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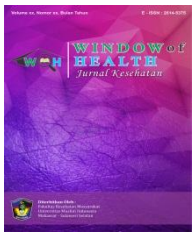

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Prevalence of Prediabetes in Adolescents

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ABSTRACT

Prediabetes is closely associated with an increased risk of adult-onset diabetes, and the risk is even greater when it occurs in adolescence. Prediabetes is increasing globally across all age groups, including children and adolescents, and increases significantly with age and is particularly common in adolescents with obesity, inactivity, and unhealthy lifestyles. The highest rate of type 1 diabetes in Asia is in the number of cases, which reached 13,311 cases for those aged below 20 years. Prevention of cases in children includes lifestyle programs, weight reduction, dietary changes, and increased physical activity. The purpose of the study was to analyze the prevalence of prediabetes in adolescents. This research employs an observational, cross-sectional design. The research population consists of first-year students at the Russian College of Health Sciences, and the sampling technique used is total sampling, resulting in 115 respondents. The variables studied were diet, physical activity, stress, fast food, and prediabetes. The results showed the value of genetic influence with prediabetes (p-value = 0.002, no influence of BMI on prediabetes (p-value = 0.158, no influence of physical activity on prediabetes (p-value = 0.310, no influence of diet on prediabetes (p-value = 0.863, and no influence of stress on prediabetes in adolescents (p-value = 0.580. There is no influence of active/passive smoking habits on prediabetes, p-value = 0.653. Genetic and environmental factors among ethnic groups can contribute to increasing the risk of prediabetes or type 2 diabetes and early hypertension. Conclusion: The results showed that only one genetic variable influenced prediabetes in adolescents.

Keywords: Prevalence; prediabetes; adolescents.

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INTRODUCTION

The diabetes epidemic is one of the major global public health concerns (1). Prediabetes is associated with an increased risk of diabetes and cardiovascular disease in adults, and the risk is even greater when it occurs in adolescence (2). A large proportion of the population is unaware that they have the condition, so it goes undiagnosed with costly health implications (3). Prediabetes develops gradually and takes years but is consistent enough to become Diabetes Mellitus (DM) (4). The prevalence of diabetes in adolescents is rapidly posing a major clinical challenge and public health burden worldwide (5).

The prevalence of prediabetes is increasing globally across all age groups, including children and adolescents (6). Prediabetes plays an important role in the risk of developing diabetes, and the incidence of diabetes has increased markedly over the past few decades (7), with incidence rates 1.7-2.4 times higher in adolescent boys than in adolescent girls (8). In the prevalence of DM in 2019, Indonesia was ranked among the ten countries with the highest number of DM sufferers by ranking seventh with 10.7 thousand cases (9). The total population of people with type 1 DM at the age of less than 20 years in the world is 17%, which is equivalent to 1.52 million. Indonesia is the country with the highest number of type 1 diabetes in ASEAN, and no. 34 in the world globally in 2022, with a total of 41.8 thousand in the age range of 20-59 years with 26,781 cases and 13,311 cases for ages less than 20 years (10). Banyuwangi Regency, the number of uncomplicated Non-Insulin Diabetes Mellitus (NIDM) cases is ranked 4th out of the ten most common diseases in 2022 with 16,945 new cases, while for all diabetes cases, there were 22,035 cases or 15.57% (11).

DM is a metabolic disorder characterized by hyperglycemia and impaired insulin function that results in an aggressive clinical course and reduced life expectancy when it occurs in adolescents (5). Prediabetes is a complex increase in blood glucose levels (12), and the rate of prediabetes increases significantly with age and is very common in adolescents with obesity, inactivity, and unhealthy lifestyles (13). Increased plasma glucose levels above the normal range and below the normal threshold for diabetes, which is 110-125 mg/dL fasting plasma glucose and 140-200 mg/dL for glucose tolerance test (14). Unhealthy lifestyles, along with high carbohydrate and fat diets and traditional diets, have been replaced with processed foods that are high in sugar, salt, and oil (15) (16).

Early diagnosis of prediabetes helps prevent the risk of progression to type 2 DM (T2DM) by providing healthy lifestyle interventions in adolescents (2). Elevated blood glucose levels are the basis for the diagnosis of prediabetes where the disorder appears dominant in T1DM and T2DM, therefore preventing cases in the pediatric population by including intensive lifestyle programs as the main intervention with a short-term evaluation of <6 months and evaluating the effects of drugs and

considering the physiological conditions of children to prevent or delay the occurrence of DM (8). In addition, reducing body weight by 5-7% by changing diet and increasing physical activity is also proven to be the most effective way to prevent prediabetes (17).

