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Determinants of Risk for Type 2 Diabetes Mellitus Among the Community at The Birobuli Community Health Center

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ABSTRACT

To identify the determinants of risk for type 2 diabetes mellitus among the community at the Birobuli Community Health Center. Type of quantitative research with a case-control approach at a confidence level of 95%. The sample size was taken using the Slovin formula with a result of 76 people and a 1:1 ratio and using gender matching with a total sample of 152 people. Sampling was done using the purposive sampling technique. The data source used secondary data in the form of medical records and primary data in the form of interviews using questionnaires measuring physical activity, unhealthy eating patterns, and sleep quality with the criteria that a doctor diagnosed the respondent as suffering from Type 2 DM and not suffering from other types of Diabetes Mellitus (DM). Data analysis used the odds ratio test, the results showed that physical activity (OR=4.455 and CI=2.250-8.819), unhealthy eating patterns (OR=3.145 and CI=1.616-6.120), sleep quality (OR=5.444 and CI= 2,703 10,966), and dyslipidemia (OR=4,287 and CI=2,121-8,667) are determinants of the risk of Type 2 DM. It is suggested that health workers should improve health services at each Integrated Development Post (known as POSBINDU), an integrated monitoring and early detection activity for NCD risk factors (heart and blood vessel disease, diabetes, acute obstructive pulmonary disease, and cancer) as well as disorders due to accidents and acts of domestic violence which are managed by the community through integrated guidance, meanwhile, provide education on healthy lifestyles to overcome the incidence of DM.

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Key Messages:

- A study at the Birobuli Community Health Center identified physical activity, unhealthy eating patterns, poor sleep quality, and dyslipidemia (abnormal blood fat levels) as significant risk factors for type 2 diabetes mellitus (T2DM) in the community
- The study suggests strengthening health services at Integrated Development Posts (POSBINDU) to address these risk factors through early detection and education on healthy lifestyles to prevent T2DM.

Introduction

As time goes by, and various technologies result in people's lifestyles experiencing very rapid changes from traditional culture to modern culture. These changes also cause changes in existing disease patterns, especially diseases related to people's lifestyles. A bad lifestyle can trigger diseases such as hypertension, coronary heart disease, obesity, and Diabetes Mellitus (DM) (1). Type 2 diabetes mellitus (DM) is a chronic metabolic disorder characterized by high blood sugar levels (2). It's a major global health concern, contributing significantly to morbidity (illness) and mortality (death) by increasing the risk of heart disease, stroke, and other complications(3).

The World Health Organization (WHO) predicts that diabetes will affect at least 366 million people by 2030 (4). In 2021, the International Diabetes Federation (IDF) recorded that 537 million adults (aged 18-40) worldwide suffered from DM. DM causes 6.7 million deaths or 1 death every 5 seconds. China is the country with the highest number of adults suffering from DM in the world at 140.87 million sufferers. Furthermore, India occupies the second highest position with DM sufferers at 74.19 million people. Pakistan is recorded as having 32.96 million DM sufferers and the United States has 32.22 million people. Indonesia is in fifth place with 19.47 million people suffering from DM. Indonesia has a diabetes prevalence rate of 10.6% with a population of 179.72 million people (5).

In Southeast Asia, Indonesia is one of the countries in it, it is ranked 3rd with the number of Diabetes Mellitus sufferers at 11.3% (6). 2018 Basic Health Research (Riskesdas) data shows that the province with the highest prevalence of Diabetes Mellitus is DKI Jakarta (3.4%) while the province with the lowest prevalence of Diabetes Mellitus is NTT (0.9%). Central Sulawesi is in tenth place with the most cases with a prevalence of 2.1% (7).

Diabetes Mellitus is classified into type 1 DM, type 2 DM, gestational DM and other types of DM. Of the four types, type 2 DM is the disease that causes the most deaths throughout the world. Type 2 DM is a group of metabolic diseases characterized by hyperglycemia due to abnormalities in insulin secretion, insulin action, or both. 90% of diabetes cases are Type 2 DM, which is characterized by impaired insulin sensitivity and/or insulin secretion (8).

