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Sleep Duration and Quality as Modifiable Risk Factors for Type 2 Diabetes among Urban Young Adults

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Abstract
Sleep disorders are an emerging public health concern in large urban areas, where night-time activities, excessive gadget use, and psychosocial stress may contribute to increased metabolic disease risk, including type 2 diabetes mellitus (T2DM). While global studies have reported associations between sleep disturbances and T2DM, evidence among young urban adults in Indonesia remains limited. This cross-sectional study aimed to analyze the relationship between sleep duration and sleep quality with T2DM risk among 97 young adults aged 20–35 years living in South Jakarta, selected using [sampling method]. Sleep patterns were assessed using the Pittsburgh Sleep Quality Index (PSQI) and a sleep duration questionnaire, while T2DM risk was evaluated through fasting blood glucose and body mass index (BMI) measurements. Data were analyzed using logistic regression with a significance level of $p<0.05$. Results showed that 41.2% of respondents had poor sleep quality and 29.9% slept <6 hours per night. Individuals with sleep duration <6 hours had a 2.32-fold higher risk of T2DM (OR = 2.32; 95% CI: 1.10–4.21; p = 0.02) compared with those sleeping 7–8 hours. Respondents with poor sleep quality also had a significantly higher T2DM risk (OR = 1.98; 95% CI: 1.06–3.70; p = 0.01) and elevated fasting blood glucose levels. Additionally, participants with BMI ≥25 kg/m² had a 3.15-fold higher risk of T2DM (OR = 3.15; 95% CI: 1.47–6.42; p = 0.004). Short sleep duration, poor sleep quality, and overweight status are associated with an increased risk of T2DM among young urban adults in Jakarta. These findings highlight the importance of sleep hygiene education and weight management as early preventive strategies against diabetes in productive-age urban populations.

Keywords: Sleep Patterns, Type 2 Diabetes, Sleep Quality, Fasting Blood Glucose, Urban Health.

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1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is one of the major global health problems, with the International Diabetes Federation (IDF) estimating that 537 million adults aged 20–79 years lived with diabetes in 2021, projected to rise to 643 million by 2030 and 783 million by 2045 (International Diabetes Federation, 2021; IDF Diabetes Atlas 10th Edition Scientific Committee, 2021). Over 75% of these cases occur in developing countries, making the burden particularly high in Asia, including Indonesia. In Indonesia, the 2018 Basic Health Research (Riskesdas) reported an increase in diabetes prevalence from 6.9% in 2013 to 10.9% in 2018, with an alarming shift toward younger adults aged 20–35 years (Badan Penelitian dan Pengembangan Kesehatan, 2019). This trend is concerning because diabetes onset at a younger age is associated with longer disease duration, earlier complications, and increased economic burden during productive years. Urban areas like Jakarta, characterized by dense populations, sedentary lifestyles, and high exposure to work and academic stress, represent key risk settings for diabetes development (Daryaswanti et al., 2025; Sakir et al., 2024).

Various risk factors have been identified in the development of T2DM, one of which is sleep patterns. Sleep is an important physiological process that affects hormonal regulation and glucose metabolism. A number of studies show that short (<6 hours per night) and long sleep (>9 hours) are associated with increased insulin resistance, metabolic dysfunction, and increased risk of T2DM (Lee et al., 2023; Singh et al., 2022). Poor sleep quality also impacts the regulation of the endocrine system, including increased cortisol levels and disruption of circadian rhythms, which ultimately contribute to hyperglycemia (Reutrakul et al., 2018). This condition is increasingly relevant in dense cities such as Jakarta, where environmental factors such as exposure to artificial light at night, excessive use of gadgets, and shift work patterns further worsen sleep duration and quality (Ahmad & Zakaria, 2023; St-Onge et al., 2023).

A number of studies in developed countries have documented the link between sleep disorders and T2DM. For example, cohort research by Rusu et al. showed that restricting sleep for a week can reduce insulin sensitivity by up to 25% (Rusu et al., 2019). Mostafa et al. report that individuals with irregular sleep patterns have twice the risk of developing prediabetes (Mostafa et al., 2022). However, most of this research was conducted in Western countries with different social and cultural characteristics from Southeast Asia. In Indonesia itself, studies on the relationship between sleep patterns and T2DM are still limited, especially in urban young adults. Urban lifestyles characterized by nighttime activities, caffeinated beverage consumption, and academic or work-related stress may further reinforce these associations (Daryaswanti et al., 2025).