METHODE

This research is an observational study with an analytic cross-sectional design using a quantitative approach, namely measuring or observing all dependent variables with independent variables carried out at the same time. The population in this study amounted to 115 students of the Rustida College of Health Sciences. Sampling technique with total sampling method. The research implementation time was from June to July 2023. Independent variables become an influence on changes in the dependent variable; the independent variables in this study are genetics, BMI, physical activity, diet, stress, active smoking, and passive smoking. The dependent variable is prediabetes.

Researchers collected, processed, analyzed and presented data systematically using an instrument in the form of a questionnaire consisting of gender (male and female), age (middle adolescence and late adolescence), genetics (yes and no), BMI (obesity, overweight, normal, thin), physical activity (heavy, moderate, light), diet (less, enough, good), stress (heavy, moderate, light), active smoking (yes and no), passive smoking (yes and no) and the incidence of prediabetes, with a total questionnaire of 49 statements. Univariate analysis summarizes the data set into information; univariate analysis is genetic, BMI, physical activity, diet, stress, active smoking, and passive smoking. Bivariate analysis is intended to determine the effect between independent and dependent variables, using the chi-square test using $\alpha = 0.05$ and 95% Confident Interval (CI); if the p value> α, there is no effect; if the p-value $\leq \alpha$ means, there is an effect. Researchers are very concerned about ethical issues by using methods, agreement from respondents, and maintaining the identity of respondents by writing initial names. Researchers have also conducted an ethical test with the number 037/04 / KEPK - STIKESBWI / X / 2023

RESULT

Based on the research that has been conducted, the researcher will present the data that has been collected in the form of percentages and tables.

Table 1 Researchers present data on respondent characteristics

Respondent Characteristics		Frequency (n)	Percentage (%)
Gender	Male	21	18.3
	Female	94	81.7
	Total	115	100
Age	Middle Teens	3	2.6
	Late Teens	112	97.4
	Total	115	100

It is known that the average gender of female respondents is 94 people (81.7%), while the average age of late adolescent respondents is 112 people (97.4%).

Researchers present data analysis of the prevalence of prediabetes in adolescents that have been collected in the form of percentages and tables.

Table 2 data analysis of the prevalence of prediabetes in adolescents

Variables		DM Status				Total		*p*
		Prediabetes		Normal				
		n	%	n	%	n	%	
Genetic	Yes	12	10.4	16	13.9	28	24.3	.002
	No	13	11.3	74	64.4	87	75.7	
	Total	25	21.7	90	78.3	115	100	
IMT	Obesity	2	1.73	3	2.6	5	4.34	.158
	Overweight	7	6.08	12	10.4	19	15.5	
	Normal	4	3.47	28	24.3	32	27.8	
	Skinny	12	10.4	47	40.8	59	51.3	
	Total	25	21.7	90	78.3	115	100	
Activities Physical	Heavy	5	4.34	25	21.7	30	26.08	.310
	Medium	18	15.5	63	54.7	81	70.4	
	Lightweight	2	1.73	2	1.73	4	3.47	
	Total	25	21.7	90	78.3	115	100	
Pattern Eating	Less	7	6.08	25	21.7	33	28.6	.863
	Enough	18	15.5	63	54.7	81	70.4	
	Good	0	0	1	0.86	1	0.86	
	Total	25	21.7	90	78.3	115	100	
Stress	Heavy	1	0.86	3	2.60	4	3.47	.580
	Medium	8	6.95	20	17.4	28	24.3	
	Light	16	13.9	67	58.2	83	72.1	
	Total	25	21.7	90	78.3	115	100	
Smokers Active	Yes	2	1.	10	8.69	12	10.5	.653
	No	23	20	80	69.5	103	89.5	
	Total	25	21.7	90	78.3	115	100	
Smokers Passive	Yes	11	9.56	34	29.5	45	39.1	.573
	No	14	12.1	56	69.5	70	60.8	
	Total	25	21.7	90	78.3	115	100	

Table 2 shows that respondents who have genetics with the incidence of prediabetes are 12 people (10.4%) p value 0.002 means there is a genetic influence with the incidence of prediabetes in adolescents, thin average BMI with prediabetes incidence 12 people (10.4%) p value 0.158 means there is no influence of BMI with prediabetes in adolescents, moderate average physical activity with prediabetes incidence 18 people (15.5%) p value 0.310 means there is no influence of physical activity with prediabetes in adolescents, adequate average diet with prediabetes incidence 18 people (15. 5%) p value 0.863 means there is no effect of diet with prediabetes in adolescents, mild average stress with prediabetes 16 people (13.9%) p value 0.580 means there is no effect of stress with prediabetes in adolescents, active smokers on average not with prediabetes 23 people (20%) p value 0. 653 means there is no influence of active smoking habits with prediabetes in adolescents, passive smokers on average not with the incidence of prediabetes 14 people (12.1%) p value 0.573 means there is no influence of passive smoking habits with prediabetes in adolescents.