Type 2 Diabetes Mellitus can be managed well if the risk factors are known. Factors that influence type 2 DM are physical activity, unhealthy eating patterns, sleep quality, and dyslipidemia. These risk factors can result in the severity of type 2 DM which has an impact on increasing the number of sufferers, the incidence of death, and complications from type 2 DM (9).

Data from the Central Sulawesi Provincial Health Service in 2022 showed that the highest number of Diabetes Mellitus sufferers was in Palu City with 23,677 cases, followed by Toli-toli Regency with 13,453 cases, and Buol Regency with 9,255 cases. Data from the Palu City Health Service shows that the incidence of Type 2 Diabetes Mellitus spread across several Palu City Health Centers is highest at the Community Health Center of Puskesmas Birobuli with a prevalence of 1,108 cases and an incidence of 310 cases in 2022. To identify the determinants of risk for type 2 diabetes mellitus among the community at the Birobuli Community Health Center

Methods

The type of research used was quantitative research using a case-control study approach. This research was carried out in the Community Health Center of Puskesmas Birobuli, Palu City, Central Sulawesi. Conducted on 7 August-14 September 2023. The population in this study were people who were in the Working Area of the Community Health Center of Puskesmas Birobuli, Palu City, Central Sulawesi. The case population in the study was 310 people suffering from Type 2 DM who were registered in the report from the Community Health Center of Puskesmas Birobuli, Palu City, Central Sulawesi for January-December 2022. The control population was people who were not suffering from Type 2 DM and who had visited and resided in the Working Area of the Community Health Center of Puskesmas Birobuli in Palu City, Central Sulawesi. The sample size was taken using the Slovin formula with a result of 76 people and a 1:1 ratio and using gender matching with a total sample of 152 people. Sampling used a purposive sampling technique.

Primary data was obtained through direct interviews and secondary data was obtained from medical records in the form of HDL and triglyceride levels. The Chi-square test was used to analyze the variables of physical activity, unhealthy eating patterns, sleep quality, and dyslipidemia on the incidence of type 2 DM. To determine the risk determinants of Type 2 Diabetes Mellitus, an odds ratio (OR) analysis was carried out.

Results

Table 1 shows that of the 152 respondents in the Community Health Center of Puskesmas Birobuli Work Area, the distribution of respondents based on the highest age group was in the 59-63-year age group with 43 respondents (28.3%). Distribution of respondents based on gender with the highest number being female, about 96 respondents (63.2%). The distribution of respondents based on their latest education with the highest frequency was in the Senior High School/Equivalent group, with 64 respondents (42.1%). The distribution of respondents based on occupation with the highest frequency was Housewives, 70 respondents (46.1%).

The distribution of respondents based on physical activity was that the majority of respondents were high risk and had low physical activity, 81 respondents (53.3%). The distribution of respondents based on unhealthy eating patterns is that the majority of respondents are high risk and have irregular eating patterns, 83 respondents (54.6%). The distribution of respondents based on sleep quality was that the majority of respondents were high risk and had poor sleep quality, 84 respondents (55.3%). The distribution of respondents based on dyslipidemia was that the majority of respondents were low-risk and had HDL cholesterol > 35 mg/dL and/or triglycerides < 250 mg/dL, 93 respondents (61.2%).

Table 1 Respondent Characteristics in the Working Area of the Community Health Center of Puskesmas Birobuli

Respondent Characteristics	n	%
Age group (years old)		
34-38	4	2.6
39-43	4	2.6
44-48	6	3.9
49-53	27	17.8
54-58	33	21.7
59-63	43	28.3
64-68	25	16.5
69-74	10	6.6
Gender		
Male	56	36.8
Female	96	63.2
Education		
Not schooling	2	1.3
Elementary school/equivalent	20	13.1
Junior High School/equivalent	13	8.6
Senior High School/equivalent	64	42.1
College	53	34.9
Occupation		
Housewife	70	46.1
Retirement	29	19.1
Entrepreneur/Private	33	21.7
Civil servant	20	13.1
Physical activity		
High Risk	81	53.3
Low Risk	71	46.7
Unhealthy Food Pattern		
High Risk	83	54.6
Low Risk	69	45.4
Sleeping Quality		
High Risk	84	55.3
Low Risk	68	44.7
Dyslipidemia		
High Risk	59	38.8
Low Risk	93	61.2

