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Impact of lifestyle modification on early-onset type 2 diabetes among urban young adults

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Abstract:
Early-onset type 2 diabetes (T2D) is becoming more common in urban young adults and is linked to greater lifetime exposure to hyperglycemia, obesity, sedentary lifestyle and early cardiometabolic risk. In this interventional study, 120 urban adults (18-40 years) who had type 2 diabetes were diagnosed within the past 5 years and participated in a structured 24-week lifestyle modification program. The HbA1c level was reduced more in the participants who received the lifestyle modification as well as standard care (8.2 ± 0.8% to 7.0 ± 0.7%) than in those who received standard care alone (8.1 ± 0.7% to 7.7 ± 0.8%, $p<0.001$ for between-group change). The intervention group also achieved greater weight loss, decreased waist circumference, increased physical activity, improved diet and higher HbA1c <7% at 24 weeks. Thus, structured lifestyle modification resulted in clinically significant glycemic and anthropometric improvements in young adults from urban settings with early onset type 2 diabetes and should be implemented early in routine care.

Keywords: Early-onset type 2 diabetes, lifestyle modification; young adults, HbA1c, urban health, physical activity, weight loss

Background:
Type 2 diabetes is a significant public health problem worldwide and is rising in both high-income and low- and middle-income countries. According to recent international estimates, hundreds of millions of adults are living with diabetes and this figure is expected to grow significantly in the next few decades if there is no strengthening of diabetes prevention and early management **[1, 2]**. Diabetes is no longer limited to older age groups and the increasing burden is a result of urbanization, dietary change, physical inactivity, obesity, disruption of sleep and ageing of the population. The early onset type 2 diabetes, which is generally considered to be diagnosed before the age of 40, has become an important clinical issue. Young adults with type 2 diabetes tend to have a higher BMI, stronger family history, more insulin resistance, psychosocial stress, irregular work schedules and poor long-term adherence when compared to older adults. Due to earlier onset, affected people have more years of glycemic exposure and may develop microvascular and macrovascular complications at a time when they are in their productive years of life **[3, 4]**. Young onset diabetes is especially worrisome when it comes to complications. Progressive development of nephropathy, neuropathy, retinopathy, hypertension, dyslipidemia and cardiovascular risk is seen in youth and young adult cohorts with increasing duration of disease **[5]**. Thus, early glycemic control and risk-factor reduction is not just a short-term goal, but a chance to change the trajectory of diabetes-related disability for life. A key component of diabetes prevention and management is lifestyle change. A systematic review and meta-analysis of lifestyle interventions in low- and middle-income countries found reductions in diabetes incidence as well as modest improvements in HbA1c and fasting glucose, although substantial heterogeneity was observed across studies **[6, 7]**. For established type 2 diabetes, lifestyle intervention has been shown to improve weight, fitness, blood pressure, lipids and glycemic control, but long term cardiovascular outcomes are dependent on intensity, adherence, medication history and maintenance of lifestyle change **[8, 9]**. The barriers for urban youth adults are unique. Recent Indian evidence has also reported a substantial burden of young-onset type 2 diabetes among adults aged 18–40 years, with physical inactivity being common and lack of time, willpower and energy identified as important barriers to physical activity **[10]**. The routine advice may not be effective because of sedentary jobs, screen time, shift work, dependence on food delivery, consumption of refined carbohydrates and sugar-sweetened drinks, lack of safe areas for physical activity and social eating habits. This group may require more generic counselling at the clinic. These lifestyle-related exposures may contribute to the increasing burden of type 2 diabetes at younger ages **[11, 12]**. Therefore, it is of interest to assess the effect of a structured 24-week lifestyle modification program on glycemic control, anthropometry, physical activity and dietary adherence in young adults living in urban areas with newly diagnosed type 2 diabetes.

Materials and Methods:
Study design and setting:
This was a prospective, parallel group interventional study in the diabetes clinic of a tertiary care hospital in an urban area that ran for 24 weeks. The sequence was computer-generated and participants were randomly assigned to lifestyle modification plus standard care or standard care alone. Both groups received ongoing, physician-prescribed pharmacotherapy as needed.

Number of samples:
120 samples, 60 samples in each group. The sample size was determined to be able to detect a minimum difference of 0.5%

between the groups at 24 weeks, with a standard deviation of 0.9%, 80% power, 95% confidence level and a 15% attrition allowance.

Eligibility criteria:
Adults aged 18-40 years, diagnosed with type 2 diabetes within the past five years and with an HbA1c level of 7.0% to 10.5% were included. Diagnosis was made according to the usual clinical and biochemical criteria. Exclusion criteria included suspected type 1 diabetes, pregnancy, lactation, severe renal or hepatic disease, a major psychiatric illness that would impact participation, physical disability that would prevent moderate activity and current participation in another structured weight loss program.

