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Exploring and Comparison Study on Diabetic Patients Between Rural and Urban Area

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ABSTRACT

Nowadays, Diabetes is very common & fast-growing global problem with huge social, health, and economic consequences, 3 in 4 adults, in 2045 IDF projection shown that 1in 8 adult, approximately 783 million will be living with diabetes an increasing of 46%. Unbeknownst to us Over 90% of people with diabetes have type II diabetes, which is driven by socio-economic, demographic, environmental, and genetic factors. This study compares the experiences of diabetic patients in rural and urban areas. It's found in urban (8.1%) compared with rural populations (2.3%). Highlights differences in access to healthcare, lifestyle, and support systems. In urban areas, the fast-paced lifestyle and high stress in cities can negatively impact diabetes management. In rural areas, patients often have more physical activity and fresher food. Both environments present unique challenges for diabetic patients, affecting their ability to manage the condition effectively. In summary, Urban areas face challenges related to lifestyle changes, and stress, while rural areas struggle with healthcare access, education, and economic barriers. Urban strategies should emphasize lifestyle modifications and stress management, while rural strategies should enhance healthcare access and integrate traditional practices with modern medicine.

Keywords: Type-ii diabetes, genetic factors, fast-paced lifestyle, lifestyle modifications, modern medicine.

1. INTRODUCTION:

Diabetes is a chronic medical condition characterized by the inability to regulate blood sugar levels. It is classified into two types: insulin dependent diabetes mellitus (IDDM) and non-insulin dependent diabetes mellitus (NIDDM). The disease burden of type 2 diabetes, which accounts for 90-95% of all diabetes cases, has increased globally.(1)

India, the largest and most populous developing country in the South Asian region, has the second-largest diabetes population globally. Diabetes is caused by several risk factors, including environmental factors, proximity, diet routine, availability of fresh food, daily routine, work stress, physical exercise, and mental health.

The prevalence of diabetes for all age-groups worldwide was 2·8 % in 2000 and is estimated to be 4·4 % in 2030. The total number of people with diabetes was projected to rise from 171 million in 2000 to 366 million in 2030. In 2021, the global age standardised total diabetes prevalence was 6.1% and is expected to reach 10% by 2050 if the current trend continues.(2)

Now the diabetes is caused by several risk factor but we mainly focused on few particular points like 1. Environmental factor {Air pollution} 2. Other. {Diet, lack of exercise} For comparison of rural & urban

diabetes patients.

Rural areas often have limited access to healthcare service es, leading to delayed diagnosis and inadequate treatment for chronic conditions like diabetes. Factors such as longer travel distances, a shortage of medical professionals, and lack of diabetes education can exacerbate health risks. Rural lifestyles often include more physically demanding occupations, which can affect dietary habits and exercise routines.(3) Urban areas, despite better access to healthcare infrastructure, present challenges such as sedentary lifestyles, higher stress levels, unhealthy diets, pollution, and obesity rates.

Understanding these contrasting factors is crucial for developing targeted interventions and public health strategies aimed at reducing the burden of diabetes in both rural and urban areas. By exploring and comparing the experiences of diabetic patients in these two distinct environments, researchers can gain valuable insights into the role that geography, lifestyle, and healthcare access play in the management and prevention of diabetes. (4)

2. Aim of the study:

Prevalence of Diabetes: To determine and compare the prevalence rates of diabetes (Type 1 and Type 2) among rural and urban populations.

Identification of Risk Factors:

- To identify the key risk factors (such as obesity, physical inactivity, poor diet, and family history) contributing to diabetes in rural versus urban populations.
- To compare lifestyle-related factors, including dietary patterns, physical activity levels, and smoking habits, between the two groups.
- To explore the influence of environmental factors (e.g., pollution in urban areas, occupational hazards in rural areas) on diabetes prevalence.

Additionally, it focuses on patient awareness and education regarding diabetes, comparing the effectiveness of community-based programs in both regions.

