Associated Factors of Type 2 Diabetes Mellitus in Indonesian Women

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ABSTRACT

Diabetes Mellitus (DM) is a degenerative disease whose prevalence has consistently increased over the past two decades, as reported by the IDF (2017). Its etiology is complex, and it is known that the prevalence of DM is higher in women than in men in Indonesia. This study aimed to analyze the factors associated with the incidence of DM, specifically Type 2 DM, among women in Indonesia. This research employed a cross-sectional design, utilizing secondary data from the 2018 Indonesia Basic Health Research, namely Riskesdas. The study subjects were women aged 19-59 years. Bivariate data analysis was conducted using the chi-square test. The results showed that central obesity, age, physical activity, emotional mental health, and fruit and vegetable consumption are significantly associated with the occurrence of Type 2 DM in Indonesian women (p-value < 0.05). Women with central obesity had a 2.29 times higher likelihood of developing Type 2 DM compared to those without central obesity (OR = 2.29; 95% CI: 2.09–2.50). Elevated odds were also observed in pre-elderly women aged 45-59 years (OR = 24.33; 95% CI: 15.86–37.34), those with insufficient physical activity (OR = 1.15; 95% CI: 1.03–1.28), those experiencing emotional mental health disorders (OR = 1.65; 95% CI: 1.45–1.88), and those with inadequate fruit and vegetable consumption (OR = 0.77; 95% CI: 0.67–0.89).

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Introduction

Globally, the incidence of diabetes continues to show an increasing trend year by year. Based on the 8th edition of the Diabetes Atlas published by the International Diabetes Federation (IDF), the number of people with diabetes worldwide surged from 151 million in 2000 to 425 million in 2017 (IDF, 2017). Southeast Asia ranked third in terms of the number of adult diabetes sufferers (20–79 years) in that year. Indonesia itself is among the top ten countries with the highest diabetes burden, ranking sixth in 2017 with an estimated 10.3 million sufferers. Although it is projected to drop to seventh position by 2045, the number of cases is predicted to increase to 16.7 million. These data may not yet reflect the true condition, as approximately 30% to 80% of sufferers remain undiagnosed, with an estimated 7.6 million cases in Indonesia.

Data from the 2018 Riskesdas indicate that the prevalence of diabetes based on doctor's diagnosis in individuals aged ≥15 years reached 2%, an increase from 1.5% in 2013 (Kemenkes RI, 2019a). Furthermore, based on blood glucose level measurements, 10.9% of the Indonesian population met the diagnostic criteria for diabetes according to PERKENI (2015) standards (Kemenkes RI, 2019a). Specifically, based on 2018 Riskesdas data, the prevalence of DM in women was higher than in men, at 2.4% compared to 1.7% (Kemenkes RI, 2019a).

Entering the 21st century, diabetes is categorized within the group of non-communicable diseases (NCDs) that significantly contribute to global mortality rates, alongside cancer, cardiovascular disease, and respiratory disorders, collectively accounting for 74% of deaths (WHO, 2021). In Southeast Asia, approximately 51.5% of diabetes-related deaths occurred before the age of 60 (IDF, 2017). Women with diabetes face a higher risk of complications such as preeclampsia, premature birth, and perinatal death (Kautzky-Willer, 2013). Additionally, they are more susceptible to premature death (above 40 years of age), kidney failure, stroke, sexual dysfunction, and coronary heart disease, compared to men.

One of the primary risk factors most frequently associated with the incidence of diabetes is obesity. Obesity is not only linked to DM but also to various other chronic diseases such as hypertension, stroke, heart disease, and kidney disorders. This study focuses on central obesity, which refers to the accumulation of fat in the abdominal area. The global prevalence of central obesity increased from 31.3% in the early 1990s to 48.3% between 2010 and 2014 (Wong et al., 2020). There is a societal

stigma that central obesity is synonymous with males, yet many research data contradict this. This assumption might be based on the fact that when a man has central obesity, his stomach appears significantly distended, whereas in women, it does not. In Indonesia, the prevalence of central obesity reached 46.7% in women, while in men it was only 15.7% (Kemenkes RI, 2019a). Another study in South Asia found similar results, with central obesity being higher in women (41.6%) compared to men (33%) (Prasad, Kabir, Revathi Devi, Peter, & Das, 2020).