Table 2 Analysis of the Risk of Physical Activity, Unhealthy Food Pattern, Sleeping Quality, and Dyslipidemia on the Incidence of Type 2 Diabetes Mellitus in the Working Area of the Community Health Center of Puskesmas Birobuli

Risk Factor	Status				OR (CI 95%)	p-value
	Cases		Control			
	n	%	n	%		
Physical Activity						
High Risk	54	71.1	27	35.5	4.455	
Low Risk	22	28.9	49	64.5	(2.250-8.819)	0.000
Unhealthy Food Pattern						
High Risk	52	68.4	31	40.8	3.145	0.001
Low Risk	24	31.6	45	59.2	(1.616-6.120)	
Sleeping Quality						
High Risk	57	75.0	27	35.5	5.444	0.000
Low Risk	19	25.0	49	64.5	(2.703-10.966)	
Dyslipidemia						
High Risk	42	53.3	17	22.4	5.444	0.000
Low Risk	34	44.7	59	77.6	(2.703-10.966)	
Total	**76**	**100**	**76**	**100**		

Table 2 shows that of the 76 respondents who suffered from Type 2 Diabetes Mellitus, there were 54 respondents (71.1%) carried out high-risk physical activity, and 22 respondents (28.9%) carried out low-risk physical activity, while the 76 respondents did not suffer from Type 2 DM. There were 27 respondents (35.5%) who carried out high-risk physical activities and 49 respondents (64.5%) who carried out low-risk physical activities. The results of the Chi-Square test analysis showed that $p = 0.000$ so $p < 0.05$. Calculating the risk estimate obtained an Odds Ratio (OR) value of 4.455 at a 95% Confidence Interval (CI) of 2.250-8.819, meaning that someone who does less physical activity will be 4.455 times more likely to experience Type 2 DM compared to someone who does enough physical activity.

Table 2 shows that of the 76 respondents who suffer from Type 2 Diabetes Mellitus, there are 52 respondents (68.4%) have a high-risk diet, and 24 respondents (31.6%) have a low-risk diet, while of the 76 respondents who do not suffer from Type 2 DM, there were 31 respondents (40.8%) who had a high-risk diet and 45 respondents (59.2%) who had a low-risk diet. The results of the Chi-Square test analysis showed that $p = 0.001$ so $p < 0.05$. Calculating the risk estimate obtained an Odds Ratio (OR) value of 3.145 at a 95% Confidence Interval (CI) of 1.616-6.120, meaning that someone who has an unhealthy diet will be 3.145 times more likely to experience Type 2 DM compared to someone who has a healthy diet.

Table 2 shows that of the 76 respondents who suffer from Type 2 Diabetes Mellitus, there are 57 respondents (75.0%) have high-risk sleep quality and 19 respondents (25.0%) have low-risk sleep quality, while the 76 respondents do not suffer from Type 2 DM: There were 27 respondents (35.5%) who had high-risk sleep quality and 49 respondents (64.5%) who had low-risk sleep quality. The results of the Chi-Square test analysis carried out on sleep quality with the incidence of Type 2 DM, obtained $p = 0.000$ so $p < 0.05$. Calculating the risk estimate obtained an Odds Ratio (OR) value of 5.444 at a 95% Confidence Interval (CI) of 2.703-10.966, meaning that someone who has poor sleep quality will be 5.444 times more likely to experience Type 2 DM compared to someone who has good sleep quality.

Table 2 shows that of the 76 respondents who suffered from Type 2 Diabetes Mellitus, there were 42 respondents (55.3%) had high-risk dyslipidemia and 34 respondents (44.7%) had low-risk dyslipidemia, while of the 76 respondents who did not suffer from Type 2 DM. There were 17 respondents (22.4%) who had high-risk dyslipidemia and 59 respondents (77.6%) who had low-risk dyslipidemia. The results of the Chi-Square test analysis carried out on dyslipidemia with the incidence of Type 2 DM, obtained the results of $p = 0.000$ so $p < 0.05$. Calculating the risk estimate obtained an Odds Ratio (OR) value of 4.287 at a 95% Confidence Interval (CI) of 2.121-8.667, meaning that someone who has increased triglyceride levels and/or decreased HDL levels will be 4.287 times more likely to experience Type 2 DM compared to people who have Triglyceride levels and HDL levels were normal.

