

# The Relationship between Knowledge Levels, Physical Activity Levels, and the Incidence of Type 2 Diabetes Mellitus in Individuals Aged $\geq 40$ Years within the Anak Tuha Public Health Center Service Area in 2024

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Type 2 diabetes mellitus is a chronic condition in which the body cannot use insulin effectively. Risk factors for type 2 diabetes mellitus include factors that can be changed (knowledge, nutritional intake, physical activity and stress levels) and cannot be changed (age, gender, and genes). The purpose of the study was to determine the relationship between the level of knowledge, the level of carbohydrate and fat adequacy, the level of physical activity and the level of stress with the incidence of type 2 diabetes mellitus at the age of  $\geq 40$  years in the working are of Anak Tuha Public Health in 2024. The quantitative research method used a case-control design with a population of 343 patients, while the sample consisted of 72 people, 36 cases and 36 control groups. The study was conducted on July 17 - August 17, 2024, using a purposive sampling technique. Instruments used were questionnaires, 24-hour Recall Forms, and easy-touch glucometer devices. The bivariate tests used were the chi-square test and the Mann-Whitney test. The results showed that there was a significant relationship between the level of knowledge ( $p$ -value=0.000), the level of physical activity ( $p$ -value=0.00) and the incidence of type 2 diabetes mellitus.

**Keywords:** Knowledge, Activity, Timed Blood Glucose, Type 2 Diabetes Mellitus.

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## 1. Introduction

Type 2 Diabetes Mellitus (T2DM) is a metabolic disorder characterized by the body's inability to effectively utilize glucose for energy, leading to insulin resistance and elevated blood sugar levels. T2DM is the most dominant form of diabetes, accounting for approximately 95% of all cases globally [1][2]. The global prevalence of Diabetes Mellitus (DM) has reached a staggering 10.5% (537 million people) and is projected to rise to 12.2% by 2045. This trend is particularly high in low-to-middle-income countries, including Indonesia. In Indonesia, the prevalence of DM rose from 6.9% in 2013 to 8.5% in 2018. Specifically, Lampung Province recorded a prevalence of 0.99% in 2018, with Central Lampung at 0.89%. However, a critical spike was observed in Anak Tuha, where the prevalence reached 12.8% among those aged 15–64. Data from the 2024 Semester 1 PKP shows that DM is the second most common disease at the Anak Tuha Health Center, with 115 registered patients [3][4][5].

Diabetes significantly impacts health and quality of life. Chronic complications include physical decline due to nerve and blood vessel damage, diabetic retinopathy (blindness), cardiovascular diseases, kidney failure, and impotence. Furthermore, diabetic neuropathy can lead to diabetic foot ulcers, increasing the risk of infection and amputation, thus necessitating long-term intensive care [6][7].

Risk factors for DM are generally categorized into modifiable and non-modifiable factors. Modifiable factors include knowledge levels regarding DM, obesity driven by excessive carbohydrate and fat intake, sedentary

lifestyle (lack of physical activity), and stress [8][9][10][11][12][13]. Non-modifiable factors include age, gender, and genetics [14][15][13].

Individuals over the age of 40 are at the highest risk. This demographic often experiences decreased physical activity and declining bodily functions, making them more prone to weight gain and insulin resistance. Consequently, this study focuses on patients aged 40 and above [14][16][15][13]. Poor knowledge of DM often leads to a lack of dietary management and blood sugar control [17]. Excessive carbohydrate and fat consumption directly correlate with insulin resistance [8], while regular physical activity is essential for maintaining insulin sensitivity [11]. Additionally, chronic stress triggers hormonal imbalances that elevate glucose levels [9].

A preliminary study of 10 samples conducted on December 27, 2023, at the Anak Tuha Health Center revealed that: (1) 50% of patients had Random Blood Glucose (GDS) levels >200 mg/dL. (2) 100% had a "Poor" level of knowledge regarding DM. (3) 60% had "Excessive" carbohydrate and fat intake (via 24-hour recall). (3) 20% had low physical activity levels, while 90% reported moderate stress levels. These findings highlight an urgent need for interventions to improve patient knowledge, dietary management, physical activity, and stress management among T2DM patients at the Anak Tuha Health Center.