Future Aspect: By understanding the key differences in lifestyle, awareness, and healthcare access between rural and urban populations, health authorities and policymakers can design targeted prevention programs. The findings may help promote early screening, healthier dietary habits, increased physical activity, and community education in both regions. Ultimately contributing to the reduction in new diabetes cases and better disease control in the future.

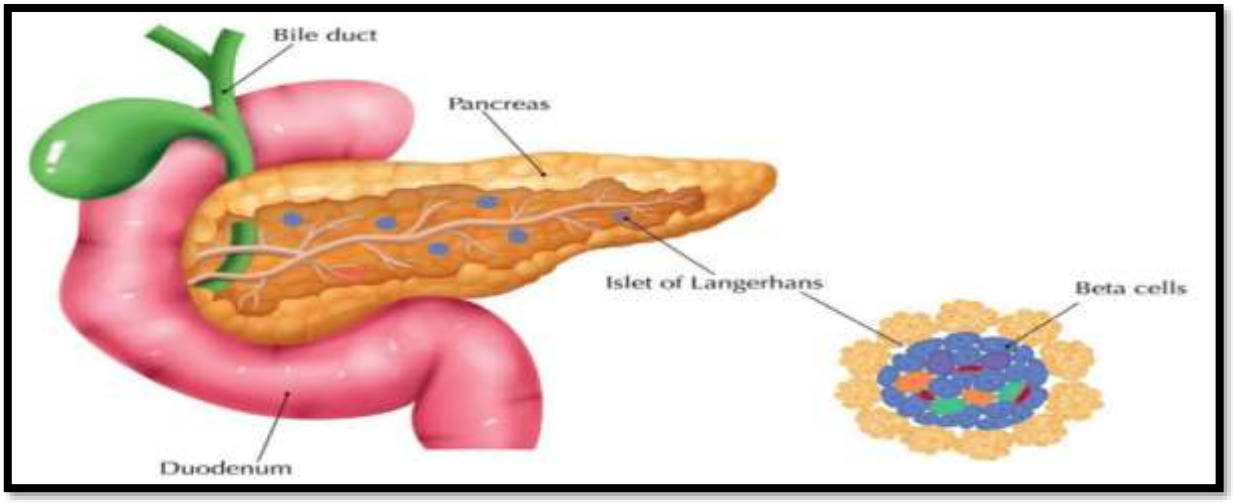

Fig. 01: Beta cell of pancreas responsible for insulin secretion

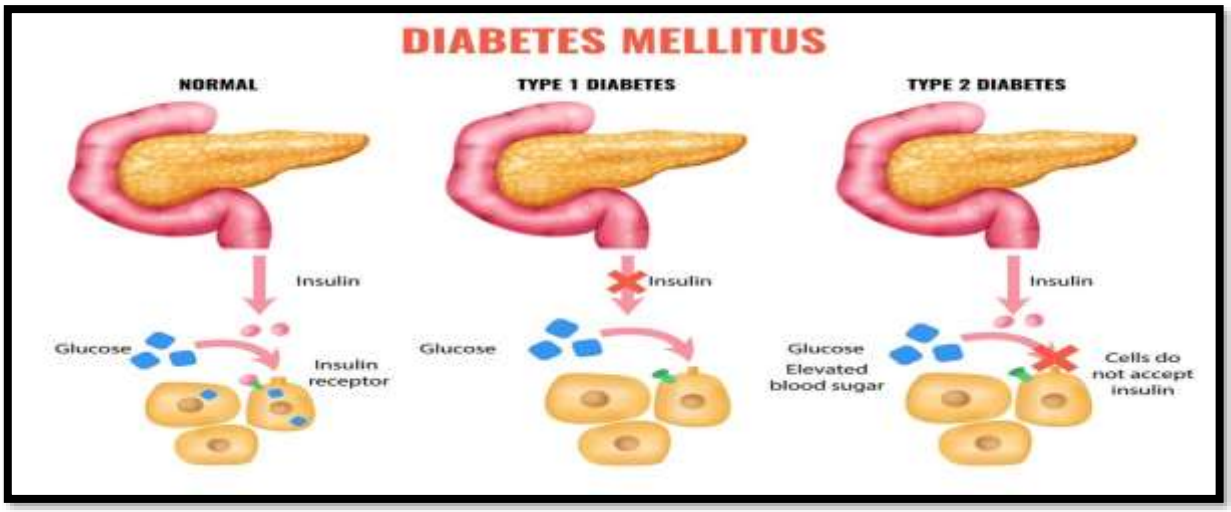

Fig. 02: Different types of diabetes & insulin action

3. Environmental Factor & Other Risk Factor with their Mechanism

