

The Effect of Education Through Animated Videos on Knowledge of Diabetes Mellitus Risk in Adolescents with Obesity at SMK Negeri 3 Gorontalo City

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ABSTRACT

Obesity is a global problem that affects every country. In the same year, about 2.5 billion adults were overweight, and 890 million of them were living with obesity. Since 1990, the prevalence of obesity has more than tripled and overweight has increased by more than 1.5 times. The type of research used in this study is a type of quantitative research with a quasi-experimental design, using a pretest-posttest approach with control group design, to determine the difference in knowledge of diabetes mellitus risk in the group that was given animated video education and the group that was given education using the usual lecture method. The results of the pretest showed that the level of knowledge of respondents in the experimental group was only 8 respondents (47.1%), the category was less than 5 respondents (29.4), the good category was 4 respondents (23.5%) in the control group of the category was 7 respondents (41.2%), the good and poor categories were 5 respondents each (29.4%). The results of the posttest showed that all respondents in the experimental group and the control group had a level of knowledge in the good category, as many as 17 respondents (100%) each. There is an effect of education through animated videos on knowledge of the risk of diabetes mellitus in obese adolescents at SMK Negeri 3 Gorontalo City, which is proven by the results of the Wilcoxon Signed Rank Test with a p-value = 0.000 ($p < 0.05$).

INTRODUCTION

Adolescence is a period of transition from childhood to adulthood, which includes all the development experienced in preparation for entering adulthood. Adolescence begins around the age of 12 and ends at the age of 18 to 21 (Trinidad and Tobago, 2021). Adolescence is also the age of transition from children to adulthood, where at that age there are many changes felt by adolescents, seeking their identity by following the flow and lifestyle of the current era, which can turn into serious health problems until adulthood, such as obesity (Hanum, 2023).

Obesity or commonly known as obesity is a condition in which the amount of fat in the body exceeds the need for the required fat. Excess body fat accumulation makes a person overweight even above normal and can also endanger health. (Hanum, 2023) Obesity is one of the major health problems in the world, not only occurring in adults but also in children, which has become a global epidemic that must be addressed immediately, as well as the fifth serious cause of death in the world, thus increasing the risk of degenerative diseases and death. (Heri et al., 2021)

The World Health Organization (WHO) by 2025, by 2022 more than 1 billion people worldwide will be obese – 650 million adults, 340 million adolescents, and 39 million children. Obesity is a global problem that affects every country. In the same year, about 2.5 billion adults were overweight, and 890 million of them were living with obesity. Since 1990, the prevalence of obesity has more than tripled and overweight has increased by more than 1.5 times. Obesity contributes to about 5 million deaths each year globally. Based on data from the 2024 NCD Risk Factor Collaboration (NCD-RisC) published by Kompas (2024), Indonesia occupies the

168th position out of 200 countries in the prevalence of obesity in adult males with a figure of 6.53%. For the adult female category, Indonesia is ranked 150th with a prevalence of 16.58%. Meanwhile, in boys aged 5–19 years, Indonesia occupies the 105th position with a prevalence of 11.26%, and in girls it is ranked 71st with a figure of 10.30%.

In addition, the people of Gorontalo over 15 years old who carry out early detection of obesity reached 83%, which also puts this province in first position even though it is still below the national target of 90%. In comparison, the national average for early detection of obesity is only 27% (Gorontalo Provincial Health Office 2024). Based on data obtained by the Gorontalo Provincial Health Office, it shows that during the period 2023 to 2025 in adolescents aged 10-17 years, the number of adolescents experiencing obesity in Gorontalo Province was recorded at 229 cases. Gorontalo City again occupies the highest position with 89 cases or around 38.86% of the total cases. Followed by Gorontalo Regency with 85 cases (37.12%) and Bone Bolango with 44 cases (19.21%). Pohuwato recorded 8 cases (3.49%) and Boalemo 3 cases (1.31%), while North Gorontalo recorded no cases of obesity at all (0.00%). The increase in obesity in children and adolescents is influenced by environmental, behavioral, and genetic factors. Obesity not only affects physical appearance, but also increases the risk of developing various non-communicable diseases, including diabetes mellitus. (Sumarni & Bangkele, 2023) (Fitriyani et al., 2025)

A number of studies have shown that obesity has a strong relationship with the incidence of diabetes mellitus and is related to the duration and onset of obesity. Based on the results of the study, of the 3,911 respondents with diabetes mellitus in Indonesia, as many as 32.9% of them were obese, indicating a high prevalence of obesity among individuals with diabetes. Physiologically, obesity can cause insulin resistance which is directly related to the occurrence of diabetes mellitus. This condition occurs due to increased release of free fatty acids, glycerol, hormones, as well as proinflammatory cytokines from fat tissue that worsen the work of insulin in the body. Severe obesity in childhood and adolescence has also been shown to increase the risk of diabetes mellitus in youth to early adulthood. (Azam et al., 2022) (Azam et al., 2022)

Diabetes Mellitus (DM) according to *the American Diabetes Association (ADA)* is a metabolic disorder characterized by an increase in blood glucose levels due to disturbances in insulin secretion or the body's response to insulin. (Maharani et al., 2024) Diabetes mellitus is a disease where blood sugar levels in the body are quite high so that the body cannot produce or use insulin, so blood sugar cannot be metabolized and this disease can attack anyone. The case of Diabetes Mellitus has the potential to attack adolescents because it is included in the category of often consuming various types of food without being balanced with a healthy lifestyle and behavior (Ulya et al., 2023).

