Scholars Journal of Applied Medical Sciences
Abbreviated Key Title: Sch J App Med Sci
ISSN 2347-954X (Print) | ISSN 2320-6691 (Online)
Journal homepage: https://saspublishers.com

OPEN ACCESS

Anesthesia & Analgesia

Management Strategies and Outcomes of Type 2 Diabetes in Urban and Rural Populations of Bangladesh

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DOI: https://doi.org/10.36347/sjams.2024.v12i10.013 | **Received:** 07.09.2024 | **Accepted:** 12.10.2024 | **Published:** 15.10.2024

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Abstract **Original Research Article**

Introduction: Type 2 diabetes (T2D) is a chronic metabolic disorder marked by insulin resistance and poses significant health risks, including cardiovascular diseases, vision impairment, nerve damage, and kidney failure. The disease is linked to a reduced life expectancy and increased risks for complications like dementia and cancer, highlighting the urgent need for effective management strategies tailored to urban and rural populations. ***Aim of the study:*** This study aimed to identify the management strategies and outcomes of T2D in urban and rural populations of Bangladesh. ***Methods:*** This cross-sectional study was conducted in the Department of Anaesthesia Analgesia and Intensive Care Medicine, National Institute of Cardiovascular Disease and Hospital (NICVD). Dhaka, Bangladesh during the period from July 2023 to Jun 2024. A total of 200 participants were included in the study, with 100 patients from urban areas and 100 from rural areas. The study encompassed both male and female participants, who underwent treatment in both indoor (hospital-based) and outdoor (outpatient) settings. ***Result:*** A total of 200 participants were included in the study, with 100 patients from urban areas and 100 from rural regions. Among urban respondents, 35% were aged 20-30, while the rural group had a higher representation in this age group at 45%. The study revealed that individuals with higher education levels in rural areas had a lower prevalence of T2D, while overweight participants had a higher incidence in both urban and rural settings. In rural regions, the risk of T2D was notably higher among those who consumed caffeinated drinks and were less physically active, while these factors did not significantly influence T2D risk in urban populations. Additionally, urban participants exhibited a correlation between T2D and hypertension. ***Conclusion:*** Our study presents a comprehensive strategy to tackle the rising prevalence of T2D in urban and rural areas. Key elements include promoting healthier diets, encouraging regular physical activity, early detection through health check-ups, and tailored awareness campaigns. Additionally, improving healthcare access in rural regions, focusing on stress management in urban settings, and training healthcare professionals are vital. Policy advocacy, such as taxing sugary drinks, along with ongoing research and monitoring interventions, will help address the unique challenges of T2D in both contexts.

Keywords: T2D, Management Strategy, Outcome.

INTRODUCTION

Type 2 diabetes (T2D) is a chronic metabolic disorder characterized by insulin resistance and relative insulin deficiency. It poses significant health risks, contributing to a variety of severe complications that can affect multiple organ systems. These include cardiovascular diseases such as heart attacks and strokes,

which are leading causes of death among those with diabetes. Additionally, T2D can lead to vision impairment, including diabetic retinopathy, which may result in blindness. It also affects the nervous system, causing neuropathies that lead to numbness, pain, and weakness, particularly in the extremities. This, in turn, raises the risk of infections and injuries that, if left untreated, can necessitate limb amputations. Furthermore, diabetes significantly increases the likelihood of developing kidney disease, which can progress to kidney failure, requiring dialysis or transplantation. Globally, T2D has reached epidemic proportions, with an especially sharp rise in developing regions such as Asia, the Middle East, and North Africa, due to changes in lifestyle, diet, and urbanization [1]. By 2030, it is projected that diabetes prevalence will have surged by 69% in developing countries, largely driven by factors such as population growth, aging, urban migration, and sedentary lifestyles. In contrast, developed countries are expected to see a more modest increase of 20%, possibly due to better healthcare infrastructure, prevention strategies, and public awareness [2].

By 2045, the global landscape of diabetes is set to change dramatically, with projections indicating that 700 million individuals will be living with the condition—a 51% increase compared to figures from 2019. This alarming rise in diabetes prevalence is accompanied by a significant increase in the incidence of pre-diabetes, which is expected to grow from 374 million adults (7.5% of the population) to 548 million (8.6%) within the same time frame [3].

