

IDENTIFICATION OF PHYSICAL ACTIVITY AND BODY MASS INDEX ON THE INCIDENCE OF PREDIABETES MELLITUS IN HIGH SCHOOL STUDENTS

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Abstract

Prediabetes mellitus is a condition of a person's blood sugar, which, if in a fasting state, ranges from 100-125 mg / dL (IFG) or 2 hours after eating, the blood sugar level is 140-199 mg / dL. Physical activity and BMI are factors that trigger prediabetes mellitus. Therefore it is necessary to hold preventive efforts to reduce the rate of development of prediabetes mellitus which is increasing and increasing public awareness regarding the importance of maintaining a healthy lifestyle. The purpose of writing this literature is to analyze physical activity and body mass index on the incidence of prediabetes mellitus in high school students. The research writing method used a literature review. Data were collected from 30 journals which were then selected into 22 journals with related variables, namely physical activity and body mass index with the incidence of prediabetes mellitus, a sample of high school students aged 15-18 years . The results of the literature review are that physical activity plays a role in controlling blood sugar and Body Mass Index (BMI) contributes to the occurrence of prediabetes if followed by an unhealthy waist circumference, less physical activity results in an increase in BMI which ultimately triggers prediabetes mellitus.

Keywords: *Physical Activity, BMI, Prediabetes Mellitus*

Introduction

Physical activity is a motion that arises due to contraction of skeletal muscles and requires energy. Moderate intensity in doing physical activity is beneficial to reduce the risk of obesity. This is due to the energy that comes out with the incoming balanced (Swift et al., 2014). Physical activity for adults can be done through daily activities such as sweeping, cooking, and purifying the motor not only by exercising (Vuori., 2018). Based on its intensity, physical activity is divided into moderate and vigorous. Vigorous physical activity is 2 times greater than moderate one. While the energy expended at vigorous intensity is more than 6 METs (Metabolic Equivalent Tasks) and physical activity at moderate intensity between 3 - 55.9 METs (Gebel et al., 2015).

The result of physical activity which has been done is a classification factor between vigorous and moderate. Vigorous is an intensity that triggers increased breathing and heart (playing football, jogging, and climbing) in contrast to moderates that increase heart work such as dancing (Physical Activity Guidelines

for Americans, n.d.). The development of technology causes instantaneous lifestyle changes, such as motorcycles affecting a person's physical activity to walk or cycle, washing machines affect a person's physical activity to wash using brushes, influential video games to have physical habits for teenagers and school age. Independent risk factors of lack of physical activity are death and chronic diseases (WHO, 2013). Furthermore, it can also cause an ideal weight, it can be known by calculating the Body Mass Index (BMI).

Body Mass Index is a barometer to find out a person's weight category. The categories in BMI are skinny, normal, overweight, obesity 1, and obesity 2. A good BMI is when the body belongs to the normal category where the weight and high are balance. When an adult male's BMI is ≥ 27 , it is included to obesity but when it is ≥ 25 and < 27 , it means that it is included in overweight. While adult women's BMI is ≥ 23 and < 27 , then it is included to overweight (Guidelines for medical nutrition therapy practitioners of Indonesian Ministry of Health, 2018). The bad development of times and lifestyles is very influential on the value of BMI that is classified as obesity. According to (Dayinta et al., 2018), recent year obesity increases significantly. The prevalence of obesity in developed and developing countries reaches 2-4 times. The people deaths cause of obesity reached 3.4 million which cause lots of loss 3.8%. Those results is the number of overweight and obese (The GBD 2013 Obesity Collaboration, 2014). However, overweight can cause health problems such as prediabetes mellitus.

