



The Influence of the Proximity of Residence to Rice Field Areas and Country Areas Area Industry to Incident Diabetes Mellitus Type 2

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Abstract

Diabetes mellitus (DM) is a metabolic disorder characterized by hyperglycemia (high blood glucose levels) due to insulin deficiency, insulin resistance or both. The International Diabetes Federation (IDF) estimates that in the 20-79 age group, there were 463 million people in the world suffering from diabetes mellitus in 2019. Based on data from the Kendal Regency Health Office, in 2021 there were 19,020 people suffering from diabetes mellitus, with a prevalence rate of 2.8% of the total population. People who live in rice fields have a risk factor risk of type 2 diabetes mellitus such as exposure to pesticides as well as not enough activity Physical pollutants from exposure to nitrogen dioxide (NO₂), particulate matter (PM_{2.5}) and (PM₁₀) found in industrial areas can cause glucose metabolism disorders and increase HbA1C levels. Study This For analyze influence proximity place stay with rice field area And area area industry on the incidence of type 2 diabetes mellitus in Kendal Regency. This study use analytic observational with design study cross sectional. Technique taking sample Which used is purposive sampling. Analysis univariate And bivariate use test Chi-Square. Got it results Which significant based on test Chi-Square about influence place stay in area rice fields And area industry with the occurrence type 2 diabetes mellitus with p-value as big as 0,000 (p-value <0.05). Study This show existence influence proximity place stay with rice fields and area area industry to incident type 2 diabetes mellitus in Regency Kendal.

Introduction

Diabetes mellitus (DM) is a metabolic disorder characterized by hyperglycemia (high blood glucose levels) due to insulin deficiency, insulin resistance or both. Insulin is a hormone produced by pancreatic β cells to control blood glucose by regulating glucose use and storage. The cause of insulin deficiency is due to damage to pancreatic β cells, which are cells that function to produce insulin. While the cause of insulin resistance is due to reduced insulin's ability to stimulate glucose use or decreased response of target cells, such as muscles, tissues, and liver to physiological insulin levels (Hardianto, 2021; Czech, 2017; Courtney & Olefsky, 2013).

The International Diabetes Federation (IDF) estimates that in the 20-79 age group, there were 463 million people in the world suffering from diabetes mellitus in 2019 or equal to 9.3% of the total population at that age. In Southeast Asia, where Indonesia is one of the countries, it is ranked 3rd with the number of diabetes mellitus sufferers of 11.3%. Indonesia is ranked 7th out of 10 with the largest number of sufferers with 10.7 million people (Widiasari et al., 2021).

Based on data from the Kendal Regency Health Office, in 2021 there were 19,020 people suffering from diabetes mellitus, with a prevalence rate of 2.8% of the total population. Therefore, the problem of diabetes mellitus is a priority in efforts to overcome non-communicable diseases (PTM) in Kendal Regency (Sarifah & Siyam, 2023).

Kendal Regency has a diverse geographical structure, ranging from coastal areas, rice fields, highlands, and also industrial areas. Type 2 diabetes mellitus sufferers in Kendal Regency are spread across several areas, including areas near rice fields and areas near industrial areas. People who live in areas near rice fields mostly work as farmers, where farmers are often exposed to the use of pesticides. Type 2 DM can be influenced by pesticide exposure. The chemical compounds contained in pesticides act as *endocrine disrupting chemicals* (EDCs) which can disrupt the endocrine system in the body (Sari, et al., 2021). According to research conducted by Park et al. (2019)., it was found that as many as 13.85% of farmers who have worked for more than 20 years suffer from DM with a risk 2 times higher than farmers with a working period of less than 20 years (Park et al., 2019). However, this is contrary to research conducted by Rachmawati (2019) where the length of service as a farmer is not a risk factor for DM in farmers because the lower CI 95% value <1 (OR = 7.407; CI 95% = 0.996 – 55.086) (Rachmawati, 2019).