Discussion

Physical activity is an activity that is carried out non-stop for at least 10 minutes. Physical activity requires energy expenditure related to body movement in carrying out daily life activities. Physical activity has a specific goal and is carried out systematically with predetermined rules, such as time rules, target heart rate, number of repetitions of movements, and so on. Based on the characteristics of respondents regarding physical activity, it was found that the majority of respondents carried out high-risk physical activity, namely 81 respondents (53.3%). It can be concluded that the majority of respondents who suffer from type 2 DM have not done enough physical activity. This is proven by the results of the questionnaire where some respondents in their daily work only carry out relatively light physical activities such as washing dishes, cooking, ironing, sweeping, and sitting. Meanwhile, there are still a few respondents who routinely walk at least 10 minutes every day to go to the market or places of worship. However, several respondents used to often play sports such as badminton players and, in their work, lifted a lot of heavyweights.

Based on the results of research conducted in the Bureau of Public Health Center Work Area, physical activity is a risk factor that is significantly related to the incidence of Type 2 Diabetes Mellitus. Respondents who are less physically active are 4,455 times more likely to experience Type 2 DM than respondents who are moderately physically active. The results of this study are in line with the research of Zulkarnaini A et al (2022) (10) which shows that people who do less physical activity are more likely to suffer from type 2 DM with a risk of 5.7. In T2D patients, resistance training improves blood pressure and increases muscle mass and strength, which may positively impact insulin responsiveness and metabolic control (11). Someone diligent in doing physical activity will convert a certain amount of glucose in the body into energy. Lack of physical activity can also result in a decline in body condition and make a person susceptible to disease (12).

This research is not in line with research conducted by Rosita R (2022) (13), who stated that there is no relationship between physical activity and the incidence of type 2 Diabetes Mellitus. Physical

activity is a protective factor against the incidence of type 2 DM. His research also showed that people who engage in low to moderate physical activity have a 0.87 times lower risk of suffering from DM type 2 compared with people who do high physical activity. This is because there are other factors not examined in research, such as diet and genetics, which can influence the occurrence of type 2 DM .

Eating patterns are food intake consisting of various amounts, schedules, and types of food that a person obtains. Irregular eating patterns can increase the risk of degenerative diseases such as Type 2 Diabetes Mellitus. This is because one of the causes of type 2 DM is an unhealthy lifestyle and eating patterns. One of the eating arrangements (diet) that can be done for DM sufferers is to apply the regularity of the 3J eating pattern (amount of food, type of food, and eating schedule).

Based on the characteristics of respondents with unhealthy eating patterns, it was found that respondents who suffered from Type 2 Diabetes Mellitus in this study mostly had high-risk eating patterns, namely 52 respondents (68.4%). It can be concluded that the majority of respondents who suffer from type 2 DM still have unhealthy eating patterns. This is proven by the results of the FFQ questionnaire which looks at the overall picture of eating patterns, including nutritional intake such as carbohydrates, protein, fat, fiber, and vitamins, where the dietary behavior of respondents is more likely to not regulate their eating patterns. The dietary patterns found in the case group respondents consumed a lot of carbohydrates, consumed a lot of fat, and ate little fruit and vegetables. It is known that the source of carbohydrates most frequently consumed by respondents comes from rice with a frequency of eating very often/more than once per day. The most frequently consumed source of protein is fish, and the most frequently consumed source of fat is vegetable oil and coconut milk. Sources of fiber that are often consumed are kale and bananas. Soft drinks such as sweet drinks, fizzy drinks, and fried foods are also often consumed by the case group before being exposed to Type 2 DM.

Indonesian people's dietary habits of consuming too many sources of carbohydrates and fats as well as an imbalance between food consumption and energy needs in the body that continues continuously can cause diabetes mellitus (14). Excessive consumption of carbohydrates can cause higher sugar levels in the body. In people with Type 2 DM, body tissues are unable to store and use sugar, so blood sugar levels are influenced by the high intake of carbohydrates eaten (15).