DISCUSSION

The results of the analysis test obtained an X2 value with p-value = 0.002, smaller than α = 0.05; it can be concluded that there is a genetic influence with prediabetes in adolescents. The prevalence of prediabetes in children continues to increase, and it is known that children who have a family history of diabetes have a higher prevalence (7). Genetic and environmental factors among ethnic groups can contribute to increasing the risk of prediabetes or type 2 diabetes and early hypertension (6). The aetiology of type 2 diabetes is multifactorial, including genetic and lifestyle factors. The increasing number of people who lead sedentary lives accompanied by a diet high in carbohydrates and fats triggers an increase in the prevalence of diabetes cases (15).

Adolescents at puberty who have a family history of T2DM and ethnicities that have a higher risk (American, African, Hispanic and Asian) and a history of diabetes in the mother have the highest risk of prediabetes (8). A family history of diabetes mellitus has a greater chance of suffering from diabetes; this is influenced by hepatic insulin resistance caused by defects in glucose metabolism, which can be inherited in offspring (18).

Genetic and environmental factors influence adolescents who are susceptible to diabetes. The environment can be from lifestyle, eating habits and daily activities (19). Therefore, the provision of prediabetes prevention interventions prioritizes certain subgroups that have a higher risk, including groups with a family history of diabetes, a history of smoking, and a history of taking NSAID drugs. A person with a family history of diabetes consistently has a higher chance of suffering from prediabetes (20).

The results of the analysis test obtained X2 with a p-value = 0.158 greater than α = 0.05; it can be concluded that Ha is rejected and Ho is accepted. This means that there is no effect of BMI on prediabetes in adolescents. The onset of type 2 diabetes mellitus in young people can be more rapid and disruptive than in parents, and it creates a lifetime exposure that results in the risk of long-term complications that trigger early morbidity and decreased quality of life in adolescents and one of the factors is obesity (1). The general characteristics of young people are obesity with decreased insulin secretion accompanied by increased resistance (21).

Adolescents with obesity have a higher risk of developing metabolic syndrome disorders and its complications that lead to cardiometabolic diseases (22). The prevalence of prediabetes in adolescents is closely related to the increase in childhood obesity, and the prevalence increases in obese children with a diagnosis of IFG or impaired fasting glucose (23).

Obesity is known to trigger degenerative diseases because it directly affects insulin resistance, where the body produces insulin, but the body cells are resistant to it (17). Research conducted by (13) found that the incidence of prediabetes in adolescents increased significantly in children with grade 2 and 3 obesity, and the pre-diabetes phenotype was associated with increased HbA1c, cytosolic and diastolic pressure, triglycerides, and ALT.

Research in China conducted by (20) made obesity indicators a target for identifying the main causes of prediabetes in adolescents. The findings obtained targeted interventions to optimize prevention to reduce the incidence of increased prevalence of prediabetes. In contrast to research conducted by (16), the incidence of diabetes and prediabetes in adolescents occurs in those with normal weight. Because our focus is often on overweight and obese adolescents, it results in missed opportunities to identify hidden diseases in normal-weight individuals. Obese teenagers still have a pancreas that produces enough insulin to compensate for insulin resistance. Thus, blood sugar remains normal, even though the metabolic system has started working hard, but if this situation persists continuously for a long time it will have an impact on the metabolic system in the future and then diabetes will develop (12);(24).

Based on the results of the analysis test obtained X2 with a p-value = 0.310 greater than α = 0.05, it can be concluded that Ha is rejected and Ho is accepted. This means that there is no effect of physical activity on prediabetes in adolescents. Research conducted on adolescents in India found that there was a negative relationship between physical activity prediabetes and diabetes in adolescents (12). Meanwhile, research in Tanzania revealed that physical activity affects cardiorespiratory fitness conditions by reducing the risk of beta cell dysfunction, insulin resistance, prediabetes, and diabetes (25). Research conducted by (26) found that differences in physical activity carried out in diabetic

participants and those who did not have diabetes had a significant relationship, but participants who had prediabetes and participants who did not have diabetes had insignificant results.

Providing physical activity interventions can help reduce HbA1C levels in prediabetes patients because adequate physical activity can improve insulin sensitivity and increase glucose intake by muscles so as to increase carbohydrate metabolism in the body (27). A person with moderate-intensity work activity does not make a difference in insulin sensitivity and glucose utilization compared to those with low-intensity activity. Insulin sensitivity only applies to someone who has a heavy intensity activity (3). Teenagers spend most of their time on screen time without doing strenuous activities, but even though they don't do active physical activity, the metabolic system that teenagers have is still very good so the effect on insulin resistance is not that significant. Effective physical exercise should be done at least 60 minutes a day (26).