Furthermore, this study also discusses several other factors associated with Type 2 DM, specifically age, physical activity, emotional mental health, and fruit and vegetable consumption. This study will examine these various factors, and it is expected that by utilizing the latest 2018 Riskesdas data, the research findings can be leveraged for evidence-based prevention and control strategies at the population level, specifically for Indonesian women
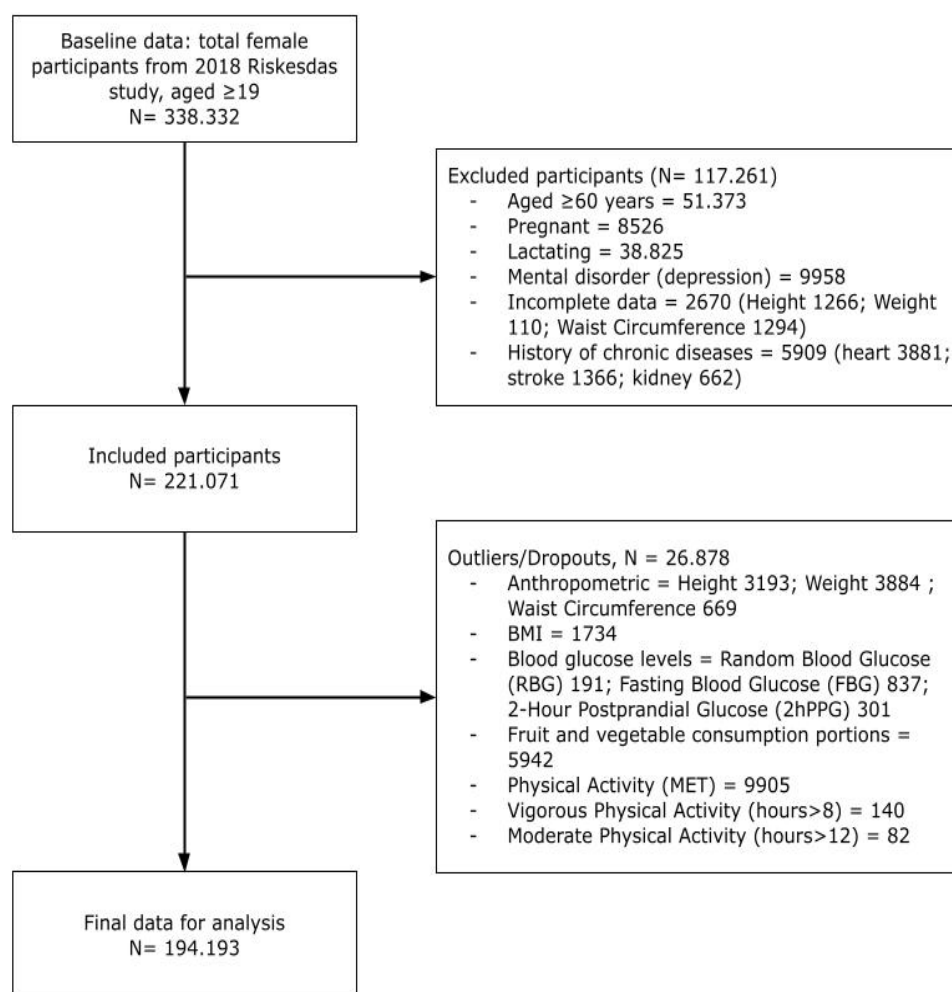

Figure 1. Data Selection Process

Method

This study employed a cross-sectional design based on secondary data sourced from the 2018 Riskesdas. The research focused on women aged between 19 and 59 years. Subject selection was carried out through a series of stages as illustrated in Figure 1, considering several exclusion criteria, namely: pregnant or lactating women, individuals with mental disorders, physical disabilities that interfere with daily activities, chronic diseases such as heart disease, stroke, or kidney disorders, and individuals with incomplete data.

