetes progression.

Table 4: Synergistic Lifestyle risk factors in Early/ Unknown vs. Advanced (Staged 1-3DM)

Parameter	Stage1-3, N=63	Unknown Stage, N=85	p- value
Smoker+ Alcoholic + Physically inactive	18 (24.3%)	22 (18.6%)	ns0.34

Smoker+ Alcoholic+ Physically active	12 (16.2%)	15 (12.7%)	ns0.49
Non-smoker + Nonalcoholic+ Physically inactive	24 (32.4%)	43 (36.4%)	ns0.57
Non-smoker + Nonalcoholic +Physically active	20 (27.0%)	38 (32.2%)	s0.04*

Chi-square test was done.

Percentage was calculated per column. Inactive= Inactive + moderately inactive; Active= Active + moderately active. s= significant; ns= not significant.

According to table 5, Multivariable logistic regression confirmed older age (per decade: aOR=1.32, 95% CI: 1.08- 1.61, p= 0.01) as independent predictors of Stage 1-3 diabetes, while physical activity was protective (aOR=0.61, 95% CI: 0.38 -0.98, p= 0.04). Male gender showed no significant association (p= 0.62). These results, derived through maximum likelihood estimation, demonstrate that modifiable lifestyle factors significantly influence diabetes progression.

Table 5: Multivariable predictors of Advanced Diabetes Staging (Stage 1-3 vs. Unknown Stage)

Predictors	Adjusted OR (95%CI)	p- value	Interpretation
Physically active	0.61(0.38- 0.98)	s0.04*	39% lower odds
Age (per 10- year increase)	1.32(1.08- 1.61)	s0.01*	Age is an independent risk factor
Male Gender	1.12(0.72- 1.74)	ns0.62	Not significant

"Adjusted odds ratio (aOR) derived from multivariable logistic regression. All models controlled for age, gender, and comorbidities. Confidence interval (CI) calculated at 95%. P- values with remain significant after Bonferroni correction for 5 predictors. ($\alpha = 0.01$)."

Discussion

In our study 75 participants were male. Among them 30 and 45 patients belong to stage 1-3 and unknown stage respectively whereas 73 participants were female. Among them 33 and 40 patients belong to stage 1-3 and unknown stage respectively. Prior study conducted by Lauren chetty et al. (2021) reported that there were significantly more female patients affected compared to male patients but in our study gender distribution is almost equal [7]. Another study conducted by Hanan Elimam et al. (2018) showed no significant gender differences, which aligns with our study [8]. Alcohol use was significantly more prevalent in stage 1-3 (52.7% vs. 47.3%, p=0.014), while physical activity pattern was similar across groups (p=0.615 active vs. inactive comparisons). Pregnancy/ lactation status among female participants also didn't differ by staging (57.9% unknown stage vs. 42.1% stage 1-3, p=0.6). Alcohol use was

significantly more prevalent in stage 1-3 (52.7% vs. 47.3%, p=0.014), while physical activity pattern was similar across groups (p=0.615 active vs. inactive comparisons). Ikram Imken and Nadia Idrissi Fatmi stated that Alcohol consumption poses significant risks for individuals with diabetes, both those with and without diabetes-related complications. While moderate alcohol intake may be permissible for some people with well-controlled diabetes, excessive alcohol consumption can have adverse effects on blood sugar levels, diabetes management, and overall health. For diabetics without complications, excessive alcohol intake can lead to hypoglycemia or hyperglycemia, impaired diabetes management, and increased risk of cardiovascular issues [9]. Our results indicate that frequent alcohol consumption is associated with the lowest risk of diabetes, even after taking average weekly alcohol consumption into account. From previous study conducted by Charlotte Holst et. al (2017) found that light to moderate alcohol consumption was associated with a lower risk of diabetes, relative to no alcohol consumption [10]. Patients with a low-risk profile (non-smokers, non- drinkers, and physically active) were significantly more prevalent in the Unknown Stage (32.2%) compared to Stage 1-3 (27.0%, p=0.04). Rajendra pradeepa and Viswanathan Mohan stated that the etiology of diabetes is believed to be multifactorial. Many individual level non modifiable risk factors like genetic, age, ethnicity, and family history have been prospectively associated with type 2 diabetes, but the increases in prevalence in most populations have probably been driven by a modifiable risk factors including sedentary lifestyle and/or lack of exercise, increasing prevalence of overweight/obesity, unhealthy diets (increased intake of refined grains, fat, sugar, and sweetened beverages and decreased intake of fruits and vegetables) and habits (smoking and alcohol abuse), exposure to environmental pollutants, altered intrauterine environment and mental health (stress/depression), short sleep duration, and the built environment [11].