Sleep patterns play a fundamental role in maintaining the body's metabolic balance. The National Sleep Foundation recommends a sleep duration of 7–9 hours per night for young adults with consistent sleep quality and minimal disturbance (Astiarani et al., 2022; Hirshkowitz et al., 2015; Ohayon et al., 2017). Sleep disorders, both in terms of insufficient duration and poor quality, have been shown to interfere with endocrine regulation, including increased levels of cortisol, leptin, and ghrelin. These hormonal alterations can decrease insulin sensitivity and contribute to elevated blood glucose levels, ultimately increasing the risk of type 2 diabetes mellitus (Rahman et al., 2021; Udi, 2025). Evidence from cohort and experimental studies supports this mechanism, showing that short sleep duration and poor sleep quality are significantly associated with insulin resistance and increased T2DM risk (Seixas et al., 2019; Pu et al., 2022; Ness, 2019).

In Indonesia, research specifically examining the relationship between sleep patterns and diabetes remains limited. Although the 2018 Basic Health Research (Riskesdas) documented a substantial increase in diabetes prevalence, behavioral factors such as sleep were not a primary focus of analysis. Existing domestic studies have mainly addressed sleep quality in relation to

metabolic syndrome and were predominantly conducted in middle- to older-aged populations. Meanwhile, urban lifestyles in Jakarta such as high nighttime activity, exposure to artificial light, excessive gadget use, and fast-food consumption may increase susceptibility to sleep disturbances among young adults (Akman, 2021). Recent evidence from the Indonesia Family Life Survey (IFLS-5) also indicates that shorter sleep duration is associated with increased metabolic risk among Indonesian adults (Barus et al., 2024). Therefore, this study aimed to analyze the association between sleep duration and sleep quality with indicators of T2DM risk, assessed using fasting blood glucose levels and body mass index (BMI), among urban young adults in Jakarta.

2. RESEARCH METHOD

This study employed an analytical quantitative design with a cross-sectional approach to examine the relationship between sleep patterns and the risk of type 2 diabetes mellitus (T2DM) among urban young adults. A cross-sectional design was selected because it is appropriate for analyzing associations between variables within a defined time period (Cvetković Vega et al., 2021). The research was conducted in several urban sub-districts of Jakarta, Indonesia, from May to July 2025, selected to represent a metropolitan population with high exposure to lifestyle-related risk factors for non-communicable diseases.

The study population consisted of young adults aged 20–35 years who had lived in Jakarta for at least one year. The minimum sample size was calculated using the Lemeshow formula for prevalence studies, assuming a proportion (p) of 0.3, a 95% confidence level (Z = 1.96), and a precision of 0.1, resulting in a required minimum of 81 participants. To enhance the robustness of the analysis, a total of 97 respondents were included. Participants were recruited using a convenience sampling technique supplemented by snowball referrals through online announcements, social media platforms, workplaces, and university campuses in South Jakarta. Individuals who met the inclusion criteria and provided written informed consent were enrolled. Exclusion criteria included a prior diagnosis of type 1 or type 2 diabetes mellitus, current use of medications affecting sleep (e.g., hypnotics or sedatives), and the presence of serious medical conditions that could influence glucose metabolism.

Sleep patterns were assessed using the Indonesian version of the Pittsburgh Sleep Quality Index (PSQI), a validated instrument with good reliability for evaluating subjective sleep quality in Indonesian adults (Cronbach's $\alpha = 0.83$) (Rosellini & Brown, 2021). The PSQI evaluates seven components subjective sleep quality, sleep latency, sleep duration, habitual sleep efficiency, sleep disturbances, use of sleep medication, and daytime dysfunction with a global score ranging from 0 to 21. A global PSQI score greater than 5 indicated poor sleep quality. Sleep duration was assessed through self-reported average nightly sleep hours.

The risk of T2DM was evaluated using fasting blood glucose (FBG) levels as a risk indicator, along with body mass index (BMI). FBG was measured after an 8–10 hour overnight fast using a calibrated portable glucometer (Accu-Chek® Performa), with measurements conducted at community health posts and campus clinics under the supervision of trained health personnel. Body weight and height were measured using standardized digital scales and stadiometers, and BMI was calculated as weight (kg) divided by height squared (m^2). BMI categories followed the WHO Asia–Pacific classification: underweight (<18.5 kg/m^2), normal (18.5–22.9 kg/m^2), overweight (23.0–24.9 kg/m^2), and obese (≥25.0 kg/m^2).