In this study, the main staple food frequently consumed by respondents was white rice, with a frequency of ≥3 times a day or included in the frequent category. Based on the glycemic index classification, white rice has a high glycemic index, while Cilembu sweet potatoes and purple sweet potatoes are included in foods with a medium glycemic index (16). The glycemic index measures how quickly a food increases blood sugar levels after the food is consumed. Eating foods with a high glycemic index can cause insulin resistance and increase the risk of Type 2 Diabetes Mellitus (17).

Based on the results of research conducted in the work area of the Birobuli Community Health Center, unhealthy eating patterns are a risk factor that is significantly related to the incidence of Type 2 Diabetes Mellitus. Respondents who have unhealthy eating patterns are 3,145 times more likely to experience Type 2 Diabetes Mellitus than respondents who have healthy eating patterns. Diets high in processed carbohydrates, sugary drinks, and unhealthy fats cause blood sugar spikes. Over time, this constant stress on the body's ability to manage blood sugar can lead to T2DM (18). Unhealthy eating habits, particularly diets high in saturated and trans fats, can contribute to insulin resistance (19). Fiber helps regulate blood sugar levels. Diets lacking fruits, vegetables, and whole grains are often low in fiber and can contribute to T2DM risk (20). By adopting a healthy eating pattern that emphasizes whole foods, fruits, vegetables, lean protein, and healthy fats. This habit can significantly reduce your risk of developing type 2 diabetes.

Sleep is a basic and important biological function in human life. Lack of quality and quantity of sleep can cause metabolic and cardiovascular disorders. Sleep functions metabolically and several studies have shown a link between poor-quality sleep and an increased risk of diabetes (21). Sleep disorders are one of the risks of developing diseases such as DM and conversely, type 2 DM can also cause sleep disorders in sufferers (22).

Based on the characteristics of respondents regarding sleep quality, it was found that respondents who suffered from Type 2 Diabetes Mellitus in this study mostly had high-risk sleep quality, namely 57 respondents (75.0%%). It can be concluded that the majority of respondents who suffer from type 2 DM do not have good-quality sleep. This is proven by the results of the questionnaire where some respondents could not sleep within 30 minutes, often woke up in the middle of the night, got up to go to the bathroom because they wanted to urinate because they also often experienced excessive thirst, often felt hot, felt pain, felt itchy on the skin. skin, often feel sleepy even in the morning and several respondents often sleep late at night.

Sleep quality is an additional risk factor for type 2 DM. Sleep disorders frequently occur among individuals diagnosed with type 2 diabetes mellitus (T2DM). Furthermore, individuals with endocrine

disorders generally experience lower sleep quality compared to those with other chronic conditions (23). Sleep disorders can influence insulin resistance and type 2 DM both directly and indirectly. Direct Effects: 1) Hormonal imbalances: During sleep, the body releases hormones that regulate blood sugar levels. Disrupted sleep patterns can lead to fluctuations in these hormones, impacting insulin sensitivity and glucose metabolism (24); 2) Increased inflammation: Chronic sleep deprivation can trigger low-grade inflammation throughout the body, which can impair insulin signaling and contribute to insulin resistance (25). Indirect Effects: 1) Lifestyle choices: Poor sleep quality can lead to unhealthy food choices and decreased motivation for physical activity, both of which are risk factors for T2DM (26); 2) Weight gain: Disrupted sleep patterns can disrupt hunger hormones, leading to increased appetite and potential weight gain, a major risk factor for T2DM (27); 3) Stress levels: Sleep deprivation can exacerbate stress levels, which in turn can increase blood sugar levels and contribute to insulin resistance (28). Poor sleep is associated with a higher risk of developing diabetes in workers without an Family History of Diabetes (FHD) (29). Promoting healthy sleeping habits may be effective for preventing the development of diabetes in people without an FHD.

Fat cell accumulation or dyslipidemia is the second highest cause of type 2 DM after pancreatic beta cell dysfunction. Dyslipidemia is a lipid metabolism disorder characterized by an increase or decrease in plasma lipid fractions. Lipid fraction abnormalities that may occur include increased levels of total cholesterol, LDL cholesterol, triglycerides, and decreased HDL cholesterol (high-density lipoprotein) in the blood (30).