Blood glucose is categorized as prediabetes mellitus when it is exceeded normal. Blood glucose is divided into low, normal, and high categories. Diabetes mellitus is diagnosed when a person's blood glucose reached from ≥ 126 mg/dL to ≥ 200 mg/dL. While prediabetes mellitus is diagnosed when a person's blood glucose in a fasting time reached 100-125 mg / dL (IFG) and after doing such a workout, the blood glucose is 140-199 mg / dL. According to Singh et al (2012), $\frac{1}{4}$ prediabetes mellitus sufferers are at risk to increase to be diabetes type 2, then $\frac{1}{4}$ of them is decreased to normal blood glucose and $\frac{1}{2}$ of them is stay in the prediabetes. According to the data of International Diabetes Federation (IDF) The population of the world will undergo to 398 million of prediabetes mellitus sufferers by 2030. The prevalence of diabetes in Indonesia is 2.6% in urban areas and 1.4% in rural areas. While the prevalence of prediabetes mellitus is two times higher and women account for 2.4% while men are 1.7% according to Basic Health Research (Risksedas, 2018). Based on the data above, it can be concluded that it needs more attention and health care.

The increasing number of people with prediabetes mellitus, especially in adolescence between 15 to 18 years, cannot be separated from several factors that cause the disease. Prediabetes mellitus can occur due to high blood glucose, smoking, over 45 years of age, mental burden, lack of activity, BMI, and unhealthy lifestyle (Irianto koes, 2014). Research conducted by (Sukenty et al., 2018) states that these factors can be at risk of developing type 2 diabetes mellitus. While excess weight 7.14 times has a risk for the occurrence of type 2 diabetes mellitus. Being overweight, lack of physical activity and unhealthy

lifestyle are the biggest factors at risk of becoming diabetes mellitus. Furthermore, in this era of globalization, many teenagers spend more time to play gadgets than going to play or doing other physical activities.

The increasing prevalence of prediabetes mellitus needs to get more attention. Thus, the number of people with diabetes can be reduced. One of the concerns can be done with precautionary measures from an early ages are by knowing the relationship between activities and BMI to the incidence of prediabetes mellitus. Diabetes mellitus is a disease with 3.7 milion people of high mortality, 43% of deaths happen in developing countries and happen to people at the age of < 70 years. Therefore, the author tried to dig up information from researches that have been done about prediabetes mellitus and the factors that influence. It is very necessary considering that Indonesia is a densely populated developing country. The sufficient activity is done for 30 minutes in a week and the total is 150 minutes (Riskesdas,. 2018). However, the balance of energy for obesity is the effect of physical activity. The main cause of diabetes type 2, heart disease and stroke is obesity or overweight. According to the U.S. Department of Health and Human Services physical activity guidelines committee (2016) diabetes mellitus and cardiovascular disease are occur when the BMI decreased.

Based on the data above, the researcher is interested to do an in-depth identification related to physical activity and body mass index of prediabetes mellitus. The background of this problem needs to be formulated to answer the question, why physical activity and body mass index need to be identified and how it is related to the occurrence of prediabetes mellitus.

Method

The research is a literature studies. The research data collection is conducted for 6 months from February to July 2020. The number of articles and journals reviewed as many as 22 journals consisting of quantitative and qualitative journals with related variables namely physical activity, body mass index, and prediabetes mellitus, the sample of this research is high school students aged 15-18 years. In addition, the researcher also sought out key relevant studies in each identified theme to complement the reviews taken, assuming that this would identify additional evidence that has not made it a systematic review. The data searched include Web of Science, PubMed (Medline), CINAHL, OMICS, SocINDEX, BMC and Nature with the following search terms: (Physical activity OR practice OR program OR intervention) and (Body mass index OR obesity OR BMI OR weight loss OR weight management).

Table 1. Journal Reviewed of Phsyscal Activity

No	Author	Method	Result	Conclusion
1.	(Swift et al., 2014)	Quantitative	HIIT Training or CON produces the increasing of glycemi control, visceral adiposity, and aerobic for prediabetes mellitus sufferers	physical activity improves fitness in prediabetes mellitus sufferers