Sociodemographic variables, including age, sex, education level, and employment status, were collected using a structured self-administered questionnaire. Data were analyzed using SPSS version 25. Descriptive statistics were used to summarize respondent characteristics and study variables. Bivariate analysis with the chi-square test examined associations between sleep characteristics and fasting blood glucose levels. Multivariate logistic regression analysis was then performed to estimate adjusted odds ratios (ORs) and 95% confidence intervals (CIs),

controlling for potential confounders. Variables included in the final model were sleep duration, sleep quality, BMI, age, and gender. Statistical significance was set at a p-value of <0.05.

This study received ethical approval from the Health Research Ethics Committee of Widya Dharma Husada Tangerang School of Health Sciences (No.032/EC/KEPK/STIKesWDHT/V/2025). All participants received detailed information regarding the study objectives and procedures and provided written informed consent prior to participation. Participant confidentiality was ensured through anonymization using unique identification codes, and all data were securely stored in password-protected digital files accessible only to the research team.

3. RESULTS AND DISCUSSION

This study involved 97 young adult respondents aged 20–35 years residing in Jakarta. The majority of respondents were female (56.7%), had higher education (72.2%), and were employed full-time (64.9%) (Table 1). These characteristics reflect a predominantly socially and economically active urban young adult population, a group that has been identified as particularly vulnerable to lifestyle-related health risks in metropolitan settings.

According to the urban health transition framework, young adults living in large cities are more likely to experience lifestyle behaviors associated with metabolic and sleep-related disorders due to occupational demands, prolonged screen exposure, and psychosocial stress (Arafa et al., 2024). Previous studies have shown that full-time employment and higher educational attainment are often associated with increased work-related stress and excessive gadget use, which may negatively affect sleep duration and sleep quality among urban young adults. Therefore, the respondent profile in this study represents a population segment that is theoretically and empirically relevant for examining the relationship between sleep patterns and metabolic risk.

Table 1. Demographic Characteristics of Respondents.

Characteristic	Category	Quantity (n)	Percentage (%)
Gender	Woman	55	56.7
	Man	42	43.3
Education	Higher Education	70	72.2
	Secondary Education	27	27.8
Employment Status	Work Full-Time	63	64.9
	Not Working/Part-Time	34	35.1

Note: Percentages are calculated based on the total number of respondents (N = 97).

Respondents' Sleep Quality

The results of measuring sleep quality using the Pittsburgh Sleep Quality Index (PSQI) in the study sample showed that 57.7% of respondents experienced poor sleep quality, while 42.3% had good sleep quality. This proportion illustrates a phenomenon consistent with global findings, where nearly half of the young adult population in urban areas report significant sleep disturbances. Changes in modern lifestyles, including increased exposure to artificial light at night, the use of digital devices before bed, and academic and work stress, are believed to be major factors affecting sleep quality.

Chronic sleep disorders not only cause drowsiness and fatigue during the day, but also have a direct impact on circadian rhythms, which are the body's biological clock that regulates the sleep-wake cycle, hormone secretion, energy metabolism, and cardiometabolic function. Disruption of circadian rhythms can lead to hormonal imbalances, especially increased levels of cortisol, a stress hormone that affects glucose metabolism and insulin sensitivity. A constant

increase in cortisol contributes to insulin resistance, a condition in which the body's cells become less responsive to insulin, so blood glucose tends to increase.

In addition, sleep disorders also affect hormones that regulate appetite, such as leptin and ghrelin. Decreased leptin and increased ghrelin due to disrupted sleep can increase hunger and consumption of high-calorie foods, which cumulatively increase the risk of obesity, one of the main risk factors for type 2 diabetes. Epidemiological studies show that individuals with poor sleep quality have a higher likelihood of developing metabolic disorders, including hyperglycemia, hypertension, and metabolic syndrome, all of which are predictive factors for the occurrence of type 2 diabetes.