Based on the characteristics of respondents regarding dyslipidemia, it was found that respondents who suffered from Type 2 Diabetes Mellitus in this study mostly had high risk dyslipidemia, namely 42 respondents (55.3%). It can be concluded that the majority of respondents who suffer from type 2 DM have dyslipidemia with increased triglyceride levels and/or decreased HDL levels. This is proven by the medical records of the samples in this study, most of whom were female and elderly, so they were likely to have abnormalities in blood fat.

Based on the results of research conducted in the Puskesmas Birobuli area, dyslipidemia is a risk factor that is significantly related to the incidence of Type 2 Diabetes Mellitus. Respondents who have a history of dyslipidemia are 4,287 times more likely to experience Type 2 Diabetes Mellitus than respondents who do not have a history of dyslipidemia. Dyslipidemia is a risk factor for diabetes in young adults. High LDL and triglyceride levels and low HDL levels are specific lipid abnormalities associated with dyslipidemia (31).

People with type 2 diabetes (T2D) are particularly susceptible to cardiovascular disease (CVD) due to a condition called dyslipidemia. This condition is characterized by abnormal levels of fats in the blood, including high triglycerides, low HDL (good) cholesterol, and high LDL (bad) cholesterol (32). In type 2 diabetes mellitus (T2DM), insulin resistance leads to a rise in the release of free fatty acids from fat cells. There are three pathways through which there is an escalation in the production of very low-density lipoproteins (VLDL) by the liver: heightened lipogenesis, increased availability of substrates, and reduced degradation of apolipoprotein B-100 (ApoB). These alterations contribute to a lipid profile characterized by decreased levels of high-density lipoprotein cholesterol (HDL-C), elevated triglycerides (TGs), heightened synthesis of ApoB, and the presence of small, dense LDL particles (32,33). Lipid toxicity causes the development of an atherogenic process. Lipoproteins will experience changes due to metabolic changes in DM, such as glycation and oxidation processes (34). One of the most common features of dyslipidemia in type 2 DM is a decrease in HDL levels. The higher the blood glucose level, the lower the HDL level in people with type 2 DM (35). Triglycerides are the main form of fat stored by the body (36). Type 2 DM sufferers were significantly associated with high triglyceride levels. Respondents with high triglycerides had a greater risk of developing type 2 DM (37).

Conclusion

Based on the research results, it can be concluded that lack of physical activity, unhealthy eating patterns, sleep quality, and dyslipidemia are determinants of the risk of Type 2 Diabetes Mellitus at the Community Health Center of Puskesmas Birobuli, Palu City.

It is suggested that the community health center will further improve health services at each Integrated Development Post (known as POSBINDU), provide education on healthy lifestyles to overcome the incidence of DM, provide education on healthy lifestyles, and ways to prevent and control Type 2 DM to prevent the occurrence of diabetes, prevent the severity of the disease, and increase the level of public health to the maximum. Future researchers are expected to develop research related to risk determinants of Type 2 Diabetes Mellitus using different tests and adding other variables such as central obesity, hypertension, history of heart disease, and smoking behavior.