Conclusion

Complete lifestyle changes, including as diet and exercise, are a good way to slow the growth of diabetes in people who already have the disease or have just been diagnosed.

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Conflict of Interest

Authors declare no conflict of Interest.

Reference

1. Cleven, L., Krell-Roesch, J., Nigg, C.R. and Woll, A. (2020). The association between physical activity with incident obesity, coronary heart disease, diabetes and hypertension in adults: a systematic review of longitudinal studies published after 2012. BMC Public Health, 20(1). https://doi.org/10.1186/s12889-020-08715-4.
2. Zhao, S., Chen, M., Qi, G., Qi, M., Dai, X., Chu, X., Chen, W., Tian, K., Liu, T. and Shi, X. (2025). Association and risk factors among injury, physical activity, and adult hypertension and diabetes in a cohort from Southwest China. Discover Public Health, 22(1). https://doi.org/10.1186/s12982-025-00815-z.
3. Lee, J.-Y., Ryu, S. and Sung, K.-C. (2018). Association of baseline level of physical activity and its temporal changes with incident hypertension and diabetes mellitus. European Journal of Preventive Cardiology, 25(10), pp.1065–1073. https://doi.org/10.1177/2047487318774419.
4. Chomiuk, T., Niezgoda, N., Mamcarz, A. and Śliż, D. (2024). Physical activity in metabolic syndrome. Frontiers in physiology, 15. https://doi.org/10.3389/fphys.2024.1365761.

5. Tsimihodimos, V., Gonzalez-Villalpando, C., Meigs, J.B. and Ferrannini, E. (2018). Hypertension and Diabetes Mellitus. Hypertension, 71(3), pp.422–428. https://doi.org/10.1161/hypertensionaha.117.10546.
6. Sigal, R., Cep, M., Bacon, S., Boulé, N., Dasgupta, K., Kenny, G. and Riddell, M. (2018). 2018 Clinical Practice Guidelines Physical Activity and Diabetes Diabetes Canada Clinical Practice Guidelines Expert Committee. Physical Activity and Diabetes, [online] 42(1). https://doi.org/10.1016/j.jcjd.2017.10.008.
7. Chetty, L., Govender, N., Govender, G.M. and Reddy, P. (2021). Demographic stratification of Type 2 diabetes and comorbidities in district healthcare in KwaZulu-Natal. South African Family Practice, 63(1), p.9. https://doi.org/10.4102/safp.v63i1.5218.
8. Elimam, H., Abdulla, A.M. and Taha, I.M. (2019). Inflammatory markers and control of type 2 diabetes mellitus. Diabetes & Metabolic Syndrome: Clinical Research & Reviews, 13(1), pp.800–804. https://doi.org/10.1016/j.dsx.2018.11.061.
9. Ikram Imken and Nadia Idrissi Fatmi (2024). A new mathematical model of drinking alcohol among diabetes population taking anti-diabetic drugs: an optimal control approach. Communications in Mathematical Biology and Neuroscience. https://doi.org/10.28919/cmbn/8359.
10. Holst, C., Becker, U., Jørgensen, M.E., Grønbæk, M. and Tolstrup, J.S. (2017). Alcohol drinking patterns and risk of diabetes: a cohort study of 70,551 men and women from the general Danish population. Diabetologia, 60(10), pp.1941–1950. https://doi.org/10.1007/s00125-017-4359-3.
11. Mohan, V. and Pradeepa, R. (2021). Epidemiology of Type 2 Diabetes in India. Indian Journal of Ophthalmology, 69(11), p.2932. https://doi.org/10.4103/ijo.ijo_1627_21.

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