Diabetes mellitus, particularly type 1 and type 2, is influenced by a wide range of risk factors that go beyond genetic predisposition. Among these, environmental factors and various lifestyle-related elements play a significant role in the onset and progression of the disease. Understanding how these risk factors contribute to the development of diabetes is crucial for effective prevention and control strategies. This section explores both environmental and non-environmental (other) risk factors, highlighting their mechanisms and potential impact on public health. The diagram below categorizes these risk factors for better visualization and understanding.

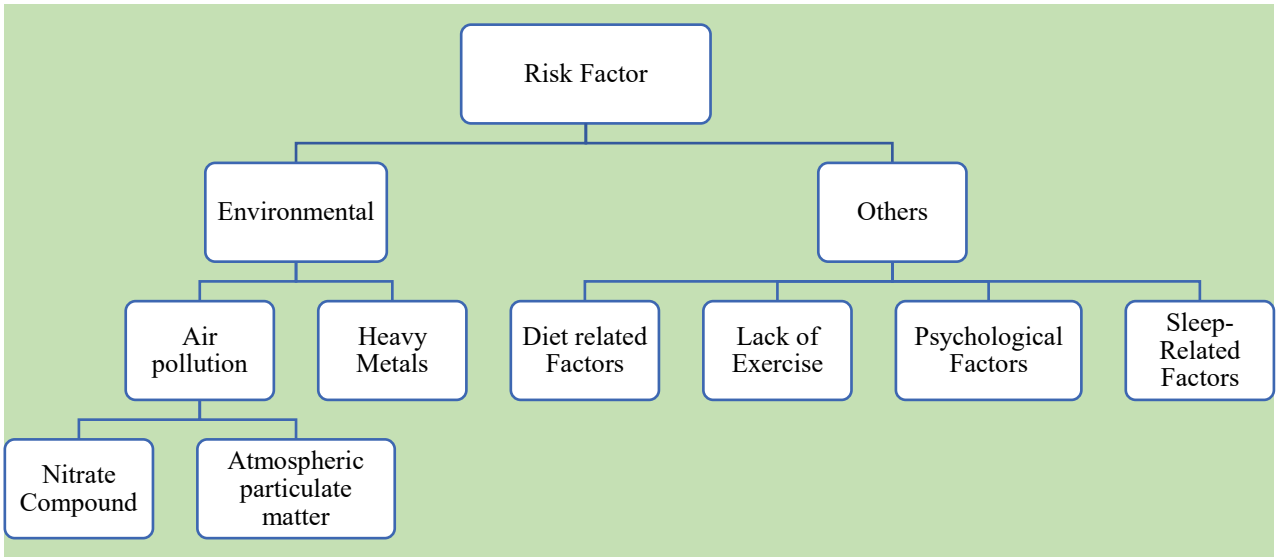

Fig. 03: Different risk factors of diabetes

3.1 Environmental Risk Factor

3.1.1Air pollution

Air pollutants can be classified as **gaseous pollutants** (sulphur compounds, nitrogen compounds, carbon oxides, etc.) and **atmospheric particulate matter** (PM10 and PM2.5).