The World Health Organization (2021) states that diabetes mellitus (DM) is among the most common diseases suffered by people worldwide and ranks fourth in the degenerative disease research priorities across countries. *The WHO* estimates that more than 346 million people worldwide have diabetes mellitus. According to *the International Diabetes Federation (IDF)*, in 2021, as many as 537 million adults. 1 out of 10 people worldwide have diabetes.

Data from *the International Diabetes Federation (IDF)* shows that the number of people with diabetes in the world in 2021 reached 537 million. This figure is predicted to continue to increase to 643 million in 2030 and 783 million in 2045. According to the *IDF*, Indonesia is ranked as the 5th country with the highest number of diabetes with 19.5 million patients in 2021 and is predicted to reach 28.6 million in 2045 (Indonesian Ministry of Health 2024). Gorontalo ranks 7th in the number of people with diabetes mellitus out of 35 provinces in Indonesia with a prevalence that increased from 1.3% in 2013 to 2.4% in 2018. (Falah et al., 2024)

Data on prediabetic patients Based on data from the Gorontalo Provincial Health Office, cases of diabetes mellitus in adolescents aged 10-17 years, from 2023 to 2025, the number of adolescents experiencing diabetes mellitus in Gorontalo Province was recorded at 242 cases. Most of the cases were found in Gorontalo City with a total of 137 cases, which accounts for about 56.61% of all cases in the province. Gorontalo Regency followed with 67 cases (27.69%), then Bone Bolango and North Gorontalo each accounted for 16 cases (6.61%). Meanwhile, Pohuwato recorded 5 cases (2.07%) and Boalemo only 1 case (0.41%).

The impact of diabetes mellitus in adolescents can include a variety of complications, both short-term and long-term. Acute complications occur when plasma blood glucose levels undergo relatively acute changes. Complications that can occur are *hypoglycemia*, *diabetic ketoacidosis* and *non-ketotic hyperosmolar*. While chronic complications are continuous and long blood sugar increases that have an impact on the occurrence of diabetic angiopathy, which is a disorder of all blood vessels throughout the body. In chronic complications, there are disorders in the form of *microangiopathy (retinopathy)* that is at risk of blindness, *nephropathy* which can lead to kidney failure) and *macroangiopathy* (coronary heart, diabetic leg injury, *stroke*) or occur in both (*neuropathy*, susceptibility to infection, amputation). (Sari, 2021)

In addressing the incidence of diabetes mellitus, this disease has become part of the main disease prevention and control program in Indonesia, which is listed in the National Medium-Term Development Plan 2020–2024, the Ministry of Health's Strategic Plan 2020–2024, and the indicators of the Basic Service Standards of Local Government. The government is trying to reduce the incidence of diabetes by increasing

awareness and educating the public to take preventive measures. One of the strategies carried out is education and *screening*, which has been proven to increase public awareness of risk factors and the importance of lifestyle changes, as well as encourage better self-management, thereby increasing knowledge. (Help et al., 2024)

Knowledge is an essential part of human existence, because knowledge is the fruit and activity of thinking carried out by humans. The knowledge that each person has is then expressed and communicated to each other in a shared life, both through language and activities; and in this way people will be further enriched in their knowledge of each other. (Octaviana & Reza, 2021)

Educational programs focused on adolescents, are an effective strategy to increase understanding of diabetes mellitus. Education using various methods and media has currently been developed in the world of education. A good and interesting medium will give confidence one of the interesting media is animated videos. (Help et al., 2024) (Halimatushadyah et al., 2025)

An animated video is a video show similar to a movie that consists of images and sounds designed to be more interesting. In animated videos, frames move towards each other over a period of time, creating the impression of moving. Animated video media provides advantages because of the presence of audio and images so that it is easier for teenagers to understand. (São Paulo , 2024)

Some previous research has also supported the importance of educational media in increasing adolescents' knowledge about diabetes mellitus. Research by. Another study was conducted by conducting (São Paulo et al., 2024) an initial screening of high school students to detect prediabetes and type diabetes mellitus, then continued with education on diabetes self-management. This activity shows an increase in adolescents' awareness and knowledge of the risks and the importance of a healthy lifestyle as a preventive measure. In addition, a study comparing the effectiveness of audiovisual-based educational media (Sarah et al., 2024) and *booklets* on adolescents' knowledge and attitudes concluded that *audiovisual media* is superior. This media is not only able to attract attention but is also more effective in increasing understanding and encouraging behavior change in a healthier direction.

Based on the results of a preliminary study conducted by researchers at SMK 3 Gorontalo City on September 17, 2025 through an interview with one of the teachers, it is known that many students are overweight at all grade levels, especially in grade XII. Based on the results of direct observation, there were 23 students who were overweight in class X, 17 students in class XI, and 36 students in class XII. Through the results of the interview with the teacher, information was obtained that there has never been education about the impact of obesity that can lead to the risk of diabetes mellitus. In addition, based on interviews with 5 students who were overweight, it was revealed that they had never received education about diabetes mellitus even 2 of them did not know what diabetes mellitus was. Meanwhile, interviews with 3 other students argued that it was easier for them to understand the material if it was delivered through animated videos, because they had seen the media before, while media such as *leaflets*, *power points*, posters, or presentations often made it difficult for them to concentrate and bored easily.

RESEARCH METHODS

The type of research used in this study is a type of quantitative research with a quasi-experimental design, using a pretest-posttest approach with control group design, to determine the difference in knowledge of diabetes mellitus risk in the group that was given animated video education and the group that was given education using the usual lecture method. The location of this research was carried out at the school of SMK 3 Gorontalo City. The time for this research was carried out by researchers in November, 2025.

