

ORIGINAL ARTICLE

Non-Exercise Activity Thermogenesis (NEAT) and Prediabetes Risk Among Adolescents

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ABSTRACT

Introduction: Prediabetes among adolescents is a growing health issue influenced by sedentary lifestyles and reduced daily physical activity. Non-Exercise Activity Thermogenesis (NEAT) contributes significantly to total energy expenditure and plays a role in glucose regulation.

Objectives: To analyze the relationship between NEAT and prediabetes among adolescents.

Methods: This cross-sectional study involved 101 students aged 15–18 years at SMAN 1 Menganti, Gresik. NEAT was calculated using the Mifflin–St Jeor basal metabolic rate equation combined with estimates of total energy expenditure and thermic effect of food. Fasting blood glucose was measured using a standardized glucometer. Data were analyzed using Spearman's Rank Correlation.

Results: Most respondents had high NEAT levels (59.4%), and 26.7% were categorized as prediabetes. A significant negative correlation was found between NEAT and fasting blood glucose ($r = -0.751$, $p = 0.009$).

Conclusion: Higher NEAT levels were associated with lower fasting blood glucose and reduced prediabetes risk among adolescents. Increasing NEAT may serve as a practical preventive approach to improving metabolic health in youth.

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Introduction

Prediabetes is a condition that reflects a disturbance in the body's metabolic system, particularly in regulating blood glucose levels. Although the blood glucose levels of individuals with prediabetes are not yet high enough to be classified as type 2 diabetes mellitus, this condition already represents a significant risk of progressing to diabetes if not properly managed. Individuals with prediabetes typically have blood glucose levels above the normal range but below the diagnostic threshold for diabetes (Kementerian Kesehatan Republik Indonesia, 2018). The challenge, however, is that prediabetes is often asymptomatic, leading many individuals to remain unaware that they are already in the prediabetic stage (Rahmayanti et al., 2022).

One of the key contributing factors to the development of prediabetes is insufficient daily physical activity. Physical activity plays a crucial role in maintaining



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metabolic balance, including glucose utilization by body cells. In this context, the concept of Non-Exercise Activity Thermogenesis (NEAT) has gained increasing attention. NEAT refers to the total energy expenditure associated with all physical activities other than intentional exercise, such as walking, standing, household chores, and other spontaneous movements in daily life. NEAT is an essential component of total daily energy expenditure and has been recognized as a determinant of metabolic health (Almatsier, 2011). Low NEAT levels are often associated with sedentary behavior, which contributes to weight gain, insulin resistance, and an increased risk of metabolic disorders, including prediabetes and type 2 diabetes. Conversely, higher levels of NEAT can enhance glucose regulation, improve insulin sensitivity, and support optimal metabolic function (Levine, 2020).

Adolescence is a critical developmental stage in which lifestyle habits are formed and can significantly influence long-term metabolic health. During this period, adolescents experience substantial changes in physical activity patterns, dietary behaviors, and lifestyle routines. Unfortunately, technological advancements and increasing academic demands have led many adolescents to adopt sedentary lifestyles characterized by prolonged sitting and screen time. Such patterns reduce NEAT levels, consequently lowering daily energy expenditure and impairing glucose metabolism, which may increase the risk of insulin resistance and prediabetes (Hidayat & Purnamasari, 2020).

Several studies have reported that adolescents with sedentary lifestyles tend to exhibit higher fasting blood glucose levels and greater metabolic risk factors compared to their more active peers (Patel et al., 2021; Rahmayanti et al., 2022). These findings highlight the importance of understanding the relationship between NEAT and prediabetes risk among adolescents. A clearer understanding of this relationship can inform effective prevention strategies aimed at maintaining healthy glucose metabolism and preventing diabetes from an early age. Furthermore, the school environment offers a strategic setting to implement lifestyle interventions that promote daily physical activity and enhance NEAT, thereby reducing the risk of prediabetes and supporting the long-term metabolic health of adolescents.

Methods

This study employed a correlational analytic design with a cross-sectional approach, emphasizing the measurement of both independent and dependent variables at a single point in time. This design was chosen to determine the relationship between Non-Exercise Activity Thermogenesis (NEAT) and prediabetes among adolescents.

The population of this study consisted of all students enrolled at SMAN 1 Menganti, Gresik 341 student. The sample was determined using simple random sampling, with inclusion criteria such as being an active student aged 15–18 years and willing to participate voluntarily. Students with a known history of diabetes or other chronic metabolic disorders were excluded from the study total 101 students.

The independent variable in this study was Non-Exercise Activity Thermogenesis (NEAT), defined as the energy expenditure derived from daily non-exercise physical activities such as walking, standing, or household chores. The dependent variable was



prediabetes status, measured through fasting blood glucose levels based on standardized clinical criteria.

Data collection was conducted through the measurement of Non-Exercise Activity Thermogenesis (NEAT) in this study was based on the Mifflin-St Jeor equation. NEAT was calculated using the following formula: $NEAT = TEE - (BMR + TEF)$ where TEE represents Total Energy Expenditure, BMR represents Basal Metabolic Rate, and TEF refers to the Thermic Effect of Food and direct measurement of fasting blood glucose using a glucometer. Respondents were instructed to fast for at least eight hours prior to testing. The questionnaires were adapted from validated instruments assessing daily physical activity levels.