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References

1. Arifin H, Chou KR, Ibrahim K, Fitri SUR, Pradipta RO, Rias YA, et al. Analysis of Modifiable, Non-Modifiable, and Physiological Risk Factors of Non-Communicable Diseases in Indonesia: Evidence from the 2018 Indonesian Basic Health Research. J Multidiscip Healthc. 2022 Sep 30;15:2203–21.
2. Dilworth L, Facey A, Omoruyi F. Diabetes Mellitus and Its Metabolic Complications: The Role of Adipose Tissues. International Journal of Molecular Sciences. 2021 Jan;22(14):7644.
3. Fan W. Epidemiology in diabetes mellitus and cardiovascular disease. Cardiovasc Endocrinol. 2017 Feb 15;6(1):8–16.
4. Wild S, Roglic G, Green A, Sicree R, King H. Global prevalence of diabetes: estimates for the year 2000 and projections for 2030. Diabetes Care. 2004 May;27(5):1047–53.
5. IDF. IDF Diabetes Atlas, tenth. International Diabetes. 2021;
6. Kemenkes RI. Infodatin: Tetap Produktif, Cegah, dan Atasi Diabetes Melitus. 2020.
7. Kemenkes RI. Hasil Riset Kesehatan Dasar Tahun 2018. Kementrian Kesehatan RI. 2018.
8. Mirna E, Agus S, Asbiran N. Analisis Determinan Diabetes Melitus Tipe II Pada Usia Produktif di Kecamatan Lengayang Pesisir Selatan. Jurnal Public Health. 2020;7(1):30–42.
9. Prasetyani D, Sodikin S. Analisis Faktor Yang Mempengaruhi Kejadian Dm Melitus (Dm) Tipe 2. Jurnal Kesehatan Al-Irsyad. 2017;10(2):1–9.
10. Zulkarnaini A, Mahatma G, Puspita D, Vani AT, Abdullah D. Aktivitas Fisik, Pola Makan, dan Konsumsi Makanan Glikemik Tinggi Meningkatkan Risiko Kejadian Diabetes Mellitus Tipe 2. Jurnal Kesehatan Metro Sai Wawai. 2022;15(2):155–63.
11. Gordon BA, Benson AC, Bird SR, Fraser SF. Resistance training improves metabolic health in type 2 diabetes: a systematic review. Diabetes Res Clin Pract. 2009 Feb;83(2):157–75.
12. Suprianti AA, Masriadi M, Gobel FA. Determinan Diabetes Mellitus di Kabupaten Kepulauan Selayar. Journal of Muslim Community Health. 2023;4(4):120–9.
13. Rosita R, Kusumaningtiar DA, Irfandi A, Ayu IM. Aktivitas Fisik Lansia dengan Diabetes Melitus Tipe 2 di Puskesmas Balaraja Kabupaten Tangerang. Jurnal Kesehatan Masyarakat. 2022;10(3):364–71.
14. Sari SW, Adelina R. Apakah Pola Makan Menjadi Faktor Dominan Kejadian Diabetes Melitus Tipe 2 Di Indonesia? Jurnal Pangan Kesehatan dan Gizi Universitas Binawan. 2020 Dec 30;1(1):54–63.
15. Murtiningsih MK, Pandelaki K, Sedli BP. Gaya Hidup sebagai Faktor Risiko Diabetes Melitus Tipe 2. e-CliniC. 2021;9(2):328–33.
16. Sutanto IA. Perbedaan Indeks Glikemik Pada Nasi Putih (Oryza sativa), Ubi Cilembu (Ipomoea batatas cultivar cilembu) dan Ubi Ungu (Ipomoea batatas cultivar ayumurasaki) [Internet] [Thesis]. [Jember]: Universitas Jember; 2015 [cited 2024 Apr 6]. Available from: https://repository.unej.ac.id/xmlui/handle/123456789/68471
17. Amirah AD, Sumiaty, Ella Andayanie. Hubungan Pola Makan Dengan Kejadian Diabetes Melitus Pada Masyarakat Usia Di Atas 40 Tahun Di Kabupaten Gowa. Window of Public Health Journal. 2022;3(3):502–15.
18. Witek K, Wydra K, Filip M. A High-Sugar Diet Consumption, Metabolism and Health Impacts with a Focus on the Development of Substance Use Disorder: A Narrative Review. Nutrients. 2022 Jul 18;14(14):2940.
19. von Frankenberg A, Marina A, Song X, Callahan H, Kratz M, Utzschneider K. A high-fat, high-saturated fat diet decreases insulin sensitivity without changing intra-abdominal fat in weight-stable overweight and obese adults. European Journal of Nutrition. 2017 Feb 1;56(1):431–43.
20. Kimura Y, Yoshida D, Hirakawa Y, Hata J, Honda T, Shibata M, et al. Dietary fiber intake and risk of type 2 diabetes in a general Japanese population: The Hisayama Study. J Diabetes Investig. 2021 Apr;12(4):527–36.
21. Ginting NMCB, Mufidah PK. Kajian Pustaka: Kurangnya Kualitas Tidur Dapat Meningkatkan Risiko Kejadian Diabetes Melitus. Jurnal Biostatistik, Kependudukan, dan Informatika Kesehatan. 2021;1(3):189.