Based on the results of the analysis test obtained X2 with a p-value = 0.863 greater than α = 0.05, it can be concluded that Ha is rejected and Ho is accepted. This means that there is no effect of diet on prediabetes in adolescents. Consuming carbohydrates and fats is closely related to the risk of increased incidence of prediabetes. Individuals who consume simple carbohydrates have a four times risk of prediabetes, while individuals who consume saturated fat have a 2.5 times risk. The behaviour of adolescents who like to consume foods high in carbohydrates, high in saturated fat, low fibre and high sugar is a trigger factor for prediabetes in adolescents (28). Parents' eating habits in everyday life affect the incidence of prediabetes in adolescents because parents' eating habits affect adolescents' eating behaviour. The healthier the parents' diet, the more adolescents will avoid the incidence of prediabetes. It is related to the practice and availability of food, drinks, and snacks served in everyday life (14).

Prediabetes can be prevented by reducing body weight by 5-7 per cent by adjusting diet and increasing daily physical activity (17). Unhealthy eating habits, improper eating arrangements and excessive preference for one type of food are nutritional problems that are often experienced by adolescents (29). Physical activity can reduce blood sugar levels for up to 24 hours or more because physical activity can increase the sensitivity of muscle cells to insulin (30). Teenagers generally have a higher metabolic rate, so their bodies process glucose more quickly and keep sugar levels stable. The effects of a bad diet usually appear in the long term. If a teenager has only been eating carelessly for a few years, the body may not yet show significant blood sugar disturbances (31).

The results of the analysis test obtained X2 with a p-value = 0.580 greater than α = 0.05; it can be concluded that Ha is rejected and Ho is accepted. This means that there is no effect of stress on prediabetes in adolescents. Early onset of prediabetes in children and adolescents results in a greater risk of long-term complications, which is a trigger factor for decreased quality of life and morbidity (1).

Adaptive responses to stressors are protective in human survival; if the trigger for stress is stronger and lasts for a long time, the stress response will be maladaptive so that it can cause decreased health quality (32). Stress affects the prevalence of cardiovascular disease and causes disturbances in the metabolic system that can trigger prediabetes (33). Stress can cause stress reactions in the neuroendocrine system that trigger diabetes and hypertension; the risk is even higher if a person experiences stress along with smoking, drinking alcoholic beverages, and obesity (34).

Stress also triggers a person to be more susceptible to metabolic syndrome in the form of insulin resistance, lipoprotein disorders, decreased fibrinolysis, central obesity, and accelerated cellular ageing. It can increase the risk of heart disease (35). Negative emotions such as anxiety and depression can affect the endocrine system, resulting in increased blood sugar levels and blood pressure. It can worsen disease conditions and cause complications and vice versa; poor disease conditions can also trigger negative emotions in individuals (36).

The results of the analysis test for active smokers obtained an X2 value with p-value = 0.653 greater than α = 0.05, while for passive smokers, p-value = 0.573 greater than α = 0.05, so there is no effect of active/passive smoking habits with prediabetes in adolescents. Research conducted in KSA found that there was no real indication of the relationship between smoking and diabetes status; on the contrary, more smokers were found in the nondiabetes group (4). In contrast, research conducted by (37) found that risk factors associated with prediabetes in urban and rural groups include hypertension, dietary patterns, smoking behaviour, and physical activity. Smoking behaviour is one of the lifestyles that can trigger the risk of various diseases, including prediabetes and diabetes mellitus.

Smoking habits and past smoking history are at risk of increasing the risk of hypertension and diabetes because smoking can increase blood viscosity, thereby stimulating the adrenergic nervous system, which results in the emergence of microvascular and macrovascular diseases (34). Smoking habits in teenagers can affect blood sugar levels, although the effects are not always immediately visible in the early period. However, they will tend to be more at risk of experiencing impaired glucose tolerance more quickly in youth and if this continues continuously, the risk of type 2 diabetes increases over time. The nicotine content in cigarettes interferes with the insulin system, where insulin is a hormone that regulates blood sugar levels, so that body cells become less responsive to insulin (insulin resistance), so blood sugar levels can increase (38); (39).

CONCLUSION AND RECOMMENDATIONS

Genetic variables become influential variables, with prediabetes incidence having a p-value of 0.002, which means there is a genetic influence on the incidence of prediabetes in adolescents. It is recommended that future researchers continue this research by using a larger sample size and applying

intervention methods to prediabetes sufferers so that better research results are obtained. The community, especially adolescents, is always expected to maintain a healthy lifestyle, routine activities, exercise, and maintain a healthy diet.

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