Data analysis techniques

Univariate analysis

Univariate analysis is used to describe descriptively the frequency distribution and proportion of each variable studied, both independent and bound variables. Univariate analysis aims to explain or describe the characteristics of each research variable. In this study, the variable analyzed was knowledge about the risk of diabetes mellitus. (Irwan , 2022) *Pretest* and *posttest* experimental groups (animated videos) and control groups (Cermah method).

Bivariate analysis

The data analysis in this study used bivariate analysis. Bivariate analysis is an analysis carried out with the aim of explaining the relationship between independent variables and bound variables. In this study, bivariate analysis was carried out to see the difference in the level of knowledge before and after education in the two groups, namely the experimental group that was given education through animated video media and the control group that was given education by the lecture method. In addition, bivariate analysis also aims to determine the influence of education through animated videos on increasing knowledge about the risk of

Diabetes Mellitus in adolescents with obesity. (Irwan , 2022)

The data normality test in this study used *the shapiro-wilk* test because the number of samples was relatively small (<50–100 respondents). Based on the results of the normality test, one of the posttest data in the experimental group showed an abnormal distribution. Therefore, statistical analysis uses nonparametric tests. To compare knowledge before and after education in both the experimental group and the control group, *a wilcoxon signed-rank test* with a significance level of $p < 0.05$ was used. Meanwhile, for unpaired (independent) data, *the mann–whitney u test* is used.

RESULTS

Univariate analysis

Characteristics of respondents based on adolescent age

Table 1 Distribution of respondent frequencies by adolescent age

Yes	Age	Groups			
		Experiments		Controls	
		Frequency (n)	Present (%)	Frequency (n)	Present (%)
1.	Early teens (10-13 years old)	0	0	0	0
2.	Middle Teens (14-16 years old)	7	41,2	7	41,2
3.	Late teens (17-21 years)	10	58,8	10	58,8
TOTAL		17	100	17	100

Source: Primary data 2025

Based on Table 1, the frequency of age characteristics of adolescent respondents showed variation in both study groups. In the experimental group ($n = 17$), the most age was 17 years old with a total of 5 respondents (29.4%). Meanwhile, the least age was found in adolescents aged 19 and 20 years, as many as 1 respondent (5.9%) respectively. In the control group ($n = 17$), the most dominant age was also 17 years with a total of 9 respondents (52.9%). The minimum age in this group was 15 years, which was 2 respondents (11.8%).

Characteristics of respondents based on adolescent BMI

Table 2 Frequency distribution of respondents by adolescent BMI

Yes	Obesity Category (BMI)	Groups			
		Experiments		Controls	
		Frequency (n)	Present (%)	Frequency (n)	Present (%)
1.	Obesity I	14	82.4	11	64.7
2.	Obesity II	3	17.6	6	35.3
Total		17	100	17	100

Source: Primary data 2025

Based on Table 2, it can be seen that the frequency of the respondents' nutritional status categories measured using the Body Mass Index (BMI) shows that in the intervention group ($n = 17$), most of the respondents were in the Obesity I category, which was 14 people (82.4%). In the control group ($n = 17$), the most dominant category was also Obesity I as many as 11 people (64.7%).

Respondent characteristics based on family disease history of diabetes mellitus and hypertension.

Table 3 Distribution of frequency of respondents based on family disease history.

Yes	Family history of illness	Groups			
		Experiments		Controls	
		Frequency (n)	Present (%)	Frequency (n)	Present (%)
1.	Diabetes mellitus	2	25	2	25
2.	Hypertension	6	75	6	75
Total		8	100	17	100

Source: Primary data 2025

Based on Table 3, it can be seen that the family history of diseases in both study groups showed the same frequency of respondents. In the experimental group ($n = 17$), there were 2 respondents (25%) who had a family history of diabetes mellitus. In contrast, the control group ($n = 17$), i.e. 2 respondents (25%) had a family history of diabetes mellitus. For a family history of hypertension, in the experimental group there were 6 respondents (75%) who had a family history of hypertension. In contrast, in the control group, 6 respondents (35.3%) had a family history of hypertension.

Univariate analysis

Univariate analysis is used to describe or explain the characteristics of each variable being studied. This data is primary data obtained from a questionnaire that has been distributed to 34 respondents. The univariate data consisted of knowledge of the risk of diabetes mellitus, both experimental groups and control groups on the *pretest* and *posttest* groups in adolescents with obesity.

Pretest knowledge of diabetes mellitus experimental group and control group

Table 4 Frequency distribution of diabetes mellitus knowledge pretest of experimental groups and control groups

Yes	Categories Knowledge (pretest)	Groups			
		Experiments		Controls	
		Frequency (n)	Introduce yourself (%)	Frequency (n)	Introduce yourself (%)
1.	Good	4	23.5	5	29.4%
2.	Enough	8	47.1	7	41.2%
3.	Less	5	29.4	5	29.4%
Total		17	100	17	100

Source: Primary data 2025

Based on table 4, it can be seen that the *pretest results* in the experimental group showed that the category with the most knowledge was the sufficient category, namely 8 respondents (47.1%), while the category with the least number of respondents was good (23.5%). In the control group, the majority of respondents were also in the moderate category (41.2%), and the category with the least number of respondents was good and less with the same number of 5 respondents (29.4%).

Posttest knowledge of diabetes mellitus experimental group and control group**Table 5** Frequency distribution of *diabetes mellitus knowledge posttest of experimental groups and control groups*

Yes	Categories Knowledge (Posttest)	Groups			
		Experiments		Controls	
		Frequency (n)	Introduce yourself (%)	Frequency (n)	Introduce yourself (%)
1.	Good	17	100	17	100
2.	Enough	0	0	0	0
3.	Less	0	0	0	0
Total		17	100	17	100

Source: Primary data 2025

Based on table 5, it can be seen that *all* respondents in the experimental group had a level of knowledge in the good category, namely 17 respondents (100%). Likewise, in the control group, all respondents were also in the good category, namely 17 respondents (100%).