The main variables investigated were the incidence of Type 2 Diabetes Mellitus as the dependent variable, with central obesity status, age, physical activity, emotional mental health status, and fruit and vegetable consumption as independent variables. All data were obtained using instruments consistent with those employed in the 2018 Riskesdas implementation. Analysis was conducted using the chi-square test to examine the relationship between variables with the aid of STATA version 14 software.

Results

Univariate Analysis

Demographic characteristics and a general overview of the variables used in this study are presented in Table 1, including results from both weighted and unweighted analyses. In large-scale survey-based studies, sampling methods often vary, meaning that each individual in the population does not

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always have an equal chance of being selected. Therefore, the use of weighting is necessary to ensure more accurate representation (Herlawati, Kurnia, & Afendi, 2013).

Table 1. Characteristics of Research Subjects

Characteristic	Total (N=194.193)			
	N	%	N*	%*
Residential Area				
Rural	106.659	54,9	84.179	43,3
Urban	87.534	45,1	110.014	56,7
Age Group				
Adolescent	27.063	14	33.600	17,3
Adult	94.049	48,4	94.047	48,4
Pre-Elderly	73.081	37,6	66.546	34,3
Type 2 Diabetes				
No DM	189.838	97,8	189.811	97,74
DM	4355	2,2	4382	2,26
Central Obesity				
No	95.550	49,2	97.198	50,1
Yes	98.643	50,8	96.995	49,9
Physical Activity				
Sufficient	165.867	85,4	163.937	84,4
Insufficient	28.326	14,6	30.256	15,6
Emotional Mental Health				
Normal	177.551	91,4	178.032	91,7
Impaired	16.642	8,6	16.16	8,3
Fruit and Vegetable Consumption				
Sufficient	18.141	9,3	17.132	8,8
Insufficient	176.052	90,7	177.061	91,2

Weighted

Based on Table 1, the majority of Indonesian women who were subjects of this study resided in urban areas (56.6%) and were classified as adults (48.4%). Regarding health conditions, the prevalence of Type 2 Diabetes Mellitus was recorded at 2.26%, with 1.8% of these having received a medical diagnosis. Meanwhile, 49.9% were categorized as centrally obese. A low level of physical activity was found in 15.6% of women, emotional mental health disorders were experienced by 8.3%, and 91.2% of them had fruit and vegetable consumption below the recommended intake.

Bivariate Analysis

Referring to the analysis results in Table 2, it was found that several factors, such as central obesity, age group, physical activity level, fruit and vegetable intake, and emotional mental health status, showed a statistically significant association with the incidence of Type 2 DM in Indonesian women in 2018 ($p < 0.05$). Women with central obesity status were recorded to have a 2.29 times higher likelihood of suffering from DM compared to those without central obesity. Overall, increasing age was directly proportional to the increased likelihood of DM. Further details show that women in the adult age group had a 5.92 times higher likelihood of experiencing DM compared to the adolescent group, while those in the pre-elderly group had an even higher likelihood, namely 24.3 times higher compared to adolescents.

Physical activity also plays a role in DM risk, where women with insufficient physical activity had a 1.15 times higher likelihood of experiencing DM compared to those with sufficient activity levels. However, for the fruit and vegetable consumption variable, the analysis results showed a protective relationship, meaning that low intake appeared to be negatively correlated with the incidence of DM. This requires further interpretation. Impaired emotional mental health was also identified as a risk factor, with a 1.65 times increased likelihood of DM compared to women with stable mental conditions.