Among those diagnosed with type 2 diabetes mellitus (T2DM), the implications for life expectancy are grave. Individuals with T2DM often face an average reduction in life expectancy of about 10 years, primarily due to severe complications related to the disease. Notably, around 80% of T2DM patients die from cardiovascular complications, underscoring the critical connection between diabetes and heart health [4]. Moreover, T2DM is recognized as the tenth leading factor affecting global life expectancy, reflecting its profound influence on public health [5].

The repercussions of T2DM extend beyond mortality statistics; the condition is linked to a range of significant health risks. For instance, individuals with T2DM are at an increased risk for developing dementia, which can be attributed to the effects of chronic hyperglycemia and associated vascular damage [6]. Additionally, the risk of cancer doubles for those with T2DM, suggesting a complex interplay between metabolic dysregulation and tumor development [7,8]. Cardiovascular diseases remain a prominent concern, with T2DM patients exhibiting a heightened susceptibility to conditions such as heart attacks and strokes due to factors like arterial stiffness and dyslipidemia [9]. The impact of T2DM on mental health is equally troubling; studies indicate that individuals with diabetes are more prone to depression, which can complicate diabetes management and worsen overall health outcomes. Furthermore, physiological disturbances, including platelet dysfunction, are often observed in T2DM patients, increasing their risk for thrombotic events and further complicating their clinical management [10,11].

The rising prevalence of type 2 diabetes (T2D) in South Asia is significantly influenced by dietary choices and lifestyle factors, with Bangladesh facing notable challenges due to its high population density, reporting a 6.31% prevalence among adults [12,13]. In 2019, 8.4 million people in Bangladesh had diabetes, a figure projected to double to 15 million by 2045, alongside 3.8 million individuals identified as having pre-diabetes [14]. The prevalence of diabetes among adults aged 35 and older increased from 10.95% to 13.75% between 2011 and 2018 [15]. Contributing factors to this trend include education level, hypertension, financial status, physical activity, abdominal obesity, social class, family history, and waist-hip ratio. Additionally, gender, age, lifestyle choices, BMI, and ethnicity have also been identified as significant risk factors [16,17]. Additionally, unfavorable living conditions, especially in crowded urban slums, may worsen the incidence of type 2 diabetes (T2D), underscoring the urgent need to explore the differences in management strategies between urban and rural populations in Bangladesh.

Objectives

The objective of the study was to identify the management strategies and outcomes of T2D in urban and rural populations of Bangladesh.

METHODOLOGY & MATERIALS

This was a cross-sectional study and was conducted in the Department of Anaesthesia Analgesia and Intensive Care Medicine, National Institute of Cardiovascular Disease and Hospital (NICVD). Dhaka, Bangladesh during the period from July 2023 to Jun 2024.

A total of 200 participants were included in the study, with 100 patients from urban areas and 100 from rural areas. The study encompassed both male and female participants, who underwent treatment in both indoor (hospital-based) and outdoor (outpatient) settings. The study population comprised adults aged 20 years and older who had received a diagnosis of type 2 diabetes. Participants were recruited from a range of healthcare facilities, with urban patients selected through convenience sampling at hospitals and clinics, while rural participants were drawn via random sampling from community health centers and family welfare clinics. Data collection involved a structured questionnaire

designed to gather detailed information on various aspects of the participants' lives, including demographic characteristics (age, gender, socioeconomic status), lifestyle factors (physical activity, dietary habits), medication adherence, and access to healthcare services. This questionnaire was pre-tested on a smaller sample to ensure clarity, reliability, and validity before the main study commenced. In addition to self-reported data, the study incorporated clinical measurements to objectively assess participants' diabetes management. Fasting Blood Glucose (FBG) levels were measured using a standard glucose meter after an overnight fast, while glycosylated hemoglobin (HbA1c) was determined through laboratory analysis to evaluate long-term glycemic control. Random blood sugar tests were also conducted during the visits, providing immediate glucose level readings. Furthermore, participants' health-related quality of life was assessed using the SF-36 questionnaire, which yields the Physical Component Score (PCS) and Mental Component Score (MCS), allowing for a comprehensive view of the impact of diabetes on both physical and mental well-being. Risk factor assessments were performed to identify common comorbidities and lifestyle-related issues associated with diabetes, such as hypertension, BMI, and smoking status. These assessments provided valuable insight into the overall health profile of the participants and helped identify potential areas for targeted interventions.