Bivariate analysis

Bivariate analysis is a statistical test that was used to analyze the influence of education through animated videos on knowledge of the risk of diabetes mellitus with obese adolescents at SMK Negeri 3 Gorontalo City.

Table 6 Analysis of the influence of education through animated videos on knowledge of diabetes mellitus risk

Groups	n	Mean Rank	Sum of Ranks	Z	p-value	with obese adolescents at SMK
Animated video (Posttest > Pretest)	17	9.00	153.00	-3.641	0.000	

Negeri 3 Gorontalo City.

Source: Primary data 2025

Based on Table 6, it can be seen that in the experimental group all respondents (n = 17) experienced an increase in knowledge scores in the posttest compared to the pretest, which was shown by *the positive ranks* of 17 respondents, with a *mean rank* of 9.00 and a *sum of ranks* of 153.00. The results of *the wilcoxon signed-rank test* showed a value of $Z = -3,641$ with a $p\text{-value} = 0.000$ ($p < 0.05$), which means that there was a significant increase in knowledge after being educated through animated video media.

DISCUSSION**Knowledge about the risk of diabetes mellitus in adolescents with obesity before (*pretest*) was educated in the experimental group and the control group**

Based on the results of the research on the experimental group and the control group with a total of 34 respondents, the results were obtained that in the experimental group (n = 17) at SMK Negeri 3 Gorontalo City, the knowledge category before being given was enough for 8 respondents (47.1%), the knowledge category was lacking 5 respondents (29.4%), and the good knowledge category was 4 respondents (23.4). In the control group, the knowledge category before being given education was sufficient for 7 respondents (41.2%), the knowledge category was good for 5 respondents (29.4%), and the knowledge category was lacking for 5 respondents (29.4%). The measuring tool that measures the results of the research obtained is in the form of a questionnaire on the knowledge of adolescents with obesity about risk factors for diabetes mellitus with question indicators including definition, risk factors, causes, and prevention of diabetes mellitus.

Based on the results of the study, in the experimental group with 17 respondents, the category of knowledge before (*pretest*) was given the intervention showed that as many as 5 respondents (29.4%) had good knowledge of diabetes mellitus. The results of the study showed that 5 respondents had good knowledge based on the distribution of respondents' answers, the majority of respondents were able to answer most of the questions that represented each indicator, which was true above 75% about the risk factors for diabetes mellitus, namely "The possibility of the onset of diabetes mellitus is only influenced by the history of the disease".

This is in line with the theory put forward by Irayani (2024) explaining that family history is one of the risk factors for diabetes mellitus that cannot be modified. Diabetes mellitus is a hereditary disease, where if parents suffer from diabetes mellitus, their children will be at risk of suffering from diabetes mellitus as well. A person with a family of diabetes has a risk of two to six times of developing diabetes, but if only one of his parents or grandparents is diabetic, then it is likely that 50% of his children will suffer from diabetes, either type 1 diabetes or type 2 diabetes. This is because the pancreatic organ that produces insulin can be damaged due to genetic factors. In line with that, based on research by Yahya, Arsin, & Ayu (2024) shows that individuals who have a family history of diabetes mellitus, are 5 times more at risk of developing diabetes mellitus compared to people who do not have a family of diabetes mellitus. The findings show that family history is one of the causes of diabetes mellitus, because diabetes is a genetic disease that can be passed from parents to children.

The factors that can affect adolescents' knowledge of diabetes mellitus are a family history of diseases. Based on the characteristics of the respondents in this study, out of 4 respondents with the good knowledge category, as many as 2 respondents had a family history of diabetes mellitus and 1 respondent had a family history of hypertension. This is in line with the theory of Mokalalu, Masi, & Sirat (2023) which states that adolescents with families with diabetes basically have more experience and information related to diabetes compared to adolescents without a family history of diabetes, so it can affect the level of adolescent knowledge about diabetes mellitus. These findings are supported by research by Fiqi & Zulamsyah (2021) which shows that the presence of a family history of disease can affect a person's level of knowledge of the disease, where most of the respondents with the category of good knowledge are owned by individuals who have a family history, namely as many as 10 people (19%). This condition suggests that family history is associated with a better level of awareness of risk factors for diabetes mellitus.

Based on the results of the study, as many as 8 respondents (47.1%) had sufficient knowledge about diabetes mellitus. The results of the study showed that as many as 8 of the respondents had sufficient knowledge based on the distribution of respondents' answers, the majority of respondents could answer most of the questions that represented each indicator request, which was true above 75% about diabetes mellitus in the diabetes mellitus prevention indicator, namely "A good diet can be used as one of the preventive measures against the onset of diabetes mellitus". Meanwhile, overall the majority of respondents who had knowledge answered incorrectly in the indicator of risk factors for diabetes mellitus, which was 62.5%, "Lack of physical activity is a triggering factor for the onset of diabetes mellitus."

This is in line with the theory of Manurung (2020), which explains that diet is one way or effort to direct the amount and type of food for certain purposes, for example, maintaining health, good nutritional status, helping to cure a disease. Daily eating patterns reflect the individual's repetitive behavior. Then according to the theory of Sutriyawan (2021), physical activity has a very strong correlation with non-communicable diseases. If a person does not exercise for 30 minutes a day or three times a week, this will trigger a buildup of fat in the body and insufficient insulin to convert glucose into energy. As a result, blood sugar levels will increase and diabetes mellitus occurs.

