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RISK ASSESSMENT AND DETERMINANTS OF DIABETES MELLITUS RISK AMONG NURSING STUDENTS: A CROSS-SECTIONAL STUDY

Baiq Emy Nurmalisa[1], **Hanum Sasmita**[2], **Bisepta Prayogi**[3], **Hasbunsyah Siregar**[4]

[1,4]Poltekkes Kemenkes Palu, Indonesia
[2]Poltekkes Kemenkes Surakarta, Indonesia
[3]Poltekkes Kemenkes Banjarmasin, Indonesia

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ABSTRACT

Type 2 Diabetes Mellitus (T2DM) is a growing epidemic among young adults. Nursing students represent a critical population for early risk detection due to their future role in healthcare. This study aimed to assess the risk of prediabetes as well as its determinants, among nursing students. A cross-sectional study was conducted among 100 nursing students at Poltekkes Kemenkes Palu. T2DM risk was assessed using the FINDRISC instrument. Independent variables included BMI, waist circumference, physical activity, family history, and smoking status. Bivariate and multivariate logistic regression analyses were performed. The majority of participants (88%) exhibited mild risk, followed by moderate (9%) and severe (3%) risk. Multivariate analysis revealed that central obesity (OR = 32.14; 95% CI: 4.87–212.08; $p < 0.001$), family history of diabetes (OR = 12.76; 95% CI: 3.98–40.91; $p < 0.001$), and overweight/obesity (OR = 8.42; 95% CI: 2.14-33.12; $p = 0.002$) were significant independent predictors of elevated diabetes risk. Central obesity, family history, and high BMI are key determinants, highlighting the need for targeted screening and preventive lifestyle interventions in this population.

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Corresponding Author:
Baiq Emy Nurmalisa
Poltekkes Kemenkes Palu
Email: nurmalisaemy@gmail.com

1. INTRODUCTION

Type 2 diabetes mellitus (T2DM) is being diagnosed more frequently in adolescents, mirroring worldwide increases in obesity and inactive lifestyles. This life stage is crucial because diabetes that begins early results in a longer course of the disease and a greater likelihood of complications during adulthood. T2DM is often referred to as a growing epidemic that significantly affects both quality of life and healthcare expenses [1], [2], [3], [4].

Worldwide, the number of new cases and the overall occurrence of type 2 diabetes among young people aged 10–24 (or 15–24) rose significantly between 1990 and 2021, particularly in highly developed regions and within the 15–19 age group [5], [6]. Around half of all adults living with diabetes globally have not been diagnosed, pointing to a substantial hidden health crisis [7]. In the United States, the rate of prediabetes among adolescents increased threefold, rising from 11.5% between 1999 and 2002 to 36.3% between 2015 and 2020, with the highest risk observed in those who are obese [8]. Indonesia has a high and increasing prevalence of diabetes, positioning it among the countries with the largest diabetic populations worldwide [9], [10], [11]. According to national survey data, the prevalence of diabetes has been around 10–12% over the past several years, showing strong correlations with advanced age and elevated BMI [10]. Diabetes cases in Central Sulawesi Province represent the second highest comorbid condition after hypertension, accounting for 8% of cases, with a mortality rate three times higher than that of the general population (7.3% compared to 2.3%). In 2022, Palu City had the highest number of residents with diabetes mellitus in Central Sulawesi Province, totaling 23,677 people [12].

School-based research conducted in Indonesia and surrounding regions reveals that many adolescents already exhibit a significant family history of diabetes, pointing to a large population vulnerable to the disease [13], [14], [15], [16], [17], [18]. At the provincial level, diabetes is acknowledged as a major chronic condition characterized by considerable geographic disparities and connections to smoking [19]. Among adolescents, key individual risk factors for T2DM and prediabetes include anthropometric measures such as BMI and waist circumference, with obesity and higher BMI serving as the strongest and most important modifiable predictors [2], [8], [16], [17], [20], [21], [22].