22.Tiajiwalar MS, Adnyana IGA, Pratiwi MRA. Hubungan Kualitas Tidur dengan Kadar Glukosa Darah Sewaktu pada Pasien Diabetes Melitus Tipe 2. Journal of Pharmaceutical and Health Research. 2023;4(1):134–40.
23.Alamer WM, Qutub RM, Alsaloumi EA, Natto NK, Alshehri RM, Khafagy A. Prevalence of Sleep Disorders Among Patients With Type 2 Diabetes Mellitus in Makkah City: A Cross-Sectional Study. Cureus. 2022;14(12):e33088.
24.Mesarwi O, Polak J, Jun J, Polotsky VY. Sleep disorders and the development of insulin resistance and obesity. Endocrinol Metab Clin North Am. 2013 Sep;42(3):617–34.
25.Garbarino S, Lanteri P, Bragazzi NL, Magnavita N, Scoditti E. Role of sleep deprivation in immune-related disease risk and outcomes. Commun Biol. 2021 Nov 18;4(1):1–17.
26.Grandner MA, Seixas A, Shetty S, Shenoy S. Sleep Duration and Diabetes Risk: Population Trends and Potential Mechanisms. Curr Diab Rep. 2016 Nov;16(11):106.
27.Hagen EW, Starke SJ, Peppard PE. The Association Between Sleep Duration and Leptin, Ghrelin, and Adiponectin Among Children and Adolescents. Curr Sleep Medicine Rep. 2015 Dec 1;1(4):185–94.
28.Nollet M, Wisden W, Franks NP. Sleep deprivation and stress: a reciprocal relationship. Interface Focus. 2020 Jun 6;10(3):20190092.
29.Kita T, Yoshioka E, Satoh H, Saijo Y, Kawaharada M, Okada E, et al. Short Sleep Duration and Poor Sleep Quality Increase the Risk of Diabetes in Japanese Workers With No Family History of Diabetes. Diabetes Care. 2012 Feb;35(2):313–8.
30.Lestari A, Handini MC, Sinaga TR. Faktor Risiko Kejadian Dislipidemia Pada Lansia. Jurnal Riset Hesti Medan. 2018;3(2):16–26.
31.Wahidah N, Rahayu SR. Determinan Diabetes Melitus pada Usia Dewasa Muda. Higeia Journal of Public Health Research and Development. 2022;6(1):114–25.
32.Martín-Timón I, Sevillano-Collantes C, Segura-Galindo A, del Cañizo-Gómez FJ. Type 2 diabetes and cardiovascular disease: Have all risk factors the same strength? World J Diabetes. 2014 Aug 15;5(4):444–70.
33.Cannon CP. Mixed dyslipidemia, metabolic syndrome, diabetes mellitus, and cardiovascular disease: clinical implications. Am J Cardiol. 2008 Dec 22;102(12A):5L-9L.
34.Bonilha I, Zimetti F, Zanotti I, Papotti B, Sposito AC. Dysfunctional High-Density Lipoproteins in Type 2 Diabetes Mellitus: Molecular Mechanisms and Therapeutic Implications. J Clin Med. 2021 May 21;10(11):2233.
35.Pratiwi WR, Hediningsih Y, Isworo JT. Hubungan Kadar Glukosa Darah Dengan Kadar Hdl (High Density Lipoprotein) Pada Pasien Diabetes Melitus Tipe 2. Jurnal Labora Medika. 2021;5:29–34.
36.Nizar M, Amelia R. Hubungan Kadar Trigliserida Dengan Indeks Masa Tubuh Pada Penderita Diabetes Melitus Tipe 2 di RS Krakatau Medika. Journal of Medical Laboratory Research. 2022;1(1):7–12.
37.Garbuzova EV, Shcherbakova LV, Rymar OD, Khudiakova AD, Shramko VS, Ragino YI. Triglycerides, Obesity and Education Status Are Associated with the Risk of Developing Type 2 Diabetes in Young Adults, Cohort Study. J Pers Med. 2023 Sep 19;13(9):1403.