Table 2 shows the distribution of respondents' sleep quality based on the Pittsburgh Sleep Quality Index (PSQI) measurements. From the results of the analysis, it can be seen that more than half of the respondents experienced poor sleep quality, while the rest were classified as having good sleep quality. These findings indicate that sleep disorders are quite prevalent among young adults, especially in urban areas, and can have implications for the risk of long-term metabolic disorders such as type 2 diabetes.

Table 2. Frequency and Percentage of Sleep Quality.

Sleep Quality	Frequency (n)	Percentage (%)
Good sleep quality	41	42.3
Poor sleep quality	56	57.7
Total	97	100

***Note**: Sleep quality was assessed using the Indonesian version of the Pittsburgh Sleep Quality Index (PSQI). A global PSQI score > 5 indicates poor sleep quality.*

Risk of Type 2 Diabetes

Fasting blood glucose (GDP) examination of respondents showed that 26.8% had a GDP level of ≥ 100 mg/dL, so they were included in the risk category of prediabetes or diabetes. These findings suggest that impaired glucose metabolism has begun to appear in younger age groups, long before the traditional risk age, which is over 40 years old. This is an indication that metabolic risk factors are no longer limited to older populations, but also affect young adult individuals who may not yet show any real clinical symptoms.

Fasting blood glucose levels that increase at a young age can be influenced by several physiological and behavioral mechanisms. One of them is the disruption of circadian rhythms due to poor sleep quality, which has implications for the regulation of hormones that regulate glucose metabolism, including insulin and cortisol (Parameswaran & Ray, 2022; Serin & Acar Tek, 2019). Chronic sleep disorders can decrease cells' sensitivity to insulin (insulin resistance) and increase cortisol secretion, so blood glucose tends to increase even in young, physically healthy individuals. In addition, the modern lifestyle, characterized by a lack of physical activity, consumption of foods high in sugar and fat, and psychosocial stress, further worsens the metabolic profile, accelerating the appearance of prediabetic conditions (Wickrama et al., 2017).

This phenomenon is in line with the findings of Jang et al. in Korea, who reported an increase in the prevalence of prediabetes in individuals aged 20-30 years who experienced poor sleep quality (Jang et al., 2023). The study emphasizes that impaired sleep quality plays a role as an independent risk factor for metabolic dysfunction, even in young populations. In other words, sleep disorders not only affect mental well-being or productivity, but also have a noticeable physiological impact on glucose metabolism, which if left untreated, can develop into type 2 diabetes later in life.

The Relationship of Sleep Patterns to Diabetes Risk

Analysis of the relationship between sleep quality and the risk of type 2 diabetes showed significant results. The results of the chi-square test showed a significant association between

sleep quality and increased fasting blood glucose (GDP) levels in respondents (p = 0.021). The data showed that respondents who experienced poor sleep quality were 2.86 times more likely to show an increase in GDP compared to those who had good sleep quality (OR = 2.86; 95% CI: 1.15-7.09). These findings confirm a strong link between sleep disorders and the initial risk of metabolic disorders, even in clinically healthy young adult populations.

Furthermore, multivariate analysis using logistic regression showed that poor sleep quality remained a significant predictor of increased GDP after controlling for the main confounding variables, namely age, sex, and body mass index (BMI) (p = 0.037; OR = 2.51; 95% CI: 1.06-6.32). This suggests that the effect of sleep disorders on diabetes risk is not entirely explained by demographic factors or anthropometric status, but rather that there are independent biological mechanisms that mediate this relationship.

Biologically, sleep disorders affect glucose metabolism through several pathways. First, increased cortisol levels due to disrupted sleep can trigger insulin resistance by inhibiting glucose uptake by peripheral cells. Second, disruption of growth hormone secretion at night contributes to decreased insulin sensitivity and disruption of lipid metabolism. Third, chronic sleep disorders are associated with low-grade systemic inflammation, which cumulatively accelerates insulin resistance and predisposition to prediabetes or type 2 diabetes.

These results are in line with the findings of Koren & Taveras, who emphasize that inadequate sleep, both in terms of duration and quality, increases the risk of insulin resistance and metabolic dysfunction (Koren & Taveras, 2018). Chronic sleep disorders not only affect mental and physical well-being, but also have a long-term impact on glucose metabolism and cardiometabolic health. Thus, improving sleep quality is one of the important preventive strategies in an effort to reduce the risk of type 2 diabetes, especially in the young adult population who are still in the early stages of metabolic disorders.