The results of the study of Vena & Yuantari (2022) show that individuals with irregular diets can lead to a risk of diabetes mellitus. The study found that poor eating habits, coupled with unbalanced nutritional intake and irregular eating portions, contribute to uncontrolled blood sugar levels in the body. Based on research by Ummah et al (2024), it is stated that the more physical activity that adolescents do, the smaller the risk of diabetes mellitus in adolescents. Regular physical activity can prevent the risk of developing diabetes mellitus. If food is not burned, it will be stored in the body in the form of fat and blood sugar. If this continues, the pancreas is no longer able to convert glucose into energy or produce insulin, leading to the occurrence of diabetes mellitus.

A factor that affects adolescents' knowledge of diabetes mellitus is age. The results showed that the majority of respondents with the knowledge category were in the late adolescent age group (17–21 years), which was as many as 5 respondents. In line with the theory of Notoatmodjo (2021) in Meldawati, Tjomiadi, & Manto (2025) which explains that the older you get, the more experience and information you get, the better the level of knowledge. In addition, at a more mature age, the individual's mindset becomes more rational so that it helps in the process of sorting out the information received. This is supported by research by Aisyah, Yunariyah, Jannah, & Triana (2024) which shows that adolescents in the age range of 17–19 years tend to have a fairly good level of knowledge. This condition is related to the continued attention and support from parents, including in providing information about health education from an early age, so that the knowledge that adolescents have tends to be better.

Based on the results of the study, as many as 5 respondents (29.4%) lacked knowledge about diabetes mellitus by answering incorrectly the question in the questionnaire with the indicator of the cause of diabetes mellitus, namely "Exercise plays a role in regulating blood sugar levels." This illustrates that some respondents do not know that exercise is important in helping control blood sugar levels in the body.

According to Sarifin & Husnul (2021), it is explained that during a resting state of muscle metabolism only slightly uses blood glucose as a source of energy, while during physical activity (physical exercise /

exercise), muscles use fat and blood glucose as the main source of energy. Muscle cells are able to store a limited amount of glucose in the form of muscle glycogen, then to a certain extent the liver can store excess glucose in the form of glycogen in the liver (liver). However, once the deposits in the liver and muscles are full, the incoming excess carbohydrates will be converted into fatty acids. Fat fatty acids will be used when fat breaks down into a source of energy (gluconeogenesis) due to reduced glucose intake or an increase in glucose needs. Increased glucose needs usually occur when physical activity is performed, especially strenuous physical activity, for example in sportsmen who do physical exercise that is intense and requires a lot of energy.

In line with the results of research by Sutrisna, Hanifah, & Sasmita (2022), it shows that there is a relationship between exercise and blood sugar levels that doing good and regular exercise can lower sugar levels, and vice versa, poor and irregular exercise behavior causes blood sugar levels to be uncontrolled. These findings suggest that exercise plays a role in helping the body regulate the use of glucose as an energy source so that blood sugar levels can remain stable.

Furthermore, the control group in this study also showed variations in knowledge levels. Based on the results of the study, it showed that in the control group with 17 respondents, the category of knowledge before (*pretest*) was given intervention in the good category, namely 5 respondents (29.4%). The results of the study showed that as many as 5 respondents had good knowledge based on the distribution of respondents' answers, the majority of respondents could answer some questions that represented each indicator request, which is true above 60% about diabetes mellitus in the indicator that causes diabetes mellitus, namely "Every day consuming fast food continuously can increase the risk of diabetes mellitus".

This is in line with the theory put forward by Labelo (2025) *junk food* can literally be interpreted as *junk* (garbage, junk) and *food* (food) so *junk food* means 'junk food'. The term *junk food* is taken because this food does not contain good nutrients that are used for the growth and development of the human body and *junk food* can have a bad impact on health. *Junk food* contains hypercalorie, low in essential nutrients for the body and additives as well as hydrogenated fats rich in trans acids. Industrial processed foods that contain synthetic additives include foods that can have an impact on excessive consumption, so they can cause insulin resistance.

Based on research conducted by Almarsyad, Algonaiman, & Alharbi (2022), it is shown that a *junk food* diet is related to the occurrence of type 2 diabetes mellitus. Individuals with a *low junk food* category had a lower risk of type 2 diabetes mellitus incidence than individuals with a medium score category of *junk food diet*. Shubhi's (2023) research shows that excessive consumption of *junk food* can result in an energy imbalance in the body and has a relationship with the incidence of type 2 diabetes mellitus. A healthy diet such as foods rich in cereals (seeds), nuts, fruits and vegetables done slowly can reduce the risk of developing diabetes mellitus.

A factor that affects adolescents' knowledge of diabetes mellitus is age. The results showed that adolescents with a good level of knowledge were mostly in the late adolescent age group (17–21 years). This is in line with the opinion of Aisyah, Yunariyah, Jannah, and Triana (2024) who explain that age is the length of time an individual lives from birth to the present. The older a person gets, the more experience and information obtained, thus contributing to the formation of knowledge. This is supported by research by Anonymous, Angkasa, Harnany, and Nofianto (2024) which states that grade XII students, the majority of whom are in their late teens, tend to have a good level of knowledge. In late adolescence approaching young adulthood, individual thinking skills are increasingly logical and scientific, and able to understand more complex concepts and social situations with a broader perspective (Sasqia & Mutiah, 2025).