Table 2. Results of Bivariate Analysis of Central Obesity and Other Variables with the Incidence of Type 2 DM in Indonesian Women in 2018

Variable	f (%)		OR (95%CI)	p-value
	DM	Non DM		
Central Obesity				
Yes	3032 (3,1 %)	93.963 (96,9 %)	2,29 (2,09-2,50)	<0,001
No	1351 (1,4 %)	95.847 (98,6 %)	Ref.	
Age				
Pre-elderly	3179 (4,8 %)	63.367 (95,2 %)	24,33 (15,86-37,34)	<0,001
Adult	1135 (1,2 %)	92.912 (98,8 %)	5,92 (3,83-9,14)	<0,001
Adolescent	69 (0,2 %)	33.531 (99,8 %)	Ref.	
Physical Activity				
Insufficient	765 (2,5%)	29.491 (97,5%)	1,15 (1,03-1,28)	0,015
Sufficient	3617(2,2 %)	160.320 (97,8 %)	Ref.	
Fruit and Vegetable Consumption				
Insufficient	3900 (2,2 %)	173.161 (97,8 %)	0,77 (0,67-0,89)	<0,001
Sufficient	482 (2,8%)	16.650 (97,2 %)	Ref.	
Emotional Mental Health				
Impaired	565 (3,5 %)	15.596 (96,5 %)	1,65 (1,45-1,88)	<0,001
Normal	3818 (2,2 %)	174.214 (97,8 %)	Ref.	

Discussion

Relationship between Central Obesity and Type 2 DM Incidence in Indonesian Women

Central obesity refers to the accumulation of visceral fat in the abdominal area, which in women is identified by a waist circumference exceeding 80 cm, according to national and international standards. In this study, nearly half of the subjects were found to have central obesity. These findings are consistent with previous epidemiological data, both in Indonesia and globally. For instance, the prevalence of central obesity reached 67.6% in Plalangan Village and 46.7% according to Riskesdas 2018, while in Iran, it was reported to be as high as 81.4% in women ((Kemenkes RI, 2019a; Puspitasari, 2018; Tabrizi, Sadeghi-Bazargani, Farahbakhsh, Nikniaz, & Nikniaz, 2018).

This study shows that central obesity has a statistically significant association with an increased likelihood of developing Type 2 DM in Indonesian women (Table 2). Women with central obesity had a 2.29 times higher likelihood of experiencing Type 2 DM compared to those with normal waist circumference. A study in the UK also strengthens this finding, showing nearly a threefold risk in women with excess waist circumference (Mary et al., 2014).

Biologically, central obesity contributes to insulin resistance through the release of free fatty acids, proinflammatory cytokines, and other metabolites that disrupt insulin signaling pathways, particularly in skeletal muscle, adipose tissue, and the liver (Mary et al., 2014; Papaetis, Panagiotis Papakyriakou, & Themistoklis N. Panagiotou, 2015). This is exacerbated by impaired fatty acid oxidation, leading to pancreatic β-cell dysfunction and the body's inability to control glucose levels (Papaetis et al., 2015). Thus, once central obesity is present, the likelihood of developing Type 2 DM inherently increases.

Various anthropometric parameters have been compared to detect the risk of Type 2 DM. Waist circumference, waist-to-height ratio (WHtR), and waist-to-hip ratio (WHR) have proven more sensitive than body mass index (BMI), especially in women (Kapoor et al., 2020). The study in India suggested an optimal waist circumference threshold for women of 83 cm. A study in Ghana also found similar results, where central obesity measured using waist circumference in women was significantly associated with Type 2 DM risk, whereas obesity measured using BMI was not associated in either women or men (Frank et al., 2013). The combination of central obesity with a history of prenatal malnutrition can increase vulnerability to Type 2 DM in adulthood (Meng et al., 2018).

Therefore, special attention needs to be given to controlling waist circumference in Indonesian women, particularly because central obesity can be an early indicator of serious metabolic risk. Community-based prevention efforts and promotional approaches need to be focused on productive age groups to curb the potential increase in Type 2 DM.