PT Kawasan Industri Kendal (KIK) is the only holder of the status of an industrial-based Special Economic Zone (KEK) on the island of Java as stated in PP No. 85 of 2019. Residents living close to the Kendal - Semarang border near the Pantura highway and industrial areas are generally easily exposed to pollutants, as can be seen from air pollution and traffic noise, especially in industrial areas. Air pollution can inhibit physical activity, while noise can affect sleep (Dendup et al., 2018; Basner & McGuire, 2018). Pollutants from exposure to nitrogen dioxide (NO₂), particulate matter (PM_{2.5}) and (PM₁₀) can cause glucose metabolism disorders, and increase HbA1C levels. While noise can interfere with the quality and quantity of sleep which causes disruption of the body's metabolism, which will affect glucose in the body (Sepriani et al., 2022; Zisapel, 2007; Arble et al., 2015).

Based on this background, researchers are interested in conducting research to prove whether there is an influence of the proximity of residence in rice fields and industrial areas with the prevalence of type 2 diabetes mellitus and analyzing the differences in the prevalence of type 2 diabetes mellitus in Kendal Regency.

Methods

The method used is analytical observational with a *cross sectional approach*. Study This implemented in Health Center Planting (region near rice fields), Health Center Brangsong (Region Area industry), And Health Center Patebon (Area Which Far from rice fields and industrial areas). The sample was participants of the Integrated Development Post (Posbindu) in the month of May to July 2024 whose residence is in an area near rice fields (Puskesmas Plantungan), area industry (Health Center) Brangsong), And No both of them (Health Center) Patebon). The sample size was calculated using the lemeshow formula and obtained as many as minimum of 96 samples in each health center. Sampling was carried out by type *purposive sampling*, the samples are taken based on certain criteria. criteria inclusion study This is all participant post office in area near the rice fields (Health Center) Plantungan), industrial area (Brangsong Health Center), and not the area of both (Patebon Health Center), all Posbindu participants aged ≥ 40 years, and have a record health Which complete (address And blood sugar). Type data Which used in This research is secondary data. The variables studied are the place of residence in the rice field area. with the criteria of being close to rice fields and far from rice fields, as well as living in industrial areas with criteria near industrial areas and far from industrial areas which will be measured using *Google Earth*, and variable type 2 diabetes mellitus with normal criteria (GDS < 200 mg/dl) And diabetes mellitus type 2 (GDS ≥ 200

mg/dl). Analysis data conducted univariately and bivariately. The statistical test used is the *Chi-Square test*. with degrees trust 95% (0.05). Researcher has to obtain permission study from Faculty Medical University Muhammadiyah Surakarta 4381/C.4-III/FK/VIII/2024 as well as agreement study from Head Body Unity Nation And Political Regency Kendal No. 000.9 /1535 /VIII /2024.

Result and Discussion

Secondary data in this study are residential address, type of sex, random blood sugar, And age. Data results study analyzed with use Software SPSS 26.0 for windows consisting of univariate analysis to determine frequency distribution and analysis bivariate use test Chi-Square . Following is the result analysis data :

Characteristics Respondents

The following univariate analysis shows that the description of the characteristics of the respondents in study This can be seen on the following table:

Table 1. Characteristics Region Stay Respondents

Category Region	Frequency	Percentage
Near Rice fields	112	26.9%
Area Industry	112	26.9%
Far from the beach And area industry	193	46.3%
Total	417	100%

Source: Data Secondary (2024)

Based on univariate analysis using SPSS version 26 on the category of area, it is known that there are 112 people with a percentage of 26.9% who live near rice fields, there are 112 people with a percentage of 26.9% who live near industrial areas, and there are 193 people with a percentage of 46.3% who live far from rice fields and industrial areas. The following univariate analysis on the gender variable can be seen in the following table:

Table 2. Type Sex Respondents

Type Sex	Frequency	Percentage
Man	59	14.1%
Woman	358	85.9%
Total	417	100%

Source: Data Secondary (2024)

Based on univariate analysis using SPSS version 26 on gender, it is known that there are 59 people with a percentage of 14.1% who are male and there are 358 people with a percentage of 85.9% who are female. The following univariate analysis on blood sugar variables can be seen in the following table:

Tablen 3. Characteristics Random Blood Sugar Respondents

Random Blood Sugar	Frequency	Percentage
Normal (<200 mg/dl)	352	84.4%
Diabetes Mellitus Type 2 (≥ 200 mg/dl)	65	15.6%
Total	417	100%

Source: Data Secondary (2024)

Based on univariate analysis using SPSS version 26 regarding random blood sugar, it was found that there were 352 people with a percentage of 84.4% whose blood sugar was normal (<200 mg/dl) and there were 65 people with a percentage of 15.6% who had diabetes (≥ 200 mg/dl) from all of them. total existing samples. The following univariate analysis on the age variable can be seen in table following:

Table 4. Characteristics Distribution Age Respondents

Age	Frequency	Percentage
Pre-elderly below (<40 years)	285	68.3%
Elderly (≥ 40 years)	132	31.7%
Total	417	100%

Source: Data Secondary (2024)

Based on univariate analysis using SPSS version 26, it is known that age There are 285 people with a percentage of 68.3% who are aged < 40 years and there are 132 people with a percentage of 31.7% who are elderly or aged ≥ 40 years. all total sample Which There is.

Analysis Bivariate

The influence of proximity of residence to rice fields and industrial areas to incidence of type 2 diabetes mellitus.

Table 5. Distribution of Random Blood Sugar Levels by Regional Category

Category region	Random Blood Sugar		total	X 2	p
	Normal (n/%)	DM Type 2 (n/%)			
Area Rice fields	92 (82.1)	20 (17.9)	112	81,552	0,000
Area Industry	68 (60.7)	44 (39.3)	112		
Control area (No area rice fields And area industry)	192 (99.5)	1 (0.5)	193		

Sumber: Data Seconds (2024)

Significant results were obtained based on the Chi-square test on the effect of residence in areas near rice fields and industrial areas on the occurrence of type 2 diabetes mellitus with a p-value of 0.000 (p-value <0.05). In the bivariate analysis above, respondents with residences near rice fields who suffered from type 2 diabetes mellitus were 20 samples (17.9%) and those who did not suffer from type 2 diabetes mellitus were 92 samples (82.1%). Meanwhile, respondents with residences in industrial areas who suffered from type 2 diabetes mellitus were 44 samples (39.3%) and those who did not suffer from type 2 diabetes mellitus were 68 samples (60.7%). So when compared to areas near rice fields and industrial areas, those experiencing type 2 diabetes mellitus were more commonly found in industrial areas.

Influence Proximity Place Stay in Area Rice fields To Incident Diabetes Mellitus Type 2

Based on the results of the study, it is known that there is an influence of residence in areas near rice fields with the prevalence of type 2 diabetes mellitus. This is evidenced by the large p-value obtained of 0.000 (0.000 <0.05). So it can be concluded that there is an influence of residence in areas near rice fields with the prevalence of type 2 diabetes mellitus in Kendal Regency. Kendal Regency is an area that has conditions seen from a very complete geographical perspective, beaches, lowlands, highlands, and mountains are in this area. The fields of agriculture and fisheries are two sectors that are the mainstay as contributors to the APBD which are quite significant (Sriyanto et al., 2017). Although not all people who live in

areas near rice fields work as farmers. However, most people in areas near rice fields have activities in the agricultural sector, one of which is working as farmers (Kinkingninhoun et al., 2020; Kamaluddin et al., 2012).

Type of work is one of the risk factors that can cause DMT2 because it is related to a person's physical activity (Jati et al., 2023). Kusnadi (2017) explained that the risk factors that have been proven to be related to the occurrence of DMT2 in farmers and laborers are family history, BMI, and thiamine intake. Thiamine is an important micronutrient that acts as a cofactor for several enzymes in glucose and amino acid metabolism including transketolase, pyruvate dehydrogenase, α -ketoglutarate dehydrogenase, and α -keto acid decarboxylase. Thiamine deficiency can cause decreased insulin synthesis and secretion (Ziegler et al., 2023). In addition, other risk factors that can cause DMT2 in people who work as farmers are the use of pesticides. Pesticides have pollutants that can act as Endocrine Disrupting Chemicals (EDCs) which can disrupt the endocrine system in the body. EDCs are exogenous substances or substances that come from the external environment or a mixture of chemicals that change the function of the endocrine system which causes health effects (Kumar et al., 2020). The mechanism of EDC entry into the body can be through inhalation, skin surface, or digestive system, then will enter the bloodstream. In the next process will enter the organs, one of which is the pancreas. The absorbed EDC will affect beta cells in producing insulin hormone. When the body experiences insulin deficiency so that blood sugar levels become high, type 2 diabetes mellitus will occur (Saputri et al., 2018).