Statistical Analysis: All data were recorded systematically in preformed data collection form and quantitative data was expressed as mean and standard deviation and qualitative data was expressed as frequency distribution and percentage. Statistical analysis was carried out by using Statistical analysis was done by using SPSS (Statistical Package for Social Science) Version 23 for windows 10. P value <0.05 was considered as statistically significant. Ethical approval regarding the study was obtained from the institutional ethical review committee.

RESULT

Table 1: Baseline Characteristics of our respondents (N=200)

Characteristics		Urban		Rural	
		Frequency	Percentage	Frequency	Percentage
Age	20-30	35	35	45	45
	31-40	30	30	25	25
	41-50	10	10	10	10
	>51	25	25	20	20
Gender	Male	40	40	45	45
	Female	50	50	55	55
Education level	No education	5	5	40	40
	Primary	25	25	45	45
	Secondary	50	50	10	10
	Higher	20	20	5	5
Caffeinated drink	Yes	67	67	83	83
	No	43	43	27	27
Smoking	Yes	62	62	66	66
	No	48	48	44	44
Hypertension	Yes	42	42	39	39
	No	58	58	61	61
BMI	Normal	27	27	36	36
	Overweight (obesity)	65	65	53	53

Table 1 shows the baseline characteristics of the respondents in both urban and rural populations show some notable distinctions. Among urban respondents, 35% were aged 20-30, while the rural group had a higher representation in this age group (45%). In the 31-40 age bracket, urban participants made up 30% compared to 25% in the rural group. Both areas had similar distributions for the 41-50 age range (10%) and those over 51 years old (25% urban, 20% rural). Gender distribution revealed a balanced representation, with urban males at 40% and females at 50%, while the rural population had slightly more females (55%). In urban areas, 50% of respondents had secondary education, 25% had primary, 20% had higher, and 5% had no education. In rural areas, 45% had primary education, 40% had no education, 10% had secondary, and 5% had higher education, highlighting a lower education level in rural populations. Caffeinated drink consumption was more prevalent in rural areas (83%) compared to urban (67%), and smoking was also higher in rural areas (66% vs. 62% urban). Hypertension was slightly more common in urban respondents (42%) than in rural ones (39%). In terms of BMI, overweight and obesity were more frequent among urban participants (65%), while the rural population had a higher percentage of normal BMI individuals (36%).

Table 2: Management Strategy of urban and rural respondents

Management Strategy		Urban		Rural	
		Frequency	Percentage	Frequency	Percentage
Medication Adherence	Yes	85	85	60	60
	No	15	15	40	40
Dietary Management	Yes	70	70	30	30
	No	30	30	70	70
Insulin Usage	Yes	20	20	10	10
	No	80	80	90	90
Physical Activity	Yes	60	60	35	35
	No	40	40	65	65

Table 2 showed the management strategies of urban and rural respondents show distinct differences in medication adherence, dietary management, insulin usage, and physical activity. In urban areas, 85% of participants adhered to their medication, while in rural areas, this was significantly lower at 60%. Similarly, dietary management was more common among urban respondents, with 70% following a controlled diet compared to only 30% in rural areas. Insulin usage was relatively low in both groups but slightly higher in urban areas (20%) compared to rural respondents (10%). In contrast, physical activity was reported more frequently among urban respondents (60%) than their rural counterparts (35%), suggesting a more active lifestyle in rural settings.

Table: 3: Clinical outcome of the of urban and rural respondents

Clinical outcome	Urban		Rural		P-value
	Frequency	Percentage	Frequency	Percentage	
FBG					1^{ns}
≤ 7 mmol/L	70	70	40	40	
>7mmol/L	30	30	60	60	
Hba1c					1^{ns}
<7	75	75	35	35	
>7	25	25	65	65	
Random blood sugar test					1^{ns}
< 11.1 mmol/L	80	80	45	45	
> 11.1 mmol/L	20	20	55	55	
Risk factor					
Hypertension	42	42	39	39	1^{ns}
Obesity	65	65	53	53	1^{ns}
Smoking	62	62	66	66	1^{ns}
Caffeinated drink	67	67	83	83	1^{ns}
Health related quality of life					
PCS: Physical component score,	50±42.43		50±14.14		1^{ns}
MCS: Mental component score	50±35.36		50±7.07		1^{ns}