2.	(Vuori., 2018)	Qualitative	improving diet and increasing physical activity are effective ways of reducing death and disease worldwide	physical activity can be done in daily activities to maintain health
3.	(Gebel et al., 2015)	Quantitative	doing vigorous activity can decrease the risk of death until 9% to 13%	lack of physical activity may cause the risk of death
4.	(<i>Physical Activity Guidelines for Americans, n.d.</i>)	Qualitative	<i>vigorous and moderate physical activity (150-300 minutes in a week) decrease the risk of death, prediabetes mellitus, and cancer.</i>	<i>vigorous and moderate physical activity can decrease the risk of deathly disease</i>
5.	(Sari & Purnama, 2019)	Qualitative	There is a correlation between physical activity toward diabetes mellitus (P value=0.009 with OR=11.000)	Physical activity which is done <150 minutes in a week risks of prediabetes mellitus
6.	(Wang et al., 2017)	Qualitative	Physical activity in whole spare time, vigorous, and moderate correlate to the decrease of prediabetes mellitus (OR=0.46-0.77)	Physical activity at the spare time can decrease the risk of prediabetes mellitus
7.	(Sigal et al., 2018)	Quantitative	physical activity may control glucose and lose of weight	Physical activity can be the health control of prediabetes mellitus sufferer
8.	(Sipayung Ronika & Siregar Fazidah, 2019)	Quantitative	There is correlation between physical activity (p=<0,0001; OR=6,245; 95% CI 2,78-14,01) toward prediabetes mellitus	Moderate physical activity can cause 6,2 times risk for prediabetes mellitus than people with vigorous physical activity

Table 2. Journal Reviewed of Index Mass Body

No	Nama	Metode	Result	Conclusion
1.	(Al-Zahrani et al., 2019)	Quantitative	Waist size and high IMT is found at woman with prediabetes mellitus	High IMT is the factor of prediabetes mellitus
2.	(Dayinta et al., 2018)	Quantitative	There is correlation between antara physical activity, energy intake level, protein intake level, carbohydrate intake level and fat intake level toward the nutritional status of children in school (p<0,05)	IMT is influenced by physical activity
3.	(Sukenty et al., 2018)	Quantitative	prediabetes sufferer is influenced by Body Mass Index with OR 3,591 (p value 0,011), dietary habit OR 2,435 (p value 0,044), and smoking habit or passive smoker with OR 2,493 (point p 0,046)	A maintained BMI can prevent prediabetes mellitus
4.	(Saroh et al., 2019)	Quantitative	hypertension, unhealthy diet, BMI and physical activity are factors of	BMI 7.071 times greater triggers of

			prediabetes mellitus	prediabetes mellitus
5.	(Lee et al., 2010)	Quantitative	IMT can be controlled by doing physical activity for about 60 minutes in a day.	The increasing of IMT is caused by energy and imbalance output
6.	(Mainous et al., 2016)	Quantitative	Prediabetes mellitus increases in the age of 20 and over with healthy weight is not influenced by abdominal obesity	IMT is not influenced by abdominal obesity
7.	(Vijayakumar et al., 2019)	Quantitative	BMI \geq 25 kg / m ² and the presence of central obesity is the important factors of prediabetes mellitus	IMT is the main factor of prediabetes mellitus

Table 3. Journal Reviewed of Prediabetes Mellitus

No	Author	Method	Result	Conclusion
1.	(Irianto koes., 2014)	Quantitative	Physical activity plays an important role in the occurrence of prediabetes mellitus.	Prediabetes mellitus terjadi karena IMT dan aktivitas fisik
2.	(Dany et al., 2013)	Quantitative	Mental disorder or stress, the lack of physical activity can be the factor of prediabetes mellitus protective	Physical activity can be factor of prediabetes mellitus protective
3.	(Astuti et al., 2019)	Quantitative	There is correlation between IMT \geq 25 (57,7%) and physical activity (46,2%) and there is significant correlation between IMT (0,000), and physical activity (0,006) toward prediabetes mellitus.	the lack of physical activity fisik can cause the disruption in insulin release, causing prediabetes mellitus
5.	(Soewondo & Pramono, 2011)	Quantitative	Male, elderly people, high socioeconomic status, low education level, hypertension, obesity, central obesity, and smoking habits are factors in prediabetes mellitus	The prevalence increase of prediabetes mellitus is caused by BMI
6.	(Aldossari et al., 2018)	Quantitative	age, obesity and overweight, married, smoking, and having a civil job and less education are factors of prediabetes mellitus	prediabetes mellitus is caused by overweight and lack of physical activity
7.	(Sulistiowati & Tengah, 2018)	Quantitative	aging, BMI, hypertension, and hypertriglycerides are factors of prediabetes mellitus.	Prediabetes mellitus is caused by waist and body size
8.	(Meng et al., 2013)	Quantitative	using the C5.0 decision of tree method algorithm provides accurate results in research of prediabetes mellitus	Prediabetes mellitus can be controlled by lifestyle intervention methods