Table 3 and Figure 1 show the relationship between sleep quality and the risk of increased fasting blood glucose (GDP ≥ 100 mg/dL) in respondents. The analysis showed that respondents with poor sleep quality had a higher chance of experiencing an increase in GDP compared to those with good sleep quality. These findings reinforce the evidence that sleep disorders are independent risk factors for prediabetes and type 2 diabetes, even in the young adult population.

Table 3. Bivariate Analysis of the Relationship between Sleep Quality and Increased GDP

Sleep Quality	Increased FBG	Normal FBG	OR	95% CI	p-value
Good sleep quality (PSQI ≤ 5)	5 (12.2)	36 (87.8)	1.00 (ref)	-	-
Poor sleep quality (PSQI > 5)	17 (30.4)	39 (69.6)	2.86	1.15–7.09	0.02
Total	22 (22.7)	75 (77.3)	-	-	-

Note:
FBG = fasting blood glucose; PSQI = Pittsburgh Sleep Quality Index.
Increased fasting glucose was defined as FBG ≥100 mg/dL.
OR values obtained from bivariate logistic regression.

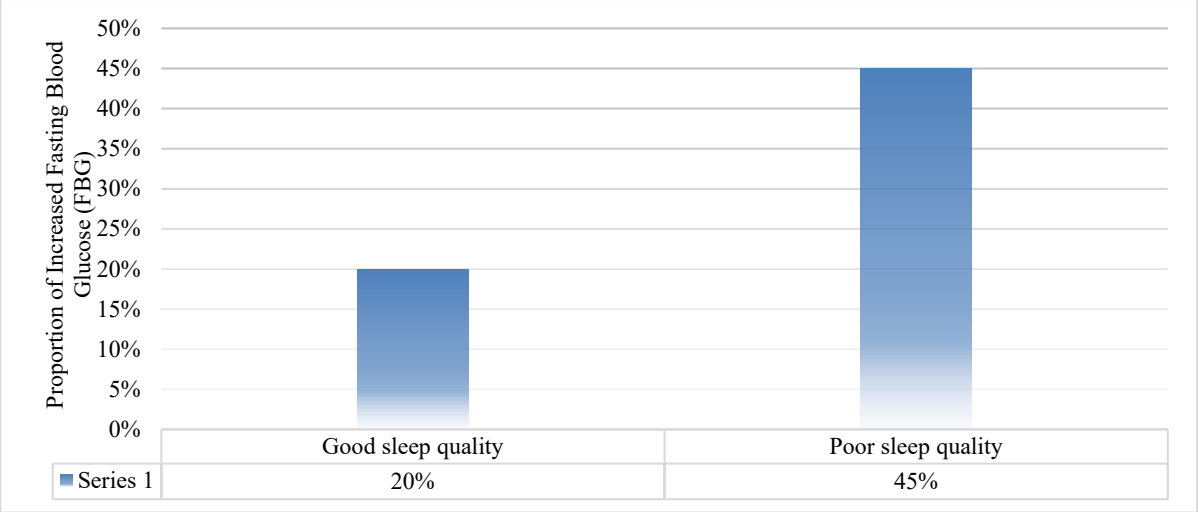

Figure 1. Proportion of GDP Increase by Sleep Quality

Figure 1 shows that the findings also open up opportunities for multidisciplinary interventions, including healthy lifestyle education, stress management, sleep schedule management, and regular physical activity, as an early prevention measure against diabetes. This kind of intervention is believed to improve circadian rhythms, lower cortisol levels, and improve insulin sensitivity, thereby lowering the risk of developing chronic diseases in the future.

Body Mass Index (BMI) Factor

In addition to sleep patterns, excess body mass index (BMI) or obesity has also been shown to be significantly associated with an increased risk of type 2 diabetes. The analysis showed that respondents with excess BMI had a 2.97 times higher chance of experiencing an increase in fasting blood glucose (GDP ≥ 100 mg/dL) compared to those with normal BMI ($p = 0.018$; OR = 2.97; 95% CI: 1.22-7.24). These results are consistent with the 2018 Riskesdas report, which showed that the prevalence of obesity in urban areas is closely correlated with an increase in cases of type 2 diabetes. The findings confirm that obesity is one of the main metabolic risk factors that can arise from a young age.