Table 3 shows the clinical outcomes between urban and rural respondents show some marked differences, particularly in blood glucose control. In urban areas, 70% of participants achieved fasting blood glucose (FBG) levels of ≤7 mmol/L, compared to only 40% in rural respondents, indicating better glycemic control in urban populations. The same trend is observed in HbA1c levels, where 75% of urban respondents had levels below 7%, while only 35% of rural respondents managed this level of control. Random blood sugar tests also favored urban respondents, with 80% achieving levels below 11.1 mmol/L, compared to 45% in rural areas. In terms of risk factors, both groups showed similar percentages for hypertension, obesity, and smoking, with 42% vs. 39% for hypertension, 65% vs. 53% for obesity, and 62% vs. 66% for smoking in urban and rural populations, respectively. Interestingly, a higher percentage of rural respondents (83%) consumed caffeinated drinks compared to urban respondents (67%). Health-related quality of life, measured by physical and mental component scores (PCS and MCS), showed no significant difference between urban and rural respondents, with both groups reporting similar scores (50±42.43 vs. 50±14.14 for PCS, and 50±35.36 vs. 50±7.07 for MCS). Overall, urban respondents displayed better glycemic control, while risk factors and quality of life were comparable across both groups.

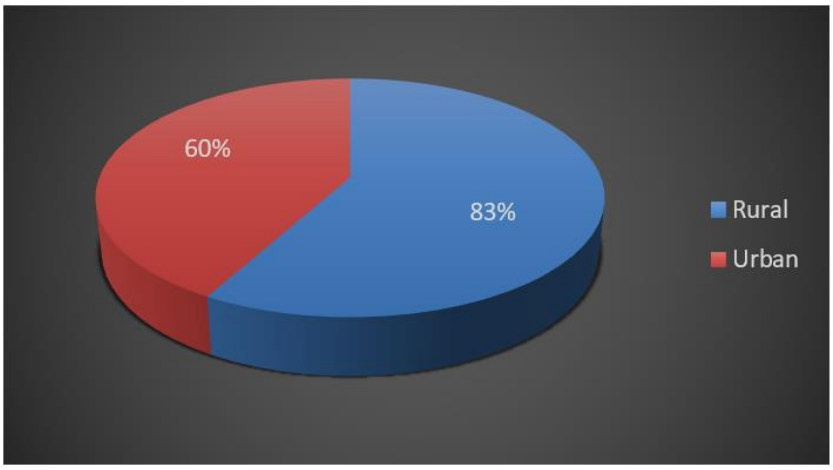

Figure 1: Outcome based on the number of complications

Figure 1 shows the outcomes based on the number of complications experienced by respondents in urban and rural settings. Among the respondents, a higher percentage of rural participants (83%) reported experiencing complications compared to urban participants (60%). This significant difference highlights the increased burden of complications in the rural population, which may be influenced by various factors such as access to healthcare, socioeconomic status, and lifestyle choices.