Based on the results of the study, as many as 7 respondents (41.2%) had sufficient knowledge about diabetes mellitus before (*pretest*) was given intervention. The results of the study showed that as many as 7 of the respondents had sufficient knowledge based on the distribution of respondents' answers, the majority of respondents could answer most of the questions that represented each indicator request, which was true above 87.5% about diabetes mellitus in the diabetes mellitus risk factor indicator, namely "Obesity is a triggering factor for the onset of diabetes mellitus". Meanwhile, overall the majority of respondents who have a level of knowledge answered one 62.5% on the indicator of the cause of diabetes mellitus, namely "Unhealthy diet at a young age, open is the cause of the onset of diabetes mellitus".

This is in line with the theory put forward by Hendrik, Nirwana, & Salsa (2024) that obesity is one of the triggering factors for the occurrence of diabetes mellitus. The link between obesity and the occurrence of diabetes mellitus, namely obesity, causes the response of pancreatic beta cells to increased blood glucose to decrease, in addition to insulin receptors in cells throughout the body, including in muscles, are reduced in number and less sensitive. Obesity can make cells insensitive to insulin. The more fat tissue in the body, the more resistant the body is to the action of insulin, especially when body fat accumulates in the central area. Then according to the theory from Istiqomah and Sholihin (2024), a poor diet is a factor that plays a major role in the incidence of diabetes mellitus, the worse the diet, the more likely it is for a person to experience diabetes mellitus.

The results of research by Nur'afifah, Burhan, & Sulastri (2025) show that people who are obese have risk factors for the occurrence of type 2 diabetes mellitus. This is due to the occurrence of an inflammatory

process in people who have excess fat in their bodies. This inflammatory process results in disruptions in the signaling and production processes. As a result, insulin resistance occurs so that cells cannot use blood glucose as energy. This further results in increased glucose in the blood which will later continue to develop into diabetes mellitus. Then based on research by Yuheni, Parmin, Rosandi, Saputra, & Safitri (2025) shows that an unhealthy diet can lead to an increase in blood glucose levels. This happens because insulin from the pancreas cannot work optimally, so glucose builds up in the blood. These findings suggest that an unbalanced diet directly affects blood sugar regulation, which is an important factor in the risk of diabetes mellitus.

A factor that affects the level of knowledge of adolescents about diabetes mellitus is the level of education. Based on the results of the study, the respondents with the category of sufficient knowledge in this study were school teenagers at SMK Negeri 3 Gorontalo City which was dominated by 4 respondents in grade XII. According to Ardila, Humalungo, Amukti, & Akrom (2024), the higher a person's level of education, the easier it is for the individual to receive and understand information. The level of education plays a role in a person's ability to receive, process, and apply the information obtained. This is supported by research by Fiki and Zulamsyah (2021) which shows that most of the students of grade XII, which is as much as 82%, have a moderate level of knowledge, which indicates that students have a good understanding of diabetes mellitus. This understanding can increase awareness and help in controlling risk factors for diabetes mellitus later in life.

The results of the next level of knowledge category research showed that as many as 5 respondents (29.4%) lacked knowledge about diabetes mellitus by answering incorrectly the question in the questionnaire on the indicators of the causes of diabetes mellitus, namely "Consuming sugar excessively will cause diabetes mellitus". This illustrates that some respondents do not know that consuming excessive sugar is one of the factors that can cause diabetes mellitus.

According to the theory of Ardiani, Permatasari, & Sugiatmi (2021), unbalanced food consumption such as high sugar is also a risk factor for diabetes mellitus. Consumption patterns of foods that contain high sugar cause an unbalanced diet so that it can trigger various non-communicable diseases such as diabetes mellitus. According to Fitriyah & Herdiani (2022), it is explained that normal sugar consumption has a good impact on the body because it is able to contribute to making balanced energy. However, high sugar consumption leads to an increase in blood glucose levels which is one of the characteristics of diabetes mellitus.

This is in line with research conducted by Sartika, Mahendika, Setainto, Azizah, & Dewi (2023) which shows that consumption of high glycemic index foods increases the risk of diabetes mellitus. The study found that there was an effect between excess sugar consumption (high hyperglycemia) on the incidence of diabetes mellitus with an *odds ratio* (OR) value of 2.0, indicating that individuals who consumed more granulated sugar with a high glucose content had a greater risk of suffering from diabetes mellitus. These findings confirm that high sugar consumption is one of the important risk factors for the occurrence of diabetes mellitus and needs to be considered in the regulation of daily diet.

Knowledge of the risk of diabetes mellitus in adolescents with obesity after (*posttest*) was educated in both experimental and control groups

Based on the results of the study involving a total of 34 respondents at SMK Negeri 3 Gorontalo City, respondents were divided into two groups, namely the experimental group of 17 respondents and the control group of 17 respondents. In the experimental group after an intervention (*posttest*) in the form of education through animation video media with a duration of 9 minutes, no respondents were found with the category of insufficient or sufficient knowledge. All respondents in the experimental group had a level of knowledge about the risk of diabetes mellitus in the good category, which was 17 respondents (100%).

In line with the theory of Ahmadi, Mulfianda, & Desreza (2023) Animation-based educational videos can be developed and become health education interventions for the community. Animated video is an audio-visual medium that contains learning messages so as to help individuals understand the material being presented. In addition, animated videos are able to provide stimulation to the senses of sight and hearing, so that the process of receiving information becomes more optimal (Syaipuddin et al., 2024). The optimal reception of this information further contributes to the increase of adolescent knowledge

This is supported by research by Savitri & Kurniasari (2024) The level of knowledge after (*posttest*) was given education through animated videos Good 15 respondents (100%). This shows that animated video media has an important role in improving respondents' understanding, so that it is relevant to the use of technological developments in the field of health education.