Intervention:
The lifestyle modification program consisted of individual diet counseling, calorie deficit planning for overweight subjects, reducing the intake of refined carbohydrates, education on the 'plate method', increasing vegetables and protein, avoiding sugar-sweetened beverages and regularity of meal timing. The physical activity prescription focused on at least 150 minutes of moderate intensity aerobic exercise and two sessions of resistance exercise each week. Participants were reinforced weekly on the telephone for one month and fortnightly thereafter. Steps, diet adherence, sleep duration and medication intake was self-monitored using self-monitoring logs. Regular diabetes consultation, medication adjustment, basic dietary counselling and follow up were provided to both groups at baseline, 12 and 24 weeks. Participants in standard care were not given structured plans of activity, behaviour logs or reinforcement calls.

Primary outcome:
Change in HbA1c from baseline to 24 weeks. Secondary outcomes were fasting plasma glucose, body weight, body mass index, waist circumference, systolic and diastolic blood pressure, lipid profile, weekly physical activity minutes, dietary adherence score and proportion with HbA1c <7%.

Data analysis:
SPSS version 28.0 was used to analyze the data. The data of continuous variables were presented as mean ± standard deviation and those of categorical variables were presented as number and percentage. Paired t-test was used to evaluate within group changes. Independent t-test was used to compare the differences between groups in change. Chi-square test was used to analyse categorical outcomes. Data were analyzed on a complete-case basis and $p<0.05$ was taken as the level of statistical significance.

Results:
Of 120 enrolled participants, 112 completed the 24-week assessment, with 57 in the lifestyle modification group and 55 in the standard care group. Baseline ages, sex distribution, duration of diabetes, body mass index, HbA1c and medication patterns were comparable between groups. The mean age of the cohort was 32.4 ± 5.1 years and 58.3% were male. Family history of diabetes was present in 65.0% of participants **(Table 1).** At 24 weeks, HbA1c decreased from 8.2 ± 0.8% to 7.0 ± 0.7% in the lifestyle modification group and from 8.1 ± 0.7% to 7.7 ± 0.8% in the standard care group. The mean HbA1c reduction was significantly greater in the intervention group (-1.2 ± 0.6% vs -0.4 ± 0.5%, $p<0.001$). Fasting plasma glucose, weight, body mass index and waist circumference also improved more in the intervention group **(Table 2).** Lifestyle adherence improved substantially in the intervention group. Mean weekly moderate physical activity increased from 62 ± 38 minutes to 168 ± 54 minutes, whereas the standard care group increased from 66 ± 41 minutes to 92 ± 47 minutes. Dietary adherence score increased from 4.8 ± 1.2 to 7.6 ± 1.1 in the intervention group compared with 4.9 ± 1.1 to 5.8 ±1.3 in the standard care group. HbA1c <7% was achieved by 42.1% of intervention participants compared with 18.2% of standard care participants at 24 weeks **(Table 3).**

Table 1: Baseline characteristics of participants

Variable	Lifestyle group (n=60)	Standard care group (n=60)	p-value
Age, years	32.2 ±5.4	32.6 ± 4.9	0.67
Male sex, n (%)	36 (60.0)	34 (56.7)	0.71
Duration of diabetes, years	2.4 ± 1.3	2.5 ± 1.2	0.64
Family history of diabetes, n (%)	40 (66.7)	38 (63.3)	0.70
BMI, kg/m2	29.1 ± 3.8	28.8 ±3.6	0.66
HbA1c, %	8.2 ± 0.8	8.1 ± 0.7	0.47
Metformin use, n (%)	55 (91.7)	54 (90.0)	0.75

Table 2: Glycemic and anthropometric outcomes at 24 weeks

Outcome	Lifestyle group change	Standard care change	Between-group p-value
HbA1c, %	-1.2 ± 0.6	-0.4 ±0.5	<0.001
Fasting plasma glucose, mg/dL	-34.6 ±22.8	-12.8 ± 20.4	<0.001
Body weight, kg	-5.4 ± 3.1	-1.6 ± 2.4	<0.001
BMI, kg/m2	-1.9 ± 1.1	-0.6 ± 0.9	<0.001
Waist circumference, cm	-6.8 ± 4.0	-2.1 ± 3.5	<0.001
Systolic BP, mmHg	-6.4 ± 9.1	-2.3 ±8.7	0.014

Table 3: Lifestyle adherence and categorical outcomes

Variable	Lifestyle group	Standard care group	p-value
Completed 24-week follow-up, n (%)	57 (95.0)	55 (91.7)	0.46

Physical activity at 24 weeks, min/week	168 ± 54	92 ± 47	<0.001
Dietary adherence score at 24 weeks	7.6 ± 1.1	5.8 ± 1.3	<0.001
Weight loss >=5%, n (%)	31 (54.4)	10 (18.2)	<0.001
HbA1c <7% at 24 weeks, n (%)	24 (42.1)	10 (18.2)	0.006
Medication intensification required, n (%)	9 (15.8)	21 (38.2)	0.007