DISCUSSION

Our findings illustrate substantial disparities in the prevalence of T2D and prediabetes between urban and rural areas, with a focus on sociodemographic risk factors such as age, gander, hypertension, BMI, consumption of caffeinated beverages and medication, insulin, dietary management and physical activity. Our study we found, urban respondents, 35% were aged 20-30, while the rural group had a higher representation in this age group (45%), urban males at 40% and females at 50%, while the rural population had slightly more females (55%). Caffeinated drink consumption was more prevalent in rural areas (83%) compared to urban (67%), and smoking was also higher in rural areas (66% vs. 62% urban). Hypertension was slightly more common in urban respondents (42%) than in rural ones (39%). In terms of BMI, overweight and obesity were more frequent among urban participants (65%), while the rural population had a higher percentage of normal BMI individuals (36%). (Table-1) Our study revealed that older individuals, particularly those in the working-age and elderly categories, are at a significantly higher risk of developing diabetes compared to younger populations in both urban and rural areas of Bangladesh. This increased susceptibility in older age groups could be attributed to the natural decline in the body's ability to effectively process glucose as people age, leading to impaired insulin sensitivity and glucose metabolism. Additionally, aging is often accompanied by a reduction in physical activity levels, further exacerbating the risk of diabetes [16,17]. The association between age and diabetes in both urban and rural areas demonstrates that aging is a critical factor influencing diabetes risk, regardless of location or lifestyle. This highlights the urgent need for focused efforts to help older individuals prevent and manage diabetes through targeted interventions, such as promoting healthy habits, regular screenings, and tailored education programs. Our findings also emphasize the importance of healthcare systems being prepared for the anticipated rise in diabetes cases among older populations. Providing the necessary resources and developing tailored care strategies will be essential to addressing the complex health challenges associated with diabetes in this age group, ensuring that they receive comprehensive support to manage the condition effectively. Our study reveals an inverse relationship between higher education levels and the incidence of diabetes in both urban and rural Bangladeshi populations. This finding aligns with previous research, [18] suggesting that education plays a protective role against diabetes. Individuals with higher education levels are more likely to be aware of health risks and adopt healthier lifestyle choices, such as better dietary habits, increased physical activity, and regular medical check-ups. These behaviors can contribute to reducing the likelihood of developing diabetes, highlighting the importance of promoting educational initiatives as part of diabetes prevention strategies in both settings [19]. These findings highlight the critical role of education in preventing and managing diabetes, reinforcing the need for educational programs designed to improve health literacy among the Bangladeshi population. The evident connection between higher education levels and a reduced risk of diabetes suggests that enhancing educational attainment can be an effective strategy in addressing the growing diabetes epidemic. Consequently, it is crucial for policymakers and health intervention programs to incorporate educational initiatives as a fundamental element of their approaches. By prioritizing education, we can foster healthier behaviors and empower individuals across all

demographic groups to take proactive steps in managing their health, ultimately contributing to a significant reduction in the diabetes burden in Bangladesh [20]. It is essential to recognize that while education may not directly lead to a reduction in diabetes incidence, it significantly enhances health literacy and raises awareness of diabetes-related complications. This improved understanding can foster better adherence to dietary recommendations and healthier lifestyle choices among individuals. Given these insights, further research is needed to explore the mechanisms that underpin this relationship. Such investigations can inform the development of tailored educational interventions that effectively address the unique needs of diverse urban and rural communities [20,21] Our study indicates that individuals categorized as overweight are significantly more likely to develop diabetes, regardless of whether they reside in urban or rural areas. This finding is consistent with existing literature, which emphasizes that body weight, as measured by Body Mass Index (BMI), serves as a strong predictor of the risk for type 2 diabetes (T2D). For instance, research conducted in Bangladesh corroborates this association, highlighting that elevated BMI levels are linked to a heightened incidence of T2D [19,22].

One reason for this connection could be attributed to dietary behaviors characterized by the consumption of high-calorie and low-nutrition foods. Such dietary patterns can lead to insulin-induced weight gain, which significantly impairs blood sugar regulation [23]. Additionally, physical inactivity is prevalent in both urban and rural areas, further exacerbating the risk of diabetes among individuals who are overweight. A sedentary lifestyle, characterized by a lack of regular physical activity, can significantly contribute to weight gain and metabolic dysfunction, increasing the likelihood of developing type 2 diabetes. Research indicates that individuals who engage in minimal physical activity are more prone to insulin resistance and obesity, both of which are critical risk factors for diabetes. Given this context, there is an urgent need for public health programs tailored to promote weight management and encourage healthier food and exercise choices. These initiatives should be customized to address the distinct needs and circumstances of individuals living in urban versus rural settings in Bangladesh [24,25]. In rural areas, our study identified a significant association between type 2 diabetes (T2D) and individuals who consume caffeinated beverages, exhibit lower levels of physical activity, and have hypertension, particularly in urban regions. The relationship between caffeinated drinks and diabetes risk may be attributed to several factors. For instance, certain caffeinated beverages, especially those high in sugar and calories, can lead to weight gain and increased insulin resistance, which are critical risk factors for developing T2D [26]. Lower physical activity levels in rural areas are influenced by various occupational and lifestyle factors, contributing to weight gain and insulin resistance. While individuals may engage in labor-intensive jobs, such as farming, these activities may not meet recommended exercise levels, especially with increasing mechanization. Limited access to recreational facilities and cultural attitudes that prioritize work over leisure can further hinder regular physical activity [25,27]. In urban areas, a notable association exists between high blood pressure and diabetes, likely driven by lifestyle factors typical of city living. Stress, unhealthy eating habits, and sedentary behavior are common in urban environments, contributing to both conditions. The fast-paced lifestyle often leads to reliance on convenience foods, which tend to be high in sugar and unhealthy fats, exacerbating weight gain and insulin resistance [25,28,29].