Nitrates, Nitrites, and Nitrosamines: In the gastrointestinal tract, nitrates can be converted to nitrites, and nitrites can react with amines to form N-nitroso compounds. Drinking water can be contaminated with nitrates resulting from fertilizer application. Foods contain nitrates, nitrites, and N-nitroso compounds.(4)

Mechanism of Nitrate: The pathogenesis associated with this increase in the prevalence of T2DM may be attributed to stress-mediated insulin resistance and/or decreased insulin sensitivity, which results in T2DM development through inflammatory response, oxidative stress, and endoplasmic reticulum. The presence of air pollutants in the lungs can stimulate alveolar epithelial cells and macrophages to produce inflammatory factors, such as interleukin and macrophage inflammatory protein 2, and lead to the disorderly interaction of other mediators of systemic inflammatory response. During the process, islet inflammation leads to the destruction or apoptosis of islet cells and insulin sensitivity is reduced, which affects the utilization of glucose by peripheral tissues, thereby increasing the risk of DM.(5)

Statical data : Dijkema et al. conducted a cross-sectional study in which 8,018 elderly people were screened for DM. Tey concluded that the odds of developing type 2 DM increased to 1.39 when NO2 level in the atmosphere increased to 10 mg·m−3.(4)

Atmospheric particulate matter (PM10 and PM2.5):

Particulate matter is generic term to classify air pollutants comprising of suspended particles in air, varying in composition and size, resulting from various anthropogenic activities. Industrial facilities, Power plants, vehicles, incinerators, dust and fires are the major source of particulate matter. The particle size ranges between 2.5 mm ($PM_{2.5}$) and 10 mm (PM_{10}).(5)

Mechanism: The lungs are stimulated by external pollutants (such as PM2.5), they release reactive oxygen species (ROS) rapidly; the overaccumulation of ROS to levels that exceed those that can be normally removed by the body disrupts the balance between the oxidation and antioxidant systems, resulting in oxidative damage to the tissues and organs. Islet β-cells, which are sensitive to ROS, have low levels of antioxidant enzymes and poor antioxidant capacity. As a result, ROS can directly damage β-cells and lead to DM.(3)

Statical data: A longitudinal cohort study of the association of PM2·5 with diabetes. We built a cohort of US veterans with no previous history of diabetes from various databases. Our results suggest that there is a significant association between increased PM2·5 exposure and the risk of diabetes.(5)

3.1.2 Heavy Metals:

Heavy metals such as Iron (Fe), Zinc (Zn), Copper (Cu), and Lead (Pb) contribute to the development of diabetes primarily through oxidative stress and inflammation

Mechanism: These metals generate reactive oxygen species (ROS) that overwhelm the antioxidant defence system, leading to cellular damage, particularly in pancreatic β-cells which are highly susceptible to oxidative stress. The excessive ROS production triggers inflammatory pathways, including the activation of nuclear factor-kappa B (NF-κB) and other pro-inflammatory cytokines. This inflammatory environment further impairs insulin secretion and disrupts insulin signalling, contributing to insulin resistance.(6)

Statical Data: A study was conduct in southwest China, among people aged 40-75 years in rural areas, which suggest that Metals play an important role in diabetes mellitus. (6)

3.2 Others Factors:

3.2.1 Diet related Factors: Food intake has been strongly linked with obesity, not only related to the volume of food but also in terms of the composition and quality of diet. High intake of red meat, sweets

and fried foods, contribute to the increased the risk of insulin resistance and T2DM.