## 2. Literature Review and Problem Statement

The global escalation of Type 2 Diabetes Mellitus (T2DM), which constitutes approximately 95% of all diabetes cases, underscores a critical public health challenge, particularly in low-to-middle-income nations like Indonesia. Current literature emphasizes that metabolic stability is heavily contingent upon modifiable risk factors, where health literacy and physical exertion serve as primary determinants of insulin sensitivity. While systemic reviews by Ismail et al. (2021) and Kyrou et al. (2020) establish a broad correlation between sedentary lifestyles and insulin resistance, there remains a discernible research gap concerning the localized socio-behavioral dynamics in high-prevalence rural regions such as Anak Tuha[18][8]. Previous studies often fail to integrate specific regional spikes such as the 12.8% prevalence observed in Anak Tuha with a rigorous analysis of the specific odds ratios associated with knowledge deficits and physical inactivity in populations aged 40 and above. Consequently, analyzing these localized variables is essential to move beyond descriptive statistics toward targeted, evidence-based clinical interventions.

Despite the established clinical frameworks for T2DM management, the Anak Tuha Public Health Center has reported a persistent rise in cases, with preliminary data indicating a 100% "poor" knowledge level and widespread sedentary behavior among the target demographic. This discrepancy between theoretical health guidelines and actual local health outcomes raises a fundamental research question: To what extent do specific knowledge deficits and physical activity levels quantify the risk of T2DM incidence in this specific Indonesian cohort? This study seeks to address this gap by analyzing the statistical significance of these behavioral determinants. Based on the identified gaps, the following hypotheses are formulated: ( $H_1$ ) there is a significant relationship between knowledge levels and the incidence of T2DM<sup>7777</sup>; and ( $H_2$ ) there is a significant relationship between physical activity levels and the incidence of T2DM<sup>8</sup>. By testing these hypotheses, this research provides a scientific basis for enhancing metabolic health outcomes through localized health education and activity-based programs.

## 3. Method

This study employed a quantitative research method utilizing a case-control design to investigate the factors influencing the incidence of Type 2 Diabetes Mellitus (T2DM). This specific design was selected for

its efficacy in analyzing the relationship between exposure and outcome by comparing individuals with the condition (cases) to those without it (controls), providing stable and accurate results for observational data.

### Study Population and Sampling

The research was conducted within the Anak Tuha Public Health Center service area between July 17 and August 17, 2024. The study population consisted of 343 registered patients. From this population, a total sample of 72 individuals was selected, comprising 36 participants in the case group (confirmed T2DM patients) and 36 participants in the control group (individuals without T2DM). A purposive sampling technique was applied to ensure that each participant met the specific inclusion criteria, primarily focusing on individuals aged  $\geq 40$  years, as this demographic faces higher metabolic risks.

### Data Collection and Instruments

To ensure data accuracy and consistency, three primary instruments were utilized for data acquisition:

1. Questionnaires: Used to assess the level of knowledge regarding DM and stress levels.
2. 24-hour Food Recall Forms: Employed to measure the adequacy of carbohydrate and fat intake.
3. Easy-Touch Glucometer: Used to obtain objective Random Blood Glucose (GDS) measurements for clinical validation.

### Analysis Techniques and Assumptions

The analytical phase involved systematic data processing to evaluate the significance of the variables. The bivariate analysis was performed using the following statistical tests:

1. Chi-square Test: Applied to determine the association between categorical variables, such as knowledge levels and T2DM incidence.
2. Mann-Whitney Test: Utilized as an alternative for data that did not meet normal distribution assumptions, ensuring the stability of the results across different data characteristics.

The application of these methods rested on the assumption of variable independence and the suitability of the case-control ratio to minimize bias. Evaluation of the results was based on a significance threshold of  $p < 0.05$  and the calculation of Odds Ratios (OR) with 95% Confidence Intervals (CI) to quantify the strength of the associations. This rigorous approach allowed for a scientific and analytical interpretation of how knowledge, diet, and physical activity impact T2DM prevalence in the target area.