These findings underscore the need for tailored strategies to address the health challenges faced by urban and rural populations. For rural communities, it's essential to promote reduced consumption of caffeinated beverages and to encourage more physically active occupations to combat the rising risk of diabetes. Meanwhile, urban areas should prioritize strategies aimed at controlling blood pressure, given its significant association with diabetes in these settings. This study highlights that prediabetes significantly impacts a considerable segment of the Bangladeshi population, both in urban and rural settings. Addressing prediabetes through effective management strategies is crucial, as it can play a vital role in curbing the escalating prevalence of type 2 diabetes (T2D) [30]. Moreover, managing prediabetes offers several significant benefits for both individuals and the healthcare system in Bangladesh. Firstly, effective control of prediabetes can prevent the progression to full-blown type 2 diabetes (T2D), alleviating the long-term burden of this chronic disease on individuals and their families [25]. Secondly, managing prediabetes not only enhances overall health but also significantly reduces the risk of diabetes-related complications such as heart disease and kidney disorders [31]. Moreover, addressing prediabetes can lead to more effective utilization of healthcare resources, potentially reducing the long-term economic burden and healthcare costs associated with managing diabetes [32].

Limitations of the study

Our study, conducted at a single center with a relatively small sample size, has certain limitations that may affect the generalizability of the findings. The short duration of the study means that the results may not fully reflect the broader population's experiences or trends in diabetes management across Bangladesh. Despite these limitations, our research presents several strengths. One notable advantage is the comprehensive comparison of the prevalence of type 2 diabetes (T2D) and associated management in both urban and rural settings, leveraging the latest Demographic and Health Survey data to enhance the reliability of our findings. However, the

study also faced challenges, including a significant number of missing values, which could potentially impact the robustness of our results. Furthermore, the limited set of risk factors examined may not capture the full range of influences on T2D prevalence. Lastly, the absence of data on other types of diabetes constrains the scope of our investigation and limits our ability to draw broader conclusions about diabetes management in Bangladesh.

CONCLUSION AND RECOMMENDATIONS

Our study provides compelling evidence that individuals living in metropolitan areas have a notably higher prevalence of type 2 diabetes (T2D) compared to those in rural settings. This finding highlights the impact of urbanization on health, as the lifestyle and environmental factors typical of urban living—such as sedentary behavior, dietary choices, and increased stress levels—contribute significantly to the development of T2D.

Moreover, the study reveals a concerning rise in pre-diabetes rates in both rural and urban populations. This trend signals a potential public health burden, as individuals with pre-diabetes are at an increased risk of progressing to full-blown diabetes and experiencing its related complications, including cardiovascular diseases, kidney failure, and neuropathies. The implications of these findings underscore the urgent need for targeted public health interventions. Our results resonate with existing literature that warns of an impending increase in the number of diabetic patients if proactive measures, such as awareness-building campaigns and preventative strategies, are not initiated. Such initiatives should be tailored to address the unique challenges and needs of both rural and urban populations. For instance, urban campaigns could focus on lifestyle modifications, nutrition education, and accessible physical activity programs, while rural initiatives might emphasize the importance of regular health screenings and access to healthcare services. This research significantly enhances our understanding of the disparity in T2D prevalence between rural and urban settings, suggesting that these differences are driven by a complex interplay of socio-economic, environmental, and lifestyle factors. As T2D continues to rise globally, it is crucial for epidemiologists, health policymakers, and researchers to work collaboratively. Developing a comprehensive program to combat this looming threat is essential, and it should prioritize increasing public awareness about diabetes prevention and management.

Acknowledgment

I would like to extend my heartfelt appreciation for the invaluable support and collaboration from the staff, participants, and my co-authors/colleagues who contributed to this study.

Financial support and sponsorship: No funding sources.

Conflicts of interest: There are no conflicts of interest.

Ethical approval: The study was approved by the Institutional Ethics Committee.

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