The results of this study are in line with the results of a study conducted by Fandana (2020) which found that the risk of diabetes mellitus in farmers is greater because in farmers the use of pesticides can increase blood glucose levels. The results of another study conducted by Kusnadi (2017) found that based on the results of the logistic regression test, BMI and thiamine intake had a 35% effect on the incidence of DMT2 in farmers and laborers. In contrast to the two results of the study, the results of the study conducted by Sriyani & Mulyana (2021) found that there was no relationship between the location of residence (rural, urban) and the incidence of type 2 DM (P-value = 0.509).

Influence Proximity Residence in Area Area Industry To Type 2 Diabetes Mellitus Occurrence

The results of the study also found that there was an influence of residence in an area near an industrial area with the prevalence of type 2 diabetes mellitus. This is evidenced by the large p-value obtained of 0.000 ($0.000 < 0.05$). So it can be concluded that there is an influence of residence in an area near an industrial area with the prevalence of type 2 diabetes mellitus in Kendal Regency. An industrial area is an area where industrial processing activities are concentrated which is equipped with infrastructure, facilities and other supporting facilities provided and managed by the industrial area company (Pradani et al., 2017; Kovács & Paganelli, 2003).

This zone is a concentration of large factories and usually areas adjacent to this zone often experience various environmental problems such as pollution, noise, traffic chaos and the like (Dirgapraja et al., 2019; Buchanan, 2015). One of the environmental problems caused by industrial activities is air pollution. Air pollution itself is a risk factor for type 2 diabetes. Several pollutants such as nitrogen dioxide (NO₂) and particulate matter (PM_{2.5}) and particulate matter (PM₁₀) originating from air pollution have been shown to cause glucose metabolism disorders and increase HbA1C levels. NO₂ and PM can damage lung function and the respiratory system, as well as trigger inflammation and oxidative stress in the body. As a result, these pollutants can affect insulin resistance, disrupt glucose homeostasis, and increase the risk of diabetes mellitus. Increased HbA1c levels are an indication of poor long-term blood

glucose control, which is a risk factor for diabetes complications (Li et al., 2019; Škrha et al., 2016).

The results of a study conducted by Meo (2020) found that exposure to dust pollution in cement factories can cause insulin resistance and ultimately lead to the development of diabetes mellitus. The results of another study conducted by Meng et al. (2023) also found that several air pollutants including O₃, NO₂, PM₁₀, and PM_{2.5} were associated with increased diabetes risk and diabetes severity among Californians, particularly among Native Americans and Alaska Natives. In contrast to these two studies, the results of a study conducted by Beulens et al. (2022) found that several environmental factors thought to influence the risk of type 2 diabetes were lifestyle factors such as physical activity or diet, microbiome, inflammation, or chronic stress.

Conclusion

Based on results study And discussion on Respondent in Health Center Plantungan, Health Center Brangsong, And Health Center Patebon so can withdrawn conclusion that There is a significant relationship between the proximity of a residence to rice fields and the incidence of type 2 diabetes mellitus in Regency Kendal with *p-value* as big as 0,000 (<0.05 It means very significant), and there is a significant relationship between proximity to residence and industrial area on the incidence of type 2 diabetes mellitus in Kendal Regency with *p-value* as big as 0,000 (<0.05 It means very significant), And amount Respondent those who experience type 2 diabetes mellitus are more in industrial areas than in rice field areas. The implications of study This show that proximity place stay with rice field area And area area industry be a factor risk the occurrence of type 2 diabetes mellitus in Kendal Regency.

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