Data were analyzed using Spearman Rank Correlation to determine the association between NEAT and prediabetes status, with a significance level set at $p < 0.05$. The results were presented in the form of frequency distributions and correlation coefficients.

Results

The results should include findings of the study, including, if appropriate, results of statistical analysis, which must be included either in the text or as tables and figures.

Table 1. Distribution of Respondents by Age

Age	F	%
15	1	1%
16	15	14.9%
17	49	48.5%
18	36	35.6%
Total	101	100%

A total of (n = 101) students participated in this study, all of whom met the inclusion criteria. The majority of participants were aged between 15 and 18 years, with an average age of 17 years.

Table 2. Distribution of NEAT

NEAT	F	%
High	60	59.4%
Moderate	28	27.7%
Low	13	12.9%
Total	101	100%

Based on the results the average NEAT score among respondents was 1371 kcal, indicating that most adolescents engaged in moderate to high non-exercise activity.

Table 3. Distribution of glucosa

glucosa	F	%
Normal	74	73.3%
Prediabetes	27	26.7%
Diabetes	0	0%
Total	101	100%



The measurement of fasting blood glucose revealed that 74% of the students were within the normal range, while 27% were classified as having prediabetes based on standard diagnostic criteria (fasting glucose 100–125 mg/dL). Correlation between NEAT and Prediabetes

Statistical analysis using Spearman's Rank Correlation Test showed a significant negative correlation between NEAT levels and prediabetes status ($r = -0.751$, $p = 0.009$). This indicates that adolescents with lower NEAT levels were more likely to exhibit higher fasting glucose levels, suggesting an increased risk of prediabetes.

These findings highlight that reduced daily physical movement outside of structured exercise contributes to the development of impaired glucose metabolism among adolescents. Increasing NEAT-related activities such as walking, standing, or household chores may therefore serve as a simple and effective preventive strategy against prediabetes.

Discussion

This section should discuss the implications of the findings in the context of existing research and highlight the limitations of the study. The findings of this study revealed a significant negative correlation between Non-Exercise Activity Thermogenesis (NEAT) and prediabetes status among adolescents. This result suggests that lower levels of NEAT are associated with higher fasting blood glucose levels, indicating a greater risk of developing prediabetes. These findings align with previous research emphasizing the importance of daily physical movement in maintaining optimal glucose metabolism and insulin sensitivity (Levine, 2020; Patel et al., 2021).

NEAT represents the energy expenditure from all physical activities outside of structured exercise, including walking, standing, and daily household chores. A reduction in NEAT has been identified as one of the key contributors to sedentary lifestyles among adolescents, leading to increased adiposity and metabolic disturbances (Hamilton et al., 2018). Adolescents who spend more time sitting—often due to prolonged screen exposure and academic demands—tend to have lower total daily energy expenditure, thereby increasing their risk of insulin resistance and prediabetes (Rahmayanti et al., 2022).

The adolescent period is a critical window for establishing long-term lifestyle habits. During this phase, physical inactivity may have a stronger impact on metabolic health compared to adulthood, as the body undergoes rapid hormonal and physiological changes. A decline in NEAT during adolescence not only reduces calorie expenditure but also alters glucose uptake in skeletal muscles, leading to impaired insulin action (Smith et al., 2020).

This study's results support the hypothesis that promoting daily non-exercise activities can be a practical and sustainable approach to preventing metabolic disorders in young populations. Simple behavioral interventions such as walking to school, using stairs, or increasing standing time can significantly enhance NEAT and improve glucose regulation (Levine, 2020). School-based health programs should therefore incorporate strategies that encourage movement throughout the day, especially among students with sedentary lifestyles.



Furthermore, this study highlights the necessity of early screening for prediabetes among adolescents, particularly those exhibiting low NEAT levels. Early detection combined with targeted lifestyle modifications can prevent the progression from prediabetes to type 2 diabetes, which has been a growing concern globally (American Diabetes Association [ADA], 2023).

In summary, the results indicate that enhancing NEAT may serve as a preventive strategy against prediabetes by improving energy balance and glucose metabolism. Encouraging adolescents to integrate more physical activity into their daily routines—beyond structured exercise—could play a vital role in reducing the future burden of diabetes and metabolic diseases.

Conclusion

The results of this study indicate a significant negative correlation between Non-Exercise Activity Thermogenesis (NEAT) and prediabetes status among adolescents. Adolescents with lower NEAT levels are more likely to exhibit higher fasting blood glucose levels, indicating an increased risk of prediabetes. These findings suggest that promoting daily non-exercise activities, such as walking, standing, and performing household chores, can serve as an effective preventive strategy to maintain glucose metabolism and reduce the risk of metabolic disorders in adolescents. Early intervention and school-based programs targeting NEAT enhancement are recommended to support long-term metabolic health in this population.

Ethics approval and consent to participate

This study was approved by the Ethics Committee of Stikes Hang Tuah Surabaya No:PE/60/II/2025/ KEP/SHT. Informed consent was obtained from all participants and their parents or guardians prior to data collection. Confidentiality and anonymity of the respondents were strictly maintained throughout the research process..

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