Discussion:

This study showed that a structured lifestyle modification programme led to significantly better glycemic control than conventional care in young adults with early onset type 2 diabetes who lived in an urban area. This clinically significant mean HbA1c decrease of 1.2% after 24 weeks was also associated with improvements in fasting glucose, body weight, waist circumference, blood pressure, dietary adherence and physical activity. These findings validate the benefits of early intensive lifestyle care, before pharmacologic escalation is inevitable. These findings are also consistent with Sagastume *et al.* Anand and Jain, who reported significant improvements in glycemic and anthropometric measures following a three-month lifestyle modification programme among newly diagnosed diabetic patients **[6, 7 and 13]**. For individuals with existing diabetes, intensive lifestyle intervention has been shown to enhance glycemic and cardiometabolic risk factors, especially if there is significant weight loss and physical activity. Observational evidence from India has also showed better glycemic and lipid profiles among patients reporting adherence to lifestyle modification compared with those without such adherence **[8, 9 and 14].** The present study generalizes this to a younger, urban, clinical population with relatively short disease duration. Young adults with type 2 diabetes are an important target group as they can have metabolic risk for several decades. Early onset disease is linked to more aggressive disease and earlier onset of vascular complications **[3-5].** This could mean that early glycemic improvement after diagnosis could benefit over the long term by lowering cumulative glycemic exposure as measured by HbA1c. Furthermore, the development of long-term dietary and activity patterns in young adulthood can help to avoid additional weight gain and the need for quick medication escalation. The intervention had a positive effect on behaviour and clinical outcomes. The weekly physical activity increased above the recommended minimum of 150 minutes per week and the dietary adherence score increased significantly. Structured exercise has been linked to reduction of HbA1c in type 2 diabetes and nutrition therapy with emphasis on caloric quality, portion control and decreased intake of refined carbohydrates is a fundamental part of the care plan **[11, 12].** Similarly, Kumari *et al*. reported sustained improvements in glycemic control and selected cardiovascular risk factors following structured lifestyle-modification counselling, together with improvements in adherence to diet and physical activity **[15]**. The findings of the present study indicate that behavior logs and reinforcement calls may be useful in making counseling a lasting behavior. The importance of behavioural and social support is also consistent with mixed-methods evidence identifying social support, health education and a conducive environment as facilitators of lifestyle modification, while lack of support and sociocultural factors may act as barriers **[16]**. Glycemic improvement was significantly due to weight loss. Over half of the intervention group lost over 5% of their body weight, while less than one-fifth of the standard care group lost weight. Weight loss enhances insulin sensitivity, hepatic glucose production and beta-cell work. Intensive weight management trials have showed that more weight loss can even help to achieve remission in some adults who have diabetes for a shorter duration **[17, 18].** While not the main goal of this study, the improvements seen suggest that early lifestyle therapy may provide a metabolic window for improved long-term control. Risk and opportunity abounds in urban environments. Poor control is caused by long sitting times, irregular meals, stress, high calorie snacks and convenient processed foods. Meanwhile, young adults can benefit from mobile reminders, step tracking, peer motivation and flexible exercise prescription. The high intervention group completion rate indicates that structured, but practical programs can be acceptable when they are tailored to fit into work schedules and social realities. The intervention group needed to be more intensively treated less often. This is significant as lifestyle intervention should not be regarded as an alternative to drugs, but as a multiplier of medical intervention. The current approach to diabetes care focuses on personalized glycemic goals, cardiovascular risk management, weight management and patient-centered decision making **[10, 19].** Lifestyle changes are used in addition to pharmacotherapy to treat underlying behavioral factors that contribute to insulin resistance. The study has some limitations. It was carried out in one urban location, with a 24-week follow-up period and was partly self-reported, using diet and activity logs. There was no blinding of the allocation process and the study was not blinded, which could lead to performance bias. No assessment was made of long-term maintenance (more than six months). Mechanistic interpretation would have been strengthened by continuous glucose monitoring, objective accelerometer-based activity measurement and body composition analysis. However, the findings offer clinically relevant evidence for early lifestyle intervention in urban young adults with type 2 diabetes despite the limitations. Further studies are needed to assess the long-term efficacy, digital delivery, culturally adapted diet plans, workplace support, cost effectiveness and remission, medication reduction and quality of life. Structured lifestyle care should be a fundamental therapeutic element in the care of a young adult with early onset diabetes and not a quick add on at the end of a consultation **[20].**

Conclusion:

A 24-week structured lifestyle modification intervention had a significant effect on HbA1c, fasting glucose, weight, waist circumference, physical activity and dietary adherence among young adults in an urban setting who had early onset type 2 diabetes. The intervention also resulted in higher proportion of

participants with HbA1c < 7% and fewer participants requiring medication intensification. To minimize long-term cardiometabolic risk, early, practical and reinforced lifestyle care should be part of the routine diabetes care for young adults.

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