## 4. Results and Discussion

### Respondent Characteristics

Based on the research, the respondent characteristics are presented in Table 1 below

**Table 1.** Respondent Characteristics

Characteristic	Case Group (n=36)		Control Group (n=36)	
	n	%	N	%
Gender				
Male	22	61%	18	50%
Female	14	39%	18	50%
Total	36	100%	36	100%
Age				
40 – 60 years old	30	83%	36	100%
> 60 years old	6	17%	0	0%

Characteristic	Case Group (n=36)		Control Group (n=36)	
	n	%	N	%
Total	36	100%	36	100%
Education Level				
Elementary School (SD)	6	17%	12	33%
Junior High School (SMP)	9	25%	11	31%
Senior High School (SMA)	13	36%	13	36%
Diploma/Bachelor's Degree (D3/S1)	8	22%	0	0%
Total	36	100%	36	100%

(Source: Primary data, 2024)

This study indicates that Type 2 Diabetes Mellitus (T2DM) patients aged  $\geq 40$  years within the Anak Tuha Public Health Center (Puskesmas) service area were predominantly male, accounting for 56% (n=40) of the total sample. This group consisted of 22 participants from the case group and 18 from the control group. Female patients represented 44% (n=32) of the study population, comprising 14 individuals from the case group and 18 from the control group. Regarding age distribution, the majority of T2DM patients were within the 40–60 years age range, totaling 92% (n=66). This included 30 participants from the case group and 36 from the control group. Patients aged  $> 60$  years accounted for only 8% (n=6) of the sample, all of whom were from the case group, with no representatives in the control group. In terms of educational background, the majority of respondents in both groups had a senior high school education. However, the control group showed higher percentages at the elementary (33%) and junior high school (31%) levels. In contrast, the case group had a higher proportion of participants with a Diploma or Bachelor’s degree (22%).

### The Association Between Knowledge Level and the Incidence of Type 2 Diabetes Mellitus

**Table 2.** The Association Between Knowledge Level and the Incidence of Type 2 Diabetes Mellitus

Variable	The Incidence of Type 2 Diabetes Mellitus	
	p-Value*	OR(95% CI)
Knowledge Level	0.000	122.5 (14,450-1038,505)

Data in Table 2 reveal a significance value (p-value) of 0.000 ( $p < 0.05$ ). This indicates a statistically significant difference in knowledge levels between the case and control groups, thereby supporting  $H_1$ . These findings demonstrate a significant association between an individual's knowledge level and the incidence of Type 2 Diabetes Mellitus (T2DM). Specifically, individuals with low knowledge levels are 122.5 times more likely to develop T2DM compared to those with adequate knowledge ( $p = 0.000$ ; OR = 122.5; 95% CI = 14.450–1038.505).

The Chi-square test results yielded a p-value of 0.000 ( $p < \alpha = 0.05$ ), leading to the conclusion that there is a significant relationship between knowledge levels and the incidence of T2DM at the Anak Tuha Public Health Center. In this study, the control group comprising individuals without T2DM generally possessed a superior understanding of diabetes compared to the case group. This is evidenced by the higher knowledge scores within the control group, encompassing a deeper comprehension of risk factors, early symptoms, and the importance of lifestyle management, such as healthy dietary patterns, regular physical activity, and routine blood glucose monitoring. Conversely, the case group exhibited lower knowledge levels, suggesting a lack of awareness regarding these critical factors in preventing or managing T2DM.

The researcher found that the case group had a higher prevalence of poor knowledge (43.1%) compared to the control group (58.6%), while 77.8% of respondents overall possessed adequate knowledge.

Individuals in the case group tended to have sedentary occupations, habits of consuming sugary foods and beverages, and a lack of awareness regarding the long-term health risks associated with high sugar intake. This correlation likely stems from the fact that neither group had previously received formal consultation or health education regarding T2DM.

These findings align with research by Yu et al. (2020)[19], which suggests that health literacy regarding diabetes is a protective factor against the development of T2DM. Individuals with limited knowledge are often unable to recognize early warning signs of metabolic impairment, such as polydipsia, polyuria, fatigue, and unexplained weight loss. Furthermore, a lack of understanding regarding balanced nutrition and physical activity can lead to unhealthy lifestyle choices, including excessive carbohydrate and fat consumption, sedentary behavior, and poor stress management. Conversely, those well-informed about the disease are more likely to monitor their blood glucose levels diligently, thereby reducing their risk.