Discussion

Prediabetes mellitus is a person's blood glucose in fasting time is 100-125 mg/dL (IFG) and after workout the blood glucose is of 140-199 mg/dL. This cannot be concluded that diabetes mellitus is not eligible (Dany et al., 2013). According to (Astuti et al., 2019) prediabetes mellitus can occur due to the factor of age, overweight and lack of physical activity. In addition, overweight and central obesity are the main factors of prediabetes mellitus (Vijayakumar et al., 2019).

Prevalence of people with prediabetes mellitus is constantly increasing into a serious health problem that must be solved especially in Indonesia. Prediabetes mellitus in Jakarta reached 24.91% of the number of other diseases (Soewondo & Pramono, 2011). This is cannot be separated from the factors that influence the occurrence of prediabetes mellitus such as physical activity and body mass index.

The results of the discussion between articles showed difference results. The researcher has analyzed 22 journals and articles. The 18 journal article is quantitative methods while 4 with qualitative methods related to variable prediabetes mellitus. Other than that, the researcher also analyzed 7 quantitative journal related to diabetes mellitus. The results that BMI is one of the factors of the occurrence of prediabetes mellitus. Therefore, the discussion will be focused on the results of research and differences in results in related articles. However, this research will be focused on the physical activity and body mass index against prediabetes mellitus.

Physical activity

Physical activity of prediabetes seems becomes a protective factor. This can be seen after bivariate analysis on environmental factors such as smoking, foods containing a lot of sugar, coffee, and physical activity (Dany et al., 2013). Therefore, the research by (Sari & Purnama, 2019) stated that physical activity can cause the risk of prediabetes mellitus. This is because physical activity has a role in controlling glucose from the bloodstream absorbed by muscle glucose. Physical activity is a core factor to control blood glucose, overweight and reduce mortality by 45-70% (Sari & Purnama, 2019). Physical activity can be performed in several levels based on its intensity.

Physical activity is divided into three types namely total, strong and moderate. Physical activity at leisure can be an option for humans to prevent of prediabetes mellitus. Since it was found that activity at leisure both in total, strong, and moderate statistically showed that associated with a decrease in the risk of prediabetes mellitus (OR = 0.46-0.77) (Wang et al., 2017). Easy physical activity can trigger the occurrence of prediabetes mellitus for 6.2 times. Easy physical activity can be even greater risk of prediabetes mellitus by 29,571 times (Sipayung Ronika & Siregar Fazidah, 2019). This is because the target has not been achieved to perform daily physical activities.

Physical activity which done for 60 minutes a day can prevent weight gain and BMI in normal condition. Weight gain is caused by an imbalance between energy intake and expenditure (Lee et al., 2010). Physical activity can help diabetics achieve a variety of goals, including improved cardio respiration fitness, increased strength, increased glycemic control, decreased insulin resistance, increased lipid profile, decreased blood pressure (BP) and weight loss maintenance (Sigal et al., 2018). Physical activities such as walking, cycling, jogging, and swimming can be done to provide adequate physical activity (Colberg et al., 2016). Therefore everyone needs to do physical activity in order to feel the benefits.

Activity has good benefits for the human body. Based on journals and articles that have been reviewed show that physical activity has a relationship with the occurrence of prediabetes. These benefits are in line with an article written by (vuori., 2018) that physical activity is beneficial in reducing global mortality and prediabetes. Physical activity performed 150-300 minutes a week can reduce the risk of death, prediabetes mellitus, and cancer. This is because physical activity plays an important role in regulating glucose and regulating the balance of energy entering and exiting the human body. It is necessary to conduct a program to perform physical activities in the community in order to ingrain the habit to do so, so as to reduce the risk of prediabetes mellitus.

