# The Relationship of Risk Factors to Incidence Prediabetes Young Age Groups

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***Abstract***

*Prediabetes is increasingly prevalent among young adults, presenting a critical opportunity for early intervention to prevent the onset of type 2 diabetes and associated cardiovascular complications. This study investigates the association between selected lifestyle-related risk factors and prediabetes incidence among undergraduate medical students. A total of 50 students from Diponegoro University (cohorts 2021 and 2022) were enrolled through purposive and random sampling methods. Clinical assessments included fasting blood glucose and 2-hour oral glucose tolerance tests, analyzed using the hexokinase method. Data on obesity (body mass index), sleep quality (Pittsburgh Sleep Quality Index), physical activity (International Physical Activity Questionnaire–Short Form), and family history of diabetes were collected through validated instruments. The prevalence of prediabetes was significantly higher among students with obesity ($p < 0.001$), poor sleep quality ($p = 0.048$), low physical activity ($p = 0.005$), and a family history of diabetes ($p = 0.006$). Multivariate analysis identified obesity as the most influential independent predictor (OR 7.30, 95% CI: 1.61–33.20, $p = 0.010$). These findings highlight the urgent need for preventive strategies targeting modifiable risk factors in young populations. Interventions focusing on healthy weight management, regular physical activity, and sleep hygiene may play a pivotal role in mitigating early metabolic risk*

***Keywords:*** *Prediabetes, Young Adults, Sleep Quality, Physical Activity, Medical Students*

## INTRODUCTION

Prediabetes is a condition where blood glucose levels are elevated above normal, but not high enough to meet the diagnostic criteria for diabetes (Lawal et al., 2020). This metabolic disorder arises from impaired insulin secretion or action and may present as Impaired Fasting Blood Glucose (IFG) and/or Impaired Glucose Tolerance (IGT). Currently, the prevalence of prediabetes is surpasses that of diabetes, standing at 29.9% (Mujiono et al., 2023). In the United States, the Centres for Disease Control and Prevention (CDC) reports that 38% of adults aged18 and olderhave prediabetes, while in Indonesia, the prevalence is approximately 10% (Kusumaningrum et al., 2020; Wagenknecht et al., 2023).

In Semarang, the prevalence of prediabetes is reported at 17.15% (Kusumaningrum et al., 2020). In addition, the condition is increasingly affecting younger populations, including children and adolescents. Han et al. (2022) reported that the global prevalence of prediabetes in children reached 8.84%, with higher rates in children who had a family history of diabetes. In the United States, obese individuals exhibit a markedly higher prevalence of prediabetes

compared to those of normal weight (Andes et al., 2020). Prediabetes is associated with increased risk for type 2 diabetes, cardiovascular disease, cancer and dementia. Patients with prediabetes can experience heart disease before developing diabetes (Lawal et al., 2020). If left untreated, individual with prediabetes is at high risk of developing diabetes within few years (Tuso, 2014). Early intervention through lifestyle modification is essential to prevent cardiovascular complications and other organ damage (Lawal et al., 2020).

Diagnosis of prediabetes may be conducted using several methods, including measuring HbA1c levels, the Oral Glucose Tolerance Test (OGTT), and measuring Fasting Blood Glucose (FBG). FBG measurements are usually carried out after fasting for 8 hours or more (Rett & Gottwald-Hostalek, 2019; Sherwood, 2018). Preventing prediabetes at an early age requires timely identification of risk factors to reduce incidence (Andriani et al., 2022; Hyun et al., 2021). Common risk factors include obesity Body Mass Index (BMI) ≥25 , lack of physical activity, family history of diabetes, and poor sleep quality. Among these, obesity is the most important risk factor, primarily due to its role insulin resistance (Budiastutik et al., 2022). According to the CDC, individual with a BMI of 35 kg/$m^2$ have a 93 times greater risk of developing diabetes (Noor et al., 2022). In fact, moderate weight loss of 5-7% through lifestyle changes can reduce the risk of type 2 diabetes by up to 58%.

Insufficient physical activity also plays a substantial role. Inadequate physical activity can lead to excess fat deposition and insulin resistance. *The American Diabetes Association* (ADA) recommends at least 150 minutes of physical activity per week to prevent prediabetes (Zhang et al., 2024). Exercise helps lower blood sugar levels by increasing insulin sensitivity and helps maintain ideal body weight.

Additionally, a family history of diabetes increases the risk of prediabetes. Analysis of *German Center for Diabetes Research* showed that a family history of type 2 diabetes significantly increased the risk of prediabetes (Wagner et al., 2013). Poor sleep quality also contributes to the risk of prediabetes. Inadequate sleep increases risk of a person developing prediabetes up to 2.197 times more compared to an individual with good sleep quality (Ghorbani et al., 2015). Lack of sleep can accelerate the progression of prediabetes to type 2 diabetes, which occurs in 5-10% of individuals each year (Andriani et al., 2022; Chattu et al., 2019).

Risk factors such as obesity, insufficient physical activity, family history of diabetes, and poor sleep quality warrant serious consideration, particularly in younger demographics. Early identification and management of these risk factors may help prevent the progression to diabetes and associated complications. Further investigation targeting younger populations,

such as university students, is essential to better understand and enhance prediabetes prevention efforts. This study therefore aims to examine in depth the relationship between lifestyle-related risk factors and the incidence of prediabetes among undergraduate students at thethe Faculty of Medicine, Diponegoro University (cohorts 2021-2022).

## METHODS

This study employed an analytical observational design with a cross-sectional approach to investigate the association between selected risk factors and the incidence of prediabetes among young adults. The research was conducted among students from the Faculty of Medicine, Diponegoro University, specifically those enrolled in the 2021 and 2022 academic cohorts.

Participants were recruited using a two-stage sampling technique. In the first stage, purposive sampling was applied to classify individuals into obese and non-obese groups based on Body Mass Index (BMI) criteria. In the second stage, simple random sampling was conducted within each group to obtain representative samples. The minimum sample size was calculated using a standard formula for analytical cross-sectional studies, resulting in a target of 50 participants.

The inclusion criteria were students aged 18–25 years from the designated cohorts. Exclusion criteria included a prior diagnosis of diabetes mellitus, dyslipidemia, hypertension, cardiovascular disease, or recent glucocorticoid use (within preceding seven days).

Anthropometric measurements were performed using standardized protocols to calculate BMI (weight in kilograms divided by height in meters squared). Sleep quality was assessed using the Pittsburgh Sleep Quality Index (PSQI), and physical activity levels were evaluated using the International Physical Activity Questionnaire-Short Form (IPAQ-SF), both of which are internationally validated instruments. Additional questionnaires were administered to collect data on other relevant risk factors, such as family history of diabetes.

The independent variables included family history of diabetes, obesity status, sleep quality, and physical activity levels. The dependent variable was the incidence of prediabetes, determined through fasting blood glucose (FBG) and oral glucose tolerance test (OGTT) results, analyzed using the hexokinase enzymatic method in accordance with standard biochemical procedures.

Data analysis was conducted using SPSS software. Normality of continuous variables was assessed using the Kolmogorov–Smirnov test. Group differences were examined using either the independent t-test or Mann–Whitney U test, depending on data distribution.

Associations between categorical variables and prediabetes incidence were analyzed using the Chi-square test. A p-value of <0.05 was considered statistically significant.

Ethical clearance was obtained from the Health Research Ethics Committee of the Faculty of Medicine, Diponegoro University (Approval Number: 330/EC/KEPK/FK-UNDIP/VII/2024). No external funding was received for this study.

## RESULTS

A total of 50 respondents who met the inclusion criteria participated in this study and were further analyzed to describe the general characteristics and relationships between the variables studied.

**Table 1. General Characteristics of Research Samples**

| Variable | Prediabetes | | | | Total | |
|---|---|---|---|---|---|---|
| | Yes | | No | | | |
| | n | % | n | % | n | % |
| **Age (years)** | | | | | | |
| 19 | 3 | 16.7 | 6 | 18.8 | 9 | 18.0 |
| 20 | 6 | 33.3 | 12 | 37.5 | 18 | 36.0 |
| 21 | 9 | 50.0 | 14 | 43.8 | 23 | 34.0 |
| **Gender** | | | | | | |
| Male | 10 | 55.6 | 9 | 28.1 | 19 | 38.0 |
| Female | 8 | 44.4 | 23 | 71.9 | 31 | 62.0 |
| **Enrollment Year** | | | | | | |
| 2021 | 6 | 33.3 | 12 | 37.5 | 18 | 36.0 |
| 2022 | 12 | 66.7 | 20 | 62.5 | 32 | 64.0 |
| **Total** | **18** | **36.0** | **32** | **64.0** | **50** | **100.0** |

The average age was 20.4 ± 0.93 years, with the majority aged 20 (36.0%), followed by 21 (34.0%) years. The sample consisted predominantly of female (62.0%) and students from the class of 2022 (64.0%).

**Table 2. Characteristics of Prediabetes Types**

| Type of Prediabetes | Frequency | Percentage (%) (N = 18) |
|---|---|---|
| IFG | 16 | 88.89% |
| IGT | 4 | 22.22% |

**IFG, impaired fasting glucose; IGT, impaired glucose tolerance*

Among the 18 students diagnosed with prediabetes, most had IFG (88.89%), while 22.22% exhibited IGT. Some participants had both.

**Table 3. Specific Characteristics of the Research Samples**

| Variable | Prediabetes | | Total | |
|---|---|---|---|---|
| | n | % | n | % |
| **Family History of Diabetes** | | | | |
| Present | 11 | 61.1 | 18 | 36.0 |
| Absent | 7 | 38.9 | 32 | 64.0 |
| **Obesity Status** | | | | |
| Yes | 12 | 66.7 | 17 | 34.0 |
| No | 6 | 33.3 | 33 | 66.0 |
| **Sleep Quality** | | | | |
| Poor | 12 | 66.7 | 24 | 48.0 |
| Good | 6 | 33.3 | 26 | 52.0 |
| **Physical Activity Status** | | | | |
| Inactive | 13 | 72.2 | 23 | 46.0 |
| Active | 5 | 27.8 | 27 | 54.0 |
| **Total** | **18** | **36.0** | **50** | **100.0** |

Based on family history of diabetes, only a small portion of the sample had a family history of diabetes (36.0%). A total of 34% were obese, 48% had poor sleep quality based on PSQI scores, and 46% reported low physical activity based on IPAQ-SF.

**Table 4. Association Between Family History of Diabetes and Prediabetes Incidence**

| Family History of Diabetes | Prediabetes | | | | PR | r | 95% CI | p |
|---|---|---|---|---|---|---|---|---|
| | Yes | | No | | | | | |
| | n | % | n | % | | | | |
| Present | 11 | 61.1 | 7 | 21.9 | 2.79 | 7.697[a] | 1.58–19.89 | 0.006* |
| Absent | 7 | 38.9 | 25 | 78.1 | | | | |

**Chi-Square test significant (p < 0.05)*

Eleven students (61.1%) with family history of diabetes had prediabetes, while seven others did not. A significant association was observed between family history and prediabetes (PR 2.79, 95%CI 1.58-19.89; p=0.006).

**Table 5. Association Between Obesity Status and Prediabetes**

| Obesity Status | Prediabetes | | | | PR | r | 95% CI | p |
|---|---|---|---|---|---|---|---|---|
| | Yes | | No | | | | | |
| | n | % | n | % | | | | |
| Yes | 12 | 66.7 | 5 | 15.6 | 3.88 | 13.375[a] | 2.75 –42.01 | <0.001* |
| No | 6 | 33.3 | 27 | 84.4 | | | | |

**Chi-Square test significant (p < 0.05)*

Twelve students (66.7%) with obesity had prediabetes, while five did not. Obesity had nearly four times the risk of prediabetes compared to non-obese groups (PR 3.88, 95%CI 2.75-42.01; p<0.001).

**Table 6. Association Between Sleep Quality and Prediabetes**

| Sleep Quality | Prediabetes | | | | PR | r | 95% CI | p |
|---|---|---|---|---|---|---|---|---|
| | Yes | | No | | | | | |
| | n | % | n | % | | | | |
| Poor | 12 | 66.7 | 12 | 37.5 | 1.54 | 3.926[a] | 0.99 –11.22 | 0.048* |
| Good | 6 | 33.3 | 20 | 62.5 | | | | |

**Chi-Square test significant (p < 0.05)*

Twelve students (66.7%) with poor sleep quality had prediabetes, while twelve did not. Poor sleep quality was associated with a higher risk of prediabetes (PR 1.54, 95%CI 0.99-11.22, p=0.048).

**Table 7. Association Between Physical Activity Status and Prediabetes**

| Physical Activity Status | Prediabetes | | | | PR | r | 95% CI | p |
|---|---|---|---|---|---|---|---|---|
| | Yes | | No | | | | | |
| | n | % | n | % | | | | |
| Inactive | 13 | 72.2 | 10 | 31.3 | 1.87 | 7.785[a] | 1.60 –20.45 | 0.005* |
| Active | 5 | 27.8 | 22 | 68.8 | | | | |

**Chi-Square test significant (p < 0.05)*

Thirteen students (72.2%) with inactive physical activity status had prediabetes, while 10 did not. Low physical activity was significantly associated with prediabetes (PR 1.87, 95%CI 1.60-20.45; p=0.005).

**Table 8. Results of Multivariate Analysis**

| Variable | Beta | OR | 95% CI | p |
|---|---|---|---|---|
| Family History | 1.14 | 3.12 | 0.69–14.00 | 0.138 |
| Obesity Status | 1.99 | 7.30 | 1.61–33.20 | 0.010* |
| Sleep Quality | -0.64 | 0.53 | 0.11–2.54 | 0.424 |
| Physical Activity Status | -1.26 | 0.29 | 0.06–1.38 | 0.119 |

**Significant based on binary logistic regression test (p < 0.05)*

Multivariate analysis using binary logistic regression showed that only obesity remained significantly associated with prediabetes (OR 7.30, 95%CI 1.61-33.20; p=0.010). This indicates that, among the risk factors for prediabetes in this study, obesity status emerges as the most dominant risk factor.

## DISCUSSION

The study of subject characteristics showed that the majority of participants were 20 years old (36.0%), female (62.0%), students from the Faculty of Medicine, Diponegoro University Class of 2022 (64.0%), had no family history of diabetes (64.0%), were not obese (66%), and exhibited good sleep quality (52%).

A significant association was found between a family history of diabetes and the incidence of prediabetes. A *Chi-Square* test yielded a p value = 0.006, indicating a statistically significant correlation. Participants with a family history of diabetes had a 5.61-fold increased risk of developing prediabetes. Moonesinghe et al. (2018) supports this finding, noting that familial predisposition influences prediabetes incidence, despite generally low awareness of genetic risk factors. Studies on twins also show a strong genetic link to the risk of prediabetes. Mutations in genes such as TCF7L2, ABCC8, CAPN10, GLUT2, and GCGR has been shown to increase susceptibility to type 2 diabetes (Willemsen et al., 2015).

Obesity, particularly central obesity, showed the strongest association with prediabetes in this study. Bivariate analysis revealed a highly significant correlation ($p<0.001$), and logistic regression confirmed obesity as an independent risk factor. Obese students have a 7.30 times higher risk of developing prediabetes. This finding aligns with Rezavitawanti et al (2024), who reported a strong association between central obesity and the incidence of prediabetes ($p=0.001$). Increased BMI is often associated with impaired glucose metabolism, which can trigger prediabetes to develop into type 2 diabetes (Chai et al., 2022). Obesity also plays a role in exacerbating insulin resistance and chronic inflammation, which contribute to elevated blood sugar levels (Rezavitawanti & Helda, 2024).

Poor sleep quality was also showed a significant association with prediabetes. Participants with poor sleep had a 3.33 fold higher risk than those with good sleep quality. The p value of 0.048 in the correlation test *Chi-Square* showed that sleep quality is significantly related to the incidence of prediabetes. This is supported by previous study by Ghorbani et al (2015) which also proves that individuals with poor sleep quality have a higher risk of developing prediabetes. Sleep disturbances may elevate cortisol and catecholamines levels, leading to reduced insulin sensitivity and impaired glucose regulation (Amelia et al., 2020).

Low physical activity likewise associated with increased prediabetes risk. The Chi-Square correlation test shows a value of $p=0.005$ between physical activity status and the incidence of prediabetes. This findings aligns with the study by Ghoraba et al (2016), which emphasized a positive relationship between physical activity and prediabetes, proven that the majority of prediabetic respondents have less physical activity. Regular physical activity enhances muscle insulin sensitivity, thereby supporting blood glucose regulation and reducing risk..

Overall, lifestyle-related factors, including family history of diabetes, obesity, poor sleep quality, and insufficient physical activity, play a significant role in the development of

prediabetes among young adults. Early and sustained lifestyle modifications are critical to mitigating these risks and preventing associated complications.

## CONCLUSIONS

This study identified a significant association between modifiable lifestyle factors, including obesity status, family history of diabetes, sleep quality, and physical activity, and the incidence of prediabetes among young adults. Among these variables, obesity emerged as the most influential independent predictor, with obese individuals demonstrating more than a seven-fold increased risk of developing prediabetes compared to their non-obese peers. Although family history of diabetes, poor sleep quality, and low physical activity levels were significantly associated with prediabetes in the bivariate analyses, only obesity retained statistical significance in the multivariate model. These findings underscore the urgency of early detection and intervention strategies tailored to young populations to prevent the progression from prediabetes to type 2 diabetes.

Based on these results, several policy actions are recommended. First, universities should adopt routine metabolic screening programs, including BMI assessments and glucose tolerance testing, to facilitate early identification of at-risk students. Second, structured health education programs focusing on non-communicable disease prevention, covering nutrition, sleep hygiene, and physical activity, should be integrated into academic curricula to improve students' health literacy. Third, institutional support for physical activity through incentive-based programs, accessible facilities, and integrated wellness platforms is essential to encourage active lifestyles. Additionally, campus health services should also offer regular sleep assessments and evidence-based counseling for students experiencing poor sleep quality. Finally, individuals with a family history of diabetes should be prioritized for targeted interventions, including personalized counseling, ongoing lifestyle monitoring, and preventive health planning. Aligning these initiatives with national non-communicable disease prevention frameworks could significantly reduce the future burden of prediabetes and its complications among young adults.

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