Dedi Pahrul et al. (2020) state that higher knowledge levels indirectly influence shifts in attitudes and behaviors, improving treatment adherence and ultimately leading to better-controlled blood glucose levels [20]. Additionally, individuals may not realize the importance of routine health screenings for early detection. Early detection is vital for the prevention and management of T2DM; those with low knowledge levels are less likely to seek medical intervention until symptoms become severe or complications arise [21][19].

### The Association Between Physical Activity Levels and the Incidence of Type 2 Diabetes Mellitus

**Table 3.** The Association Between Physical Activity Levels and the Incidence of Type 2 Diabetes Mellitus

Variable	The Incidence of Type 2 Diabetes Mellitus	
	<i>p-Value*</i>	<i>OR(95% CI)</i>
Physical Activity Levels	0.000	187 (29,339-1191,894)

Data from Table 3 indicate a significance value ( $p$ -value) of 0.000, demonstrating a statistically significant difference in physical activity levels between the case and control groups. Given that  $p < 0.05$ ,  $H_1$  is accepted, confirming a significant association between physical activity levels and the incidence of Type 2 Diabetes Mellitus (T2DM). Specifically, individuals with low physical activity levels are 187 times more likely to develop T2DM compared to those with moderate physical activity levels ( $p = 0.000$ ; OR = 187; 95% CI = 29.339–1191.894).

These findings highlight that physical activity is significantly associated with the incidence of T2DM, particularly among individuals aged  $\geq 40$  years. In this study, the control group exhibited higher physical activity levels than the case group. Specifically, participants in the control group were more active in their daily lives, engaging in routines that included walking, regular exercise, or other physical activities that improve fitness and maintain an ideal body weight. Conversely, the case group showed lower activity levels, with many individuals leading a sedentary lifestyle. This disparity is a key factor contributing to the difference in T2DM prevalence between the two groups.

The researcher observed that physical activity was lower in the case group primarily due to occupational factors, such as office-based work and domestic roles (housewives) involving minimal movement. Furthermore, there was a lack of awareness regarding the importance of exercise as a component of a healthy lifestyle. This lack of physical exertion increases T2DM risk, as the body has fewer opportunities to burn calories and regulate blood glucose levels effectively.

These results align with previous studies by Ismail et al. (2021)[18], Kyrou et al. (2020) [8], and Sevil et al. (2021)[11]. A primary benefit of physical activity is the improvement of insulin sensitivity. During exercise, skeletal muscles require more glucose for energy, prompting the body to enhance insulin sensitivity to ensure glucose uptake by muscle cells. This enhancement helps lower blood glucose levels, prevents insulin

resistance, and reduces the risk of developing T2DM. In contrast, sedentary individuals are more susceptible to insulin resistance because muscle cells do not receive sufficient stimulation to absorb glucose from the bloodstream, leading to chronic hyperglycemia. Over time, insulin resistance can progress to T2DM, especially when combined with other risk factors such as poor diet and obesity.

Regular physical activity also aids in weight management, which is critical for T2DM prevention. Obesity, particularly visceral obesity (fat accumulation around internal organs), is a well-established primary risk factor for insulin resistance and T2DM. By burning calories through physical activity, the risk of obesity is mitigated, subsequently lowering T2DM risk. Beyond general weight control, physical activity helps achieve a more favorable body fat distribution, reducing accumulation in critical areas such as the abdomen. This is vital because visceral fat is strongly linked to insulin resistance and chronic inflammation two conditions that directly contribute to the pathogenesis of T2DM [18][8][11].

## 5. Conclusion

This study concludes that there is a statistically significant association between knowledge levels ( $p = 0.000$ ) and physical activity levels ( $p = 0.000$ ) and the incidence of Type 2 Diabetes Mellitus (T2DM) among individuals aged  $\geq 40$  years within the Anak Tuha Public Health Center service area. The high odds ratios identified for low health literacy and sedentary behavior emphasize the critical need for targeted health education and lifestyle interventions to improve insulin sensitivity and prevent chronic complications. While these findings provide valuable insights into local risk factors, the research is limited by its specific geographic scope and case-control design, which may constrain the generalizability of the results. Consequently, future research should expand the geographic diversity of the study population and utilize experimental frameworks, such as randomized controlled trials, to evaluate the efficacy of specific nutritional counseling and structured exercise programs in enhancing dietary adherence and glycemic control.

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