Mechanism: The pathophysiology of type 2 diabetes mellitus (T2DM) primarily involves insulin resistance and beta-cell dysfunction. Fructose metabolism in the liver promotes lipogenesis, increasing triglyceride levels and contributing to fatty liver, which further reduces insulin sensitivity. Excess intake of red meat, sweets, and fried foods induces chronic inflammation and oxidative stress, impairing insulin signalling. On the other hand, a diet rich in vegetables and fruits provides antioxidants, fiber, and essential nutrients, which reduce oxidative stress, enhance insulin sensitivity, and protect against T2DM. The imbalance between insulin secretion and insulin resistance results in hyperglycaemia, characteristic of T2DM.(3)

Statical data: Recently, evidence suggested a link between the intake of soft drinks with obesity and diabetes, resulting from large amounts of high fructose corn syrup used in the manufacturing of soft drinks, which raises blood glucose levels and BMI to the dangerous levels.(7)

In contrast, an inverse correlation was observed between intake of vegetables and T2DM. Consumption of fruits and vegetables may protect the development of T2DM, as they are rich in nutrients, fiber and antioxidants which are considered as protective barrier against the diseases.(7)

3.2.2 Lack of Exercise: Rapid economic and technological developments have greatly changed the way people commute, resulting in a significant decline in the levels of daily physical activity.

Mechanism: Exercise can accelerate the metabolism of glucose and energy, lead to the consumption of a large amount of glycogen, increase the proportion of capillary and muscle fibers, and promote the intake of glucose in the blood. On the completion of an exercise session, blood glucose is stored in the form of glycogen, leading to further blood glucose reduction. Consumption of glycogen reduces the secretion of insulin, promotes the corresponding receptor binding of insulin in the blood circulation to improve insulin resistance, and enhances glucose metabolism.(7)

Statical data: A meta-analysis performed in the United Kingdom of 1,261,991 people enrolled in 28 cohort studies showed that the risk of T2DM associated with moderate-intensity exercise was reduced by 26% with participation in exercise for 150 min per week, by 36% with participation in exercise for 300 min per week, and by 53% with participation in exercise for 800 min per week compared with that in individuals who did not exercise.(8)

3.2.3 Psychological Factors:

Mechanism: The currently known psychological stress-related mechanisms in terms of T2DM development mainly pertain to the autonomic nervous path ways, neuroendocrine mechanisms, and direct effects on the pancreas. Long-term psychological depression promotes the hypothalamic-pituitary-adrenal axis activity to increase cortisol secretion. The process not only reduces glucose utilization and promotes gluconeogenesis, but also raises blood glucose levels by antagonizing insulin production and inhibiting blood glucose utilization.(9)

Statical data: A meta-analysis of 20 articles, including 45,514 people, showed that the risk of DM in people with stress was1.80 times higher than that in the normal population showing that blood glucose control alone is not sufficient among people with DM.(3)

3.2.4 Sleep-Related Factors:

Mechanism: Lack of sleep is also associated with various metabolic disorders, as it enhances sympathetic activity, boosts catecholamine levels, and inhibits pancreatic function, thereby reducing insulin secretion. Current studies have shown that increased levels of inflammatory factors and mediators in patients with sleep disorders, including tumour necrosis factor-«, IL-6, IL 8, high-sensitivity C-reactive protein,

transcription factors, and adhesion factors, may affect human health through low-grade inflammation pathways.(10)

Increased levels of inflammatory factors are involved in the promotion of insulin resistance by sleep disorders. Difficulties in sleeping reduce the brain's glucose ingestion and insulin sensitivity, impair glucose tolerance, and induce insulin resistance to some extent. The irritability caused by long-term difficulty in falling asleep affects hypothalamic activity, especially in the hypothalamic-pituitary-adrenal axis that is associated with stress.