Relationship between Age and Type 2 DM Incidence in Indonesian Women

In the Riskesdas questionnaire, age was calculated from the date of birth until the day the interview was conducted. The age classification in this study referred to the Ministry of Health guidelines from 2009 and 2013, but was simplified into three groups: adolescents (17–25 years), adults (26–44 years), and pre-elderly (45–59 years). The adult age group was the most dominant in this study. The analysis results show a relationship between age and the incidence of Type 2 Diabetes Mellitus (Type 2 DM) in Indonesian women. As age increases, the risk of experiencing Type 2 DM tends to rise. Adult women had a 5.9 times higher likelihood, while the pre-elderly group had a 24.3 times higher likelihood of experiencing DM compared to the adolescent group. This finding aligns with the recommendations in the PERKENI Consensus, which states that individuals over 45 years of age should undergo DM screening as they are considered a high-risk group (Soelistijo et al., 2015). Similar results were also found in a study in Iran, which reported an 11-fold increased risk in the 50–64 year age group and a 34.4-fold increase in those aged ≥65 years compared to the 21–49 year age group (Sharkia, Sheikh-Muhammad, Mahajnah, Khatib, & Zalan, 2019). This increased risk is thought to be related to the decline in the regenerative capacity of cells, including pancreatic β-cells, with increasing age. The process of apoptosis continues, while the ability to replicate and form new cells decreases, thus disrupting regenerative balance and increasing the risk of DM (Decroli, Alexander Kam, Yanne Pradwi Efendi, Garri Prima Decroli, & Afdol Rahmadi, 2019).

Relationship between Physical Activity and Type 2 DM Incidence in Indonesian Women

In Riskesdas 2018, physical activity is defined as any form of continuous activity performed for a minimum of 10 minutes, from waking up until going to bed (Kemenkes RI, 2017). The physical activity questionnaire instrument used only covered vigorous and moderate physical activity. These activities are not limited to formal exercise but also include work, recreation, and daily domestic activities. WHO recommends a minimum of 75 minutes per week of vigorous-intensity physical activity or 150 minutes per week of moderate-intensity physical activity. Based on Riskesdas data, this study categorized physical activity into 2 different groups: "sufficient," which includes vigorous and moderate physical activity, and "insufficient" physical activity, which has a MET-minute/week value of <600 (low activity).

The results of this study found that the majority of women had a sufficient level of physical activity (Table 1). This is supported by local-level research conducted in one village in Indonesia, which reported that only 22% of participants had low physical activity levels (Malinti & Malinti, 2020). Although the majority of women in this study had sufficient physical activity levels, these results differ

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from a study on women with Type 2 DM in Saudi Arabia, which showed that the majority had low physical activity levels.

Factors influencing the physical activity levels of these Arab women included the number of children (more than three), older age, DM duration of more than six years, and obesity. Common barriers faced included tradition and culture, lack of knowledge and skills, fatigue, security issues, time constraints, weather conditions, and lack of supporting facilities (Mohamed, Mahfouz, & Badr, 2020). Data limitations prevented further exploration of these differences. However, considering that many Indonesian women play dual roles as housewives and breadwinners, it can be assumed that Indonesian women's physical activity remains high even if they are not involved in formal exercise. This aligns with the findings of a study that found the majority of respondents who were housewives engaged in more moderate physical activity than low or vigorous physical activity (Novitasary, 2013).

Analysis in Table 2 shows a relationship between physical activity and the incidence of Type 2 DM in Indonesian women. The likelihood of Type 2 DM increased by 1.15 times in women with insufficient physical activity compared to those with sufficient physical activity. Research in Arab Israeli communities showed a higher risk, an increase in Type 2 DM risk of 4.35 times (unadjusted) and 1.82 times (adjusted) in the inactive group (Sharkia et al., 2019). Other research in China, physical activity was proven to reduce the risk of Type 2 DM (Abdulai et al., 2019). In Korea, high