The increase in knowledge obtained is inseparable from the characteristics of respondents which also affect the level of adolescents' understanding of health information. Based on the results of the research in the experimental group, respondents were in the age range of middle adolescents (14–16 years) as many as 7 respondents and late adolescents (17–21 years) as many as 10 respondents. In line with the theory of Sari & Afrina (2025) which states that in the adolescent age category, individuals are able to think abstractly and logically, and are able to draw conclusions from the information obtained. This is supported by research by Savitri & Kurniasari (2024) which shows that after being educated, adolescents in their middle teens and late

teens experience changes in the level of knowledge, where all respondents are in the category of good knowledge.

In addition to age, the level of education also plays an important role in the formation of adolescent knowledge. The respondents in this study were students of SMK Negeri 3 Gorontalo City, consisting of 6 respondents in class X, 3 respondents in class XI, and 8 respondents in class XII. This is in line with the theory of Suprayitno, Purnomo, Sutikno, & Indriyani (2020) which states that individuals with higher levels of education tend to be able to respond better to health education stimuli, so that the attitudes formed are in line with their health knowledge. These findings are supported by research by Anonymous, Angkasa, Harnany, & Nofianto (2024) which shows that most respondents with a high school education level have more extensive knowledge, as individuals with higher education generally have better abilities in receiving, understanding, and processing information.

Another factor that also influences adolescents' knowledge of diabetes mellitus is the characteristics of the family history of the disease. In the experimental group, respondents with a family history of diabetes mellitus were 2 respondents, while respondents with a family history of hypertension were 6 respondents. This is in line with the theory of Mokalau, Masi, and Sirat (2023) which states that a good level of knowledge about diabetes mellitus and hypertension can be influenced by a family history of diseases, because family members tend to have a better awareness of the risks and impacts of these diseases. These findings are supported by research by Fiqi and Zulmansyah (2021) which states that individuals with a family history of diabetes mellitus tend to eat fruits and vegetables more often and participate in blood sugar level screening. Meanwhile, individuals who have a family history of hypertension tend to pay more attention to food consumption patterns, such as reducing salt and fat intake, and have a higher awareness of non-communicable diseases.

Furthermore, based on the results of the study in the control group after the intervention (posttest) with the lecture method for approximately 15 minutes, there were no respondents with sufficient or insufficient knowledge categories. All respondents in the control group were in the category of good knowledge, namely 17 respondents (100%). This shows that the provision of education through lecture methods is effective in increasing adolescents' knowledge about the risk of diabetes mellitus.

In line with Rahmayani's (2023) theory, which explains that the lecture method is one of the ways of delivering information or explanation of a subject orally to the target group. The statement explained that lectures can be a medium to convey an idea to the public. This method emphasizes lecture activities which are indeed mostly done orally. Lectures can also be an alternative to provide an oral explanation of information.

Based on the research of Yulianto, Ahmad, & Putri (2020), in this study, the lecture method was used as a form of providing education about the risk of diabetes. Most of the respondents had good knowledge because they had obtained health education about the prevention of diabetes mellitus, so that they were able to change the understanding from previously ignorant to knowing. These findings suggest that the lecture method may be one of the effective ways in increasing adolescents' knowledge about the risk and prevention of diabetes mellitus.

Factors that affect adolescents' knowledge of diabetes mellitus in posttest measurements are inseparable from the characteristics of the respondents themselves. Based on the results of the research on the experimental group after being educated, respondents were in the middle adolescent age range (14–16 years) as many as 7 respondents and late adolescents (17–21 years) as many as 10 respondents. At this age range, adolescents have more mature thinking skills so that they are able to receive and understand health information provided through education.

In line with Nengah's (2020) theory, age affects a person's ability to grasp and mindset, where the older the age, the ability to understand information develops. This is supported by research by Meldawati, Tjomiadi, & Manto (2025) which shows that adolescents' knowledge levels tend to improve as they age, so that the health education provided can be optimally accepted. These findings suggest that adolescent age characteristics play a role in the success of health education, because at this stage of development respondents are better prepared to receive information and apply it in understanding the risk of diabetes mellitus.

In addition to age characteristics, another factor that also affects adolescents' knowledge of diabetes mellitus is the level of education. The respondents in this study were students of SMK Negeri 3 Gorontalo City with an educational background of class X 3 respondents, XI 4 respondents, and XII 10 respondents. The level of education plays a role in shaping adolescents' ability to receive, understand, and process the health information provided. In line with Mayasari's (2020) theory, individuals with higher levels of education tend to have better knowledge about health management as well as awareness of the importance of healthy living behaviors. The level of education also affects the way a person thinks in responding to the information received. This is supported by research by Rindu, Yeni, & Ambarwati (2024) which shows that respondents with high school education are able to understand health education well and show interest in information about diabetes mellitus. This condition shows that the educational characteristics of the respondents also play a role in supporting adolescents' understanding of the educational materials provided, especially related to the risk of diabetes mellitus.

Another factor that also influences adolescents' knowledge of diabetes mellitus is the characteristics of the family history of the disease. In this study, there were 2 respondents with a family history of diabetes mellitus and 2 respondents with a history of hypertension. In line with the theory of Fiqi and Zulmansyah (2021), the difference in the level of awareness of diabetes mellitus and hypertension can be influenced by a history of diseases in the family. A family member's history of illness can encourage other family members to be more aware of the event, risk factors, and impact of the disease. This happens because direct experience in the family increases attention to a healthy lifestyle. Najla's (2021) research in Moku, Masi, and Sirat (2023) supports this, stating that individuals with a family history of diabetes mellitus tend to eat fruits and vegetables more regularly and actively participate in blood sugar checks. Meanwhile, individuals with a family history of hypertension are also more attentive to food consumption patterns and live healthy lifestyles regularly. These findings show that a family history of the disease also influences adolescents' knowledge and awareness of the risk of diabetes mellitus.