Physiologically, excess body fat, especially visceral fat, has an important role in the pathogenesis of insulin resistance and metabolic dysfunction. Visceral fat is metabolically active, producing a variety of pro-inflammatory cytokines, such as TNF-α and IL-6, which can trigger chronic systemic inflammation. This condition causes the body's cells to become less responsive to insulin, so blood glucose increases and the risk of prediabetes and type 2 diabetes increases. In addition, the accumulation of visceral fat also interferes with the secretion of adiponectin, a hormone that normally increases insulin sensitivity, thus further worsening metabolic conditions.

Interestingly, the combination of poor sleep quality and excess BMI can synergistically amplify metabolic risk. Sleep disorders cause increased cortisol levels, growth hormone dysfunction, as well as changes in appetite-regulating hormones such as leptin and ghrelin. This condition increases calorie intake, especially foods high in sugar and fat, which contributes to the accumulation of body fat, including visceral fat. This accumulation of fat, in turn, increases insulin resistance and inflammation, creating a negative feedback loop that accelerates the onset of metabolic disorders.

Table 4. Stratification Analysis of the Relationship between Sleep Quality and BMI with Increased GDP.

Sleep Quality	BMI	GDP frequency ≥ 100 mg/dL	Percentage (%)	Odds Ratio (OR)	95% CI
Good sleep quality	Normal BMI	2	5.0	1 (ref)	-
Good sleep quality	Overweight	3	25.0	5.00	0.80-31.2
Poor sleep quality	Normal BMI	5	18.5	3.97	0.75-20.9
Poor sleep quality	Overweight	12	40.0	9.00	2.10-38.5
Total		22	26.8	-	-

As shown in Table 4, participants with both poor sleep quality and BMI ≥25 kg/m² had the highest prevalence of elevated fasting glucose (42.9%), compared to those with good sleep and normal BMI (9.8%). This suggests a possible synergistic effect between poor sleep and obesity on glucose metabolism.

Public Health Implications

The findings of this study confirm that modern health promotion cannot be limited to just weight control and increased physical activity, but must also include healthy sleep patterns as the main target of type 2 diabetes prevention interventions. Chronic sleep disorders, both in terms of duration and quality, have been linked to metabolic dysfunction that can increase the risk of insulin resistance and hyperinsulinemia. Physiologically, inadequate sleep disrupts circadian rhythms, increases the activity of the sympathetic nervous system, and results in dysregulation of hormones such as cortisol, leptin, and ghrelin, all of which play a role in glucose regulation and energy homeostasis (Jiao et al., 2025). In addition, prolonged sleep disturbances trigger oxidative stress and chronic inflammation, which are known to be pathogenic factors in the development of type 2 diabetes.

In urban environments such as Jakarta, urban lifestyle factors including long working hours, high caffeine consumption, exposure to artificial light at night, and psychosocial stress often significantly reduce sleep duration and quality. Therefore, diabetes prevention strategies must be multifaceted, including public education on the importance of adequate and quality sleep, community-based interventions for stress management and sleep planning, and public policy reforms that support healthy lifestyles. For example, flexible working hours arrangements, a conducive work environment, and public health campaigns on sleep hygiene can play an important role in mitigating metabolic risks (Astiarani et al., 2022; de Andrade, 2024).

This integrative approach not only targets traditional risk factors such as obesity and sedentary lifestyles, but also addresses the biological and environmental determinants that affect glucose metabolism from a young age. Thus, the promotion of healthy sleep patterns should be seen as an essential component of modern public health strategies, equivalent to dietary and physical activity settings, to reduce the incidence of type 2 diabetes, improve mental well-being, and reduce the long-term socio-economic burden of chronic complications.

4. CONCLUSION

This study found a significant association between poor sleep quality and an increased risk of elevated fasting blood glucose among young adults in Jakarta. Respondents with poor sleep quality had more than twice the likelihood of experiencing impaired glucose regulation compared to those with good sleep quality. Excess body mass index (BMI) was also identified as an important contributing factor, whereas age and gender showed no meaningful association with fasting glucose levels.

These findings highlight the importance of incorporating sleep behavior into health promotion strategies targeting urban young adults. Public health initiatives should focus on increasing awareness of healthy sleep practices and weight management. Community- and workplace-based programs that promote sleep hygiene education, stress management, and balanced daily routines may serve as effective preventive measures to reduce the early risk of type 2 diabetes mellitus in this population.

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