Statical data: In recent years, people's sleep time has shown a downward trend. The average daily sleep time of Chinese residents is 7.20 h, and the proportion of people with sleep insufficiency is 23.60%. Similarly, the proportion of young Americans who sleep for less than 7 hours/day has risen from 15.6% to 37.1% in the last 40 years(11)

4. Comparison of availability of risk factors in Rural & Urban Related to Diabetes

Urbanization in India has been associated with a higher prevalence of diabetes. According to studies, the prevalence of diabetes in urban areas ranges between 10-20% among adults. (12) Rapid urbanization has brought about lifestyle changes, including reduced physical activity, increased consumption of processed foods, and higher levels of stress, all contributing to the rise in diabetes cases.(13) Urban residents are more likely to have sedentary jobs, access to 37 calorie-dense diets, and face higher levels of pollution, which are significant risk factors for diabetic.(14)

4.1 Environmental Risk Factor

Factor		Rural Area	Urban Area
4.1.1Air Quality	PM2.5 (Fine Particulate Matter)	Rural regions typically have lower PM2.5 levels, often around 20–30 µg/m³.(8)	PM2.5 levels in densely populated urban areas in South India (e.g., Bengaluru, Chennai) can range from **40–80** $\mu g/m^3$.(8)
	PM10 (Coarse Particulate Matter)	Rural areas generally see PM10 levels closer to 40–60 µg/m³.(8)	PM10 levels in urban areas can range between 60–120 µg/m³.(8)
	Nitrogen Dioxide (NO_2):	Rural NO_2 levels are generally lower, around 10–20 µg/m³.(9)	O_2 levels in Indian cities are typically 20–50 µg/m³.(9)

4.1.2 Heavy Metals	In a Chinese study analysing vegetable-growing soils (Cd, Fe, Zn, copper and Pb)(6)	In rural 1.Lead (Pb) layer -1.74mg/kg 2.Zinc (Zn) layer 11.mg/kg 3.Copper (Cu) layer -4.39 mg/kg	In urban 1.Lead (Pb) layer -13.05mg/kg 2.Zinc (Zn) layer 55.44mg/kg 3.Copper (Cu) layer -6.68 mg/kg

4.2 Others Risk Factors

Factors	Rural	Urban
Psychological Factors	A study conducted in China found that among diabetic patients, 18% experienced depressive symptoms and 14% reported anxiety symptoms in urban settings.(10)	In Urban 30% experienced depressive symptoms and 25% reported anxiety symptoms in urban settings.(10)
Sleep-Related Factors	A study found that a significant portion of diabetic patients experience poor sleep quality, with approximately 64% reporting sleep disturbances. (11)	For instance, a study indicated that 72.3% of patients with type 2 diabetes experienced poor sleep quality, correlating with poor glycaemic control.(11)
Diet related Factors:	**Dietary Transition**: A study is conduct in west Africa in 7805 rural people aged between 25-64year. Found that the prevalence of impaired fasting glucose (IFG)3.0% in rural Area.(12)	**Dietary Habits:** In 7663 urban people aged between 25-64year. Found that the prevalence of impaired fasting glucose (IFG)6.6% in urban Area.(12)
Exercise	A study was conduct in 10069 individuals, between 20 and 70 years old (3036 individuals from rural and 7033 from urban areas), in Iran 2011. The prevalence in **the rural 7.4%.**(13)	The prevalence in the urban **settings was 11.1%** **Physical inactivity, abdominal obesity, and high blood pressure were the most important risk factors** associated with self-reported diabetes in Iran.(13)

5. Future Aspect

Now day's considering the modern development in contrast to rural & urban area Diabetes is very challenging for us, but if we maintain few limitations in our life its quite easy for us. (15)

Ultimately, the future implications of this study aim to contribute to reducing the healthcare disparity between rural and urban areas, creating a more equitable and effective approach to diabetes management across diverse communities. (16)

We can classify the future aspect in two type 9.1) Improvement of Personal Care 9.2) Improvement for the community. (17)