Body Mass Index (BMI)

Body Mass Index is a way to find out a person's weight category. The categories in BMI are skinny, normal, overweight, obesity 1, and obesity 2. A good BMI is when the body belongs to the normal category or when the weight and height is balanced. When an adult male's BMI is ≥ 27 it is included to obesity but when the BMI is ≥ 25 and < 27 , it means that it is included to overweight. When adult women's BMI is ≥ 23 and < 27 , it means that it includes overweight. (Guidelines for medical nutrition therapy practitioners of the Ministry of Health, 2018). According to Trisnawati and Setyorogo (2016) in (Saroh et al., 2019) older person will weaken mitochondrial performance by 35%. This is due to the reduced physical activity that a person does when entering older age.

Overweight can trigger the prediabetes mellitus. An overweight person is risk of prediabetes mellitus by 7,071 times compared to proportional person (Saroh et al., 2019). According to the journal written by (Al-Zahrani et al., 2019) found that people who suffer from prediabetes mellitus have a high BMI compared to people who do not suffer from prediabetes mellitus. In contrast with the research by (Mainous et al., 2016), they found that BMI is independently not associated with prediabetes mellitus when taking into account other factors in multivariate. His research was the first to examine the prevalence of prediabetes mellitus among individuals with a normal BMI. Prediabetes are caused by lack of physical activity that affects insulin sensitivity in the body.

Based on the journal article which has been reviewed, it can be concluded that IMT is related to the diabetes mellitus especially for women. IMT in an adult

woman increases due to the age, married, the lack of physical activity and waist circumference. Therefore, for the age of 20 and over, IMT cannot detect that can effect the diabetes mellitus (Mainous, 2016). This can be found from his research which show that the increase of diabetes prevalence in normal weight and IMT. Based on his research, waist circumference gives more effect in diabetes mellitus. Unhealthy waist circumference is >102cm for men and >88cm for women. The research in line with the research done by (sulistiwati & tengah, 2018). They found that waist circumference can be the factor of diabetes mellitus. However, IMT is the factor of diabetes mellitus when it followed by waist circumference in the adult.

Prediabetes Mellitus

The prevalence of prediabetes in the South Asian is dominated by those who live in the city than in village. Some characteristics such as high BMI, Overweight and lack of physical activity are high factors for prediabetes mellitus. People tend to do daily activities with a short time that eventually becomes a habit among the community. The habit effect the weight over a period of several years. In addition, the consumption of vegetables can decrease the factor of prediabetes mellitus. This can happen in adults who do less physical activity. (Aldossari et al., 2018).

The prediabetes mellitus sufferer is faced by people in the age around to 45 year old. Sufferers of female prediabetes mellitus are more numerous than men. This is because women have a BMI and a larger waist circumference (Sulistiwati & Central, 2018). Age, occupation, smoking habits and level of education can be factors in the occurrence of prediabetes. Contrast to the research by (Dany, 2013), he found that BMI is the protective factor of prediabetes mellitus.

Based on journals and articles that have been reviewed, it can be concluded that prediabetes mellitus can occur due to several things including age, occupation, level of education, smoking habits, especially physical activity and BMI. This means that the result is contrast to the research by (Dany, 2013) which conclude that BMI is a protective factor of prediabetes mellitus. The last, this only a difference of point of view from researchers in mentioning the risk factors for the occurrence of prediabetes mellitus.

Therefore it is necessary to develop a habit in the community to do 150-300 minutes of activity a week so that BMI in the body is controlled. The ingrained habit of doing physical activity will affect BMI control because physical activity acts as a balance between incoming and outgoing energy in the human body. So this can be a preventive step in the occurrence and growth of the prevalence of prediabetes. Further research is needed on accurate methods in conducting research on the occurrence of prediabetes, one of which is by using lifestyle intervention methods (Meng et al., 2013).

Conclusion

Based on the results that has been done, it can be concluded that physical activity and BMI are not the main factors of prediabetes, there are other factors

that influence the occurrence of prediabetes mellitus. Physical activity plays a role in controlling blood glucose, the balance energy which come and out from the body. Activities is important role in the body towards the increase of BMI and the occurrence of prediabetes mellitus. BMI can be a factor of prediabetes if it followed by unhealthy waist circumference, where the number is waist circumference >102 cm for men and >88 cm in women. People with lack of physical activity will have increasing of BMI, if it becomes a habit then the BMI will be increased and uncontrolled then caused of prediabetes mellitus.

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