The influence of education through animated videos in increasing knowledge about the risk of diabetes mellitus in adolescents with obesity.

The results showed that after being educated through animated video media, there was a significant increase in knowledge in the experimental group ($n = 17$) of respondents. This can be seen from the increase in *posttest* scores compared to *the pretest*. Based on the results of the *Wilcoxon Signed Rank Test*, p -value = 0.000 ($p < 0.05$) was obtained, which means that there was a significant difference before and after the intervention. Thus, Hypothesis Zero (H_0) was rejected and Alternative Hypothesis (H_a) was accepted, so that education through animated videos proved effective in increasing the knowledge of obese adolescents about the risk of diabetes mellitus at SMK Negeri 3 Gorontalo City.

In line with Jannah's theory, Pradita, Safira & Salsabla (2020) explained that this increase in knowledge is inseparable from the characteristics of audiovisual video media. *Computer Technology Research* (CTR) states that a person can remember 50% of information if it is obtained through the senses of sight and hearing at the same time, and up to 80% if directly involved in the learning process. Audio-visual animation video media provides a more interesting, interactive, and easy-to-understand learning experience than conventional methods. This condition shows that audiovisual media has an important role in supporting the learning process, especially in complex health materials. Therefore, one of the efforts that can be made to prevent and manage diabetes mellitus in adolescents is through educational strategies using animated video media.

Education through video media is specifically designed to increase understanding and awareness of diabetes mellitus and how to prevent it (Andriyani et al., 2022). Educational video content generally contains information about definitions, symptoms, complications, the importance of blood sugar checks, and the implementation of a healthy lifestyle in adolescents (Hasniah et al., 2021). The use of educational animation videos has been shown to be effective in increasing public knowledge and understanding of various health problems, including in adolescent age groups (Lalla & Arda, 2022). Visual media such as videos can help respondents focus more and easily understand the content of education because information is conveyed through an interesting combination of audio and visuals.

The effectiveness of these media becomes even more important when it is associated with the early condition of adolescents who still have limited understanding and access to health information. This is in line with the opinion of Fitriyani & Kurniasari (2022) who stated that the low level of knowledge of adolescents is often caused by limited understanding and access to information. After being educated through the right media, adolescents' knowledge tends to increase because they acquire new information that was previously unknown. Digital media such as animated videos are also very suitable for teenagers in today's technological era, considering that the use of *smartphones* and the internet is part of their daily lives. Video media is also considered to be able to attract attention and increase learning motivation because of its interesting and not boring contents. The presentation of material through animation helps visualize difficult concepts to be more concrete so that they are easier to understand (Sapitri & Kurniasari, 2024).

The findings in this study show that the use of animated video media is effective in increasing adolescents' knowledge about diabetes mellitus. Research conducted by Harsismanto (2020), which showed that the average level of knowledge of adolescents increased from 24.06 ± 5.873 before intervention to 40.60 ± 0.828 after education using animated videos, with a p -value = 0.000 ($p < 0.05$). These results were strengthened by Setiawan (2025) showing a significant increase in knowledge after intervention through animated video media with a p -value = 0.001 (<0.05). The alignment of these results confirms that animated video media is effective in increasing adolescents' knowledge of the risk of diabetes mellitus.

Therefore, based on the description of the research results, supporting theories, and consistent studies, it can be concluded that education through animated videos has a significant influence on increasing knowledge about the risk of diabetes mellitus in adolescents with obesity at SMK Negeri 3 Gorontalo City. This increase in knowledge shows that animated video media is one of the effective educational methods in efforts to prevent diabetes mellitus from adolescence.

CONCLUSION

The results of the pretest showed that the level of knowledge of respondents in the experimental group was only 8 respondents (47.1%), the category was less than 5 respondents (29.4), the good category was 4 respondents (23.5%) in the control group of the category was 7 respondents (41.2%), the good and poor categories were 5 respondents each (29.4%). The results of the posttest showed that all respondents in the experimental group and the control group had a level of knowledge in the good category, as many as 17 respondents (100%) each. There is an effect of education through animated videos on knowledge of the risk of diabetes mellitus in obese adolescents at SMK Negeri 3 Gorontalo City, which is proven by the results of the Wilcoxon Signed Rank Test with a p-value = 0.000 ($p < 0.05$).

ADVICE

Nurses can use educational media such as animated videos and lectures in health counseling activities for obese adolescents, especially to increase knowledge about the risk of diabetes mellitus. In addition, nurses in schools, health centers, or health facilities can design interactive media-based educational programs, monitor patient or student understanding, and provide follow-up in the form of counseling or reminders of healthy lifestyles. The use of appropriate educational media also assists nurses in increasing participant engagement and the effectiveness of health communication.

Schools should facilitate health education activities for students through video animation media and lectures as part of learning programs or extracurricular activities. The school is advised to provide sufficient facilities and time so that students can receive information optimally and apply it in their daily lives.

Adolescents are expected to be more active in participating in health education activities and applying the information obtained, especially related to a healthy lifestyle to prevent the risk of diabetes mellitus. In addition, respondents are encouraged to get used to accessing accurate health information through various educational media to increase knowledge and self-awareness.

Further research is suggested using larger sample numbers and involving participants of both sexes to improve the generalization of the study results. Researchers are also encouraged to test educational media first so that aspects of design, color, images, and content can be improved, as well as consider long-term measurements or a combination of educational methods to assess the effect of media on behavior, not just knowledge.

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