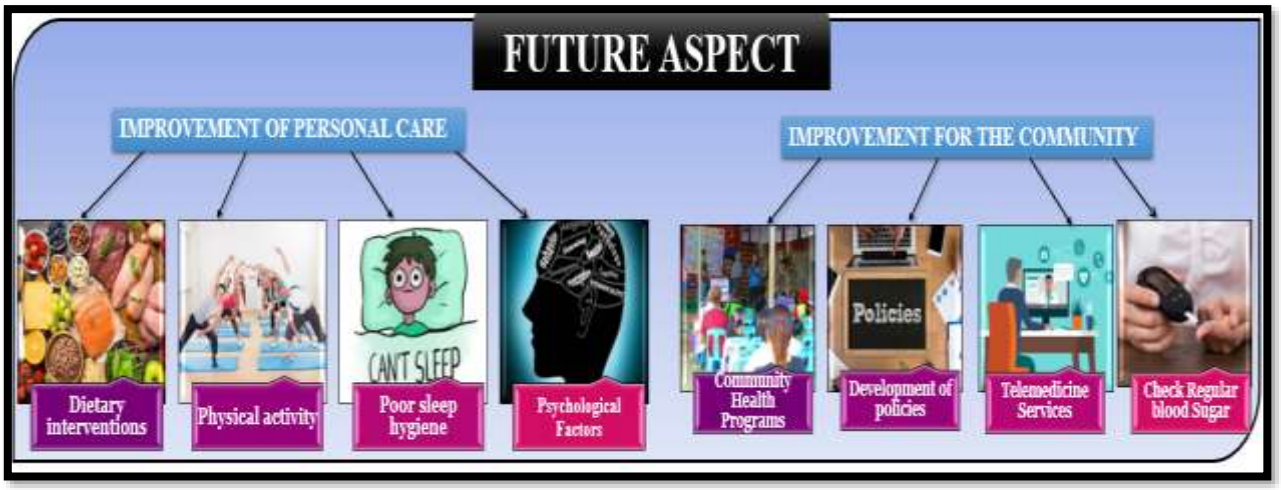

Fig. 04: Future aspect to prevent diabetic

Improvement of Personal Care

1. **Dietary Interventions**: Promote balanced diets rich in fruits, vegetables, and whole grains while reducing processed food consumption. (18)
2. **Physical Activity**: Encourage regular exercise programs tailored to individual needs, including yoga and aerobic activities.
3. **Poor Sleep Hygiene**: Address sleep disorders through awareness campaigns and lifestyle modifications. (19)
4. **Psychological Factors**: Provide mental health support to manage stress and emotional well-being, which are critical for diabetes management. (20)

Improvement for the Community

1. **Community Health Programs**: Organize diabetes awareness camps and screenings in both rural and urban areas.
2. **Development of Policies**: Implement policies to ensure accessibility to affordable medications and healthcare services. (21)
3. **Telemedicine Services**: Expand telemedicine platforms to provide remote consultations, especially in underserved rural areas.
4. **Regular Blood Sugar Checks**: Promote routine blood sugar monitoring through community-based initiatives and subsidized testing facilities.

6. Conclusion

The analysis reveals that urban areas, with their higher levels of air pollutants, sedentary lifestyles, and processed food consumption, present a greater risk for diabetes onset and complications. From this comparison, it is evident that diabetes is more likely to occur in urban settings due to the cumulative effect of pollution, stress, and lifestyle factors prevalent in these areas (22)

In this study, we explored the environmental causes and risk factors of diabetes, with a particular focus on pollutants and lifestyle influences in urban versus rural settings. (23). The analysis reveals that urban areas, with their higher levels of air pollutants, sedentary lifestyles, and processed food consumption, present a greater risk for diabetes onset and complications. In contrast, rural environments, while facing healthcare access challenges, generally have lower exposure to environmental toxins and benefit from more physical activity, which can mitigate some diabetes risks. (24)

In summary, Permanent cure of diabetes is not possible but in case of prediabetes, & diabetes patient if they regularly monitor their blood sugar level & avoid the different risk factors of it and improve quality lifestyle so, we can prevent the growth of diabetes across the world. (25)

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