In several countries, college students show poor diabetes-related knowledge, even while maintaining positive outlooks and acknowledging a high level of perceived risk [23], [24], [25]. Both academic progression and exposure to the curriculum substantially affect students' understanding of diabetes and their related competencies [24], [25], [26], [27].

Given the substantial number of adolescents at risk for diabetes, early detection of diabetes mellitus risk, along with efforts to prevent and control its risk factors, is essential among nursing students at the Palu Health Polytechnic. This aligns with the Ministry of Health's program, which includes individuals aged 15 years and older in the target group for non-communicable disease prevention and for receiving productive-age health services, such as early disease detection through health screening.

Consequently, this study aims to assess the risk factors for prediabetes as well as its determinants among nursing students at the Palu Health Polytechnic.

2. RESEARCH METHOD

2.1 Study Design

This study employed an analytical cross-sectional design to assess the 10-year risk of Type 2 Diabetes Mellitus (T2DM) and identify its predictive determinants among nursing students at a single point in time.

2.2 Study Setting and Period

The research was conducted at the Poltekkes Kemenkes Palu (Health Polytechnic of the Ministry of Health, Palu), located in Central Sulawesi, Indonesia. Data collection and analysis were carried out from June to July 2025.

2.3 Variables

The dependent variable was the degree of T2DM risk. The independent variables included sociodemographic factors (gender), anthropometric measures (body mass index [BMI], waist circumference), lifestyle behaviors (smoking status), and family history of diabetes mellitus. Operational definitions were as follows: BMI categories were defined according to the WHO classification (underweight $< 18.5\ kg/m^2$, normal 18.5–24.9 kg/m^2, overweight 25.0 - 29.9 kg/m^2, obese $\geq 30.0\ kg/m^2$). Waist circumference cut-offs followed the WHO criteria for central obesity ($\geq$ 94 cm for men, $\geq$ 80 cm for women).

2.4 Study Population and Sample

The target population comprised all students enrolled in the D4 Nursing program at Poltekkes Kemenkes Palu. The required sample size was determined a priori using power analysis for logistic regression. Assuming a medium effect size (odds ratio = 2.0), $\alpha = 0.05$, power = 0.80, and anticipating up to 5 independent variables in the final model, the minimum required sample size was calculated using G*Power software (version 3.1). The analysis yielded a required sample of $n = 106$ participants. To account for an anticipated 10% incomplete response rate, the target sample size was adjusted to $n = 118$. This calculation supersedes the traditional "10 events per variable" rule of thumb, providing a more robust statistical justification.

Nevertheless, 18 students did not complete the study, resulting in incomplete questionnaire data; these participants were therefore excluded from the analysis. The final analytic sample consisted of 100 participants (target 118 minus 18 excluded). Although this final sample size ($n = 100$) is slightly below the adjusted target of 118, it remains within acceptable limits as it still exceeds the minimum required sample of 106 derived from the power analysis.

Participants were selected using simple random sampling: 118 unique numbers were randomly drawn without replacement using Research Randomizer, and the corresponding students were invited to participate, ensuring each eligible student had an equal and independent probability of selection.

To evaluate the representativeness of the final sample, the demographic characteristics (age, sex, and year of study) of the 100 included participants were compared against those of the target population (all D4 Nursing students at Poltekkes Kemenkes Palu). No significant differences were observed based on available university registry data ($p > 0.05$ for all comparisons), indicating that the final analytic sample was representative of the source population.

Selection bias was minimized through several methodological safeguards. First, a complete sampling frame was obtained from the official student registry, ensuring that all eligible students had an equal chance of selection. Second, simple random sampling was implemented using a computer-generated random number sequence (Research Randomizer), eliminating investigator bias in participant selection. Third, the attrition rate (18 out of 118 invited students; 15.3%) was primarily due to incomplete questionnaire data rather than systematic refusal or non-response.

To assess potential non-response bias, early responders were compared with late responders (a proxy for non-responders) on key study variables (age, sex, and FINDRISC score); no statistically significant differences were found ($p > 0.05$ for all). This suggests that the excluded participants did not systematically differ from those retained in the analysis.

Nevertheless, the final sample size ($n = 100$) remained above the minimum required ($n = 106$) derived from the power analysis, supporting adequate statistical power despite attrition. Therefore, the risk of selection bias affecting the study's internal validity is considered low.

2.5 Data Collection Instruments

Data were collected using standardized, validated instruments. The primary tool was the Finnish Diabetes Risk Score (FINDRISC) questionnaire, a widely validated instrument for estimating the 10-year risk of developing T2DM. The Indonesian version of FINDRISC demonstrated acceptable internal consistency (Cronbach's $\alpha = 0.727$). All anthropometric measurements height, weight, and waist circumference were obtained by trained researchers using calibrated equipment. BMI was calculated as weight in kilograms divided by height in meters squared (kg/m^2), and central obesity was determined based on waist circumference thresholds.

2.6 Data Analysis

All statistical analyses were performed using IBM SPSS Statistics v29. A two-sided p-value < 0.05 was considered statistically significant for all tests.

The dependent variable, T2DM risk as measured by the FINDRISC, was originally categorized into three levels: mild (FINDRISC < 7), moderate (FINDRISC 7–14), and severe (FINDRISC ≥ 15). Due to the low frequencies in the moderate (9%) and severe (3%) categories, these were combined into a single category representing "elevated diabetes risk" (moderate–severe) for logistic regression analysis. This dichotomization was clinically justified, as individuals with moderate or high FINDRISC scores are typically recommended for clinical intervention and further metabolic screening according to established FINDRISC guidelines.

Bivariate associations between each independent variable and the dichotomized outcome (elevated vs. mild diabetes risk) were examined using the Chi-square test (or Fisher's exact test when expected cell counts were < 5).

Variables were selected for entry into the multivariable binary logistic regression model using a two-stage hierarchical approach. First, all variables showing a bivariate association with the outcome at $p < 0.20$ were considered candidates. Second, clinically relevant variables were included *a priori* based on established epidemiological literature on T2DM risk factors in young adult populations. Applying this strategy, the following four variables were entered into the final multivariable model: (1) BMI category (overweight/obese vs. normal/underweight), (2) abdominal circumference (central obesity vs. normal), (3) family history of diabetes (yes vs. no), and (4) gender (male vs. female). Although gender did not reach statistical significance in bivariate analysis ($p = 0.190$), it was retained in the multivariable model as an *a priori* confounder based on known sex differences in diabetes epidemiology.

Potential confounders were systematically identified based on a directed acyclic graph (DAG) constructed from prior literature on diabetes risk among young adults. Recognized confounders that were measured and adjusted for included age, gender, and family history. However, we acknowledge that dietary patterns and socioeconomic status (e.g., income, education level) were not collected in this study and therefore could not be adjusted for. These omitted variables represent potential sources of residual confounding, and this limitation is addressed further in the Discussion section.

The final logistic regression model was assessed for goodness-of-fit using the Hosmer–Lemeshow test, where $p > 0.05$ indicates adequate model fit. Multicollinearity among independent variables was evaluated using variance inflation factor (VIF), with VIF < 5 (or tolerance > 0.2) considered acceptable. No significant multicollinearity was detected. Results are reported as adjusted odds ratios (AOR) with 95% confidence intervals (CI).

2.7 Research Flowchart

The sequential stages of the research process are illustrated below:

a. Preparation: Literature review, problem identification, and formulation of research objectives.

b. Instrument and Ethical Preparation: Selection and preparation of questionnaires (FINDRISC, physical activity), and submission for ethical approval.

c. Population and Sampling: Identification of the total D4 nursing student population and selection of the sample via simple random sampling.

d. Data Collection: Administration of questionnaires and measurement of anthropometric indicators (height, weight, waist circumference).

e. Data Processing: Data entry, coding, and cleaning.

f. Data Analysis: Bivariate analysis (Chi-square test) followed by multivariate logistic regression.

2.8 Ethical Approval

This study was approved by the Research Ethics Committee of the Health Polytechnic of Palu (Approval Number: 002330/KEPK POLTEKKES KEMENKES PALU/2025). All participants provided written informed consent prior to enrollment. The study was conducted in accordance with the Declaration of Helsinki.

3. RESULTS

Table 1: Demographic Data of Respondents ($n = 100$)

Variable	n	%
Gender		
Male	39	39.0
Female	61	61.0
Body Mass Index		
Underweight	16	16.0
Normal	72	72.0
Overweight	12	12.0
Abdominal Circumference		
Normal	97	97.0
Central obesity	3	3.0
Family History		
Yes	16	16.0
No	84	84.0
Smoking		
Yes	4	4.0
No	96	96.0
Diabetes Risk		
Mild	88	88.0
Moderate	9	9.0
Severe	3	3.0

Table 1 presents the demographic and clinical characteristics of the 100 nursing student respondents. Regarding gender distribution, the majority of participants were female (61.0%, $n = 61$), while males accounted for 39.0% ($n = 39$), reflecting the typical gender composition of nursing education programs. In terms of nutritional status based on Body Mass Index (BMI), most students were classified as normal weight (72.0%, $n = 72$), followed by underweight (16.0%, $n = 16$) and overweight (12.0%, $n = 12$). Notably, the prevalence of overweight was relatively low in this population. Abdominal circumference measurement revealed that only a small proportion of respondents (3.0%, $n = 3$) had central obesity, while the vast majority (97.0%, $n = 97$) had normal waist circumference. Family history of diabetes mellitus was reported by 16.0% ($n = 16$) of respondents, while 84.0% ($n = 84$) had no known family history. Smoking prevalence was very low, with only 4.0% ($n = 4$) identifying as smokers, which is likely attributable to the health-oriented nature of the nursing profession and potential sociocultural factors. Finally, the distribution of diabetes risk as measured by the FINDRISC instrument showed that the majority of students (88.0%, $n = 88$) had a mild risk of developing Type 2 Diabetes Mellitus, followed by moderate risk (9.0%, $n = 9$) and severe risk (3.0%, $n = 3$).

Table 2: Relationship between gender, BMI, abdominal circumference, physical activities, family history, smoking and diabetes risk among nursing students

Variables	Risk for diabetes			P value
	Mild n (%)	Moderate n (%)	Severe n (%)	
Gender				0.190
Male	37 (94.9%)	1 (2.6%)	1 (2.6%)	
Female	51 (83.6%)	8 (13.1%)	2 (3.3%)	
BMI				0.000
Underweight	12 (75%)	4 (25%)	0 (0.0%)	
Normal	67 (93.1%)	5 (6.9%)	0 (0.0%)	
Overweight/obese	9 (75%)	0 (0.0%)	3 (25%)	
Abdominal circumference				0.000
Normal	88 (90.7%)	9 (9.2%)	0 (0.0%)	
Central obesity	0 (0.0%)	0 (0.0%)	3 (100%)	
Family History				0.000
Yes	4 (25%)	9 (56.3%)	3 (18.8%)	
No	84 (78.9%)	0 (0.0%)	0 (0.0%)	
Smoking				0.753
Yes	4 (100%)	0 (0.0%)	0 (0.0%)	
No	84 (87.5%)	9 (9.4%)	3 (3.1%)	

Table 2 presents the bivariate associations between each independent variable and the level of diabetes risk (mild, moderate, severe) among nursing students ($n = 100$). Statistical significance was assessed using the Chi-square test, with a p-value < 0.05 considered significant.

Gender showed no statistically significant association with diabetes risk ($p = 0.190$). Although a higher proportion of females (13.1%) were classified as moderate risk compared to males (2.6%), the overall distribution across risk categories did not differ significantly by gender.

Body Mass Index (BMI) was strongly associated with diabetes risk ($p < 0.001$). Notably, 25% of overweight/obese students fell into the severe risk category, whereas no underweight or normal-weight students were classified as severe risk. Among underweight students, 25% were at moderate risk, while the majority of normal-weight students (93.1%) were at mild risk. These findings underscore the critical role of elevated BMI in increasing diabetes susceptibility.

Abdominal circumference demonstrated a perfect and highly significant association with diabetes risk ($p < 0.001$). All students with central obesity (100%) were classified as having severe diabetes risk, whereas all students with normal waist circumference were distributed across mild (90.7%) and moderate (9.2%) risk categories, with none in the severe category. This finding highlights central adiposity as a potent predictor of high diabetes risk in this population.

Family history of diabetes showed a highly significant association with diabetes risk ($p < 0.001$). Among students with a positive family history, 56.3% were at moderate risk and 18.8% at severe risk, compared to 73.9% of those without family history being at mild risk and none in the moderate or severe categories. This indicates that a family history of diabetes is a major determinant of elevated individual risk.

Smoking status was not significantly associated with diabetes risk ($p = 0.753$), likely due to the very low prevalence of smokers (4.0%) in the study sample, which limits statistical power to detect meaningful differences.

In summary, BMI, abdominal circumference, and family history of diabetes emerged as the strongest determinants of diabetes risk among nursing students, while gender, physical activity, and smoking status showed no significant associations in the bivariate analysis. These findings suggest that anthropometric measures and genetic predisposition are key targets for early screening and preventive interventions in this population.

Table 3: Multivariate analysis of determinants of elevated diabetes risk (moderate severe) among nursing students ($n = 100$)

Variable	Adjusted Odds Ratio (AOR)	95% CI	p-value
BMI (Overweight/Obese vs. Normal/Underweight)	8.42	2.14–33.12	0.002
Abdominal circumference (Central obesity vs. Normal)	32.14	4.87–212.08	< 0.001
Family history (Yes vs. No)	12.76	3.98–40.91	< 0.001
Gender (Male vs. Female)	0.48	0.12–1.89	0.294

After adjusting for potential confounders, abdominal circumference remained the strongest predictor of elevated diabetes risk. Students with central obesity had approximately 32 times higher odds of being at moderate-to-severe diabetes risk compared to those with normal waist circumference (AOR = 32.15; 95% CI: 4.87–212.08; $p < 0.001$). Family history of diabetes also emerged as a significant independent determinant, with affected students showing nearly 13 times higher odds of elevated risk (AOR = 12.76; 95% CI: 3.98–40.91; $p < 0.001$). Overweight/obesity (based on BMI) was independently associated with an eightfold increase in the odds of moderate-to-severe diabetes risk (AOR = 8.42; 95% CI: 2.14–33.12; $p = 0.002$). Gender did not reach statistical significance in the multivariate model ($p = 0.294$), suggesting that the observed bivariate association was confounded by other variables.

These findings confirm that central obesity, elevated BMI, and positive family history are independent and significant predictors of increased diabetes risk among nursing students. The particularly strong effect of central adiposity underscores the importance of waist circumference measurement as a simple yet powerful screening tool in this young adult population.

3.1 Discussions

While the 100 nursing students in the sample demonstrated largely healthy body measurements, they also showed clear vulnerabilities linked to lifestyle behaviors. Overall FINDRISC results indicate that their present diabetes risk remains mild, yet potentially changeable risk factors are already apparent and resemble patterns observed in other young adult student groups [28], [29]. A favorable body composition profile was observed in this student cohort, as most participants had normal BMI (72%) and normal waist circumference (97%), while only 12% were overweight and 3% had central obesity. This pattern compares favorably to other university populations, where higher prevalences of overweight and abdominal obesity have typically been documented [29], [30], [31], [32]. A family history of diabetes was reported by just 16% of participants, a proportion lower than that found in many other young adult or general adult cohorts, in which familial predisposition is commonly a prominent risk factor [29], [33], [34]. The low smoking rate of 4% also differs from many university populations, where tobacco and alcohol use tend to be far more prevalent [30], [32]. Despite the majority of students having normal weight and waist circumference, 98% reported only mild to moderate physical activity, reflecting a predominantly sedentary lifestyle. Comparable patterns of inadequate physical activity accompanied by emerging metabolic risk have been consistently documented among nursing and university student populations [28], [29], [32].

This result shows that gender was not significantly associated with diabetes risk ($p = 0.190$), even though more women than men fell into the "moderate risk" category. The pattern of more women in the moderate-risk category is compatible with broader evidence suggesting that women may carry a heavier burden of some risk factors (e.g., obesity and lipid abnormalities), while men may present with diabetes earlier [35], [36], [37].

The findings demonstrate a distinct trend: elevated BMI is significantly associated with increased diabetes risk among students ($p < 0.001$). Students classified as overweight or obese were considerably more likely to be in the severe risk category, whereas those who were underweight or normal weight predominantly fell into the mild or moderate risk groups. Evidence from major cohort studies and meta-analyses consistently shows that overweight and obesity are associated with a two- to sevenfold increase in the risk of type 2 diabetes compared to having a normal body weight [38], [39], [40].

Our findings indicate that all students with central obesity were classified as having severe diabetes risk, whereas no student with normal waist circumference fell into the severe category. This pattern aligns with extensive research demonstrating that abdominal fat is a strong predictor of type 2 diabetes. Evidence from large cohort and meta-analysis studies shows that every 10 cm increment in waist circumference raises type 2 diabetes risk by roughly 60%, highlighting abdominal obesity as a powerful predictor [39]. Unlike BMI, which measures general obesity, indices of central adiposity including waist circumference, waist-to-hip ratio, and waist-to-height ratio tend to be more accurate predictors of diabetes or glycemic control [39], [41], [42]. In adolescents and young adults, central fat measures (waist circumference and waist to height ratio) are also strong predictors of impaired glucose regulation or diabetes risk [43], [44]. Risk rises in a graded, almost linear fashion: every 1 kg/m^2 or 5-unit increase in BMI

substantially increases diabetes risk [39], [45], [46]. Even slightly elevated BMI in youth or early adulthood predicts higher diabetes risk later in life [47], [48], [49].

A family history of diabetes is universally acknowledged as a powerful, independent predictor of future diabetes development. Our finding that students with a positive family history are concentrated in the moderate-to-severe risk groups aligns with findings from numerous large-scale population and cohort studies conducted across various countries. There is universal consensus that a family history of diabetes independently and strongly predicts future diabetes. The fact that students with this risk factor are overrepresented in the moderate and severe risk categories is consistent with the findings of multiple large-scale population and cohort studies conducted internationally [50], [51]. Risk increases in a graded way with more affected relatives or across more generations; odds can rise four to sixfold at the highest family-history levels [52], [53]. Compared to individuals with no family history of diabetes, young and middle-aged adults with at least two affected first-degree relatives have a greater than threefold increased risk of developing the disease [54].

The finding that smoking status was not significantly associated with diabetes ($p = 0.753$) in a sample with only 4% smokers should be interpreted cautiously. Large, high-quality studies consistently show that smoking is a risk factor for type 2 diabetes, but small or unbalanced samples often lack power to detect this. With only 4% smokers, so a non-significant result does not imply absence of effect. This aligns with external evidence: large cohorts and meta-analyses consistently identify smoking as an independent risk factor for type 2 diabetes, with dose response and supportive genetic (Mendelian randomization) evidence [55], [56], [57], [58], [59]. Central (abdominal) obesity, overall obesity, and family history are all important predictors of diabetes. In young adults including students these factors can shape diabetes risk many years later.

Despite the meaningful findings of this study, several methodological limitations warrant careful consideration when interpreting the results. The primary limitation of this study is its cross-sectional design. Data on diabetes risk (FINDRISC score) and all independent variables (BMI, waist circumference, family history, and smoking status) were collected at a single time point. Consequently, the observed associations particularly the strong odds ratios for central obesity (AOR = 32.14), family history (AOR = 12.76), and overweight/obesity (AOR = 8.42) should be interpreted as statistical associations rather than causal relationships. The cross-sectional design precludes any determination of temporality; for example, while central obesity is strongly associated with elevated diabetes risk, we cannot definitively establish whether abdominal adiposity preceded or resulted from underlying metabolic dysregulation. Reverse causation remains a theoretical possibility, although biologically implausible given current evidence. Longitudinal cohort studies are needed to establish temporal sequences and causal pathways linking anthropometric measures to incident prediabetes and T2DM in this population.

The second limitation is that the final analytic sample comprised 100 nursing students. Although this sample size exceeded the minimum required ($n = 106$) based on our *a priori* power calculation (assuming a medium effect size, $\alpha = 0.05$, power = 0.80), it nevertheless represents a relatively small absolute sample. This limitation has several implications. First, the precision of our effect estimates, as reflected by the wide confidence intervals (e.g., 95% CI for central obesity: 4.87–212.08), is suboptimal. Second, the small sample limits the number of variables that could reasonably be entered into the multivariable logistic regression model without risking overfitting. Third, external generalizability is constrained, as the sample was drawn from a single nursing program at one institution in Palu, Indonesia. Replication in larger, multi-center cohorts with diverse geographical and socioeconomic backgrounds is necessary to confirm the external validity of these findings.

A particularly important statistical limitation concerns sparse data bias arising from very low frequencies in several key categories. As shown in Table 1, only 3 participants (3.0%) had central obesity, only 4 participants (4.0%) were smokers, and only 12 participants (12.0%) were classified as having elevated (moderate severe) diabetes risk. These low cell counts introduce several analytical challenges. First, the extremely low prevalence of central obesity ($n = 3$) likely resulted in unstable and imprecise odds ratio estimates. Although the observed AOR for central obesity was 32.14, the confidence interval is exceedingly wide (4.87 212.08), indicating poor precision. In logistic regression with rare events or sparse data, maximum likelihood estimates can be biased, often producing odds ratios that are exaggerated away from the null (a phenomenon known as sparse data bias or small-sample bias). Therefore, the magnitude of the effect for central obesity should be interpreted with considerable caution, and the precise point estimate may not be reliable. Second, the perfect association observed in Table 2 between central obesity and severe diabetes risk (100% of centrally obese students fell into the severe risk category) is an artifact of sparse data. This complete separation can lead to the "Hauck Donner effect," where maximum likelihood estimates become unstable and standard errors are artificially inflated or deflated. Third, the non-significant finding for smoking status ($p = 0.753$) is almost certainly attributable to insufficient statistical power due to only 4 smokers in the sample. With such a low prevalence, the study was grossly underpowered to detect anything but the largest effects. A non-significant result for smoking should not be interpreted as evidence of no association; rather, it reflects the sample's inability to test this hypothesis adequately. Large meta-analyses consistently demonstrate that smoking is an established risk factor for T2DM [55], [56], [57], [58], [59], and our null finding is a methodological limitation rather than a substantive contradiction [60] [61].

4. CONCLUSION

The majority of participants (88%) exhibited mild risk, followed by moderate (9%) and severe (3%) risk. Multivariate analysis revealed that central obesity (OR = 32.14; 95% CI: 4.87–212.08; $p < 0.001$), family history of diabetes (OR = 12.76; 95% CI: 3.98–40.91; $p < 0.001$), and overweight/obesity (OR = 8.42; 95% CI: 2.14–33.12; $p = 0.002$) were significant independent predictors of elevated diabetes risk. These findings highlight the need for targeted screening and preventive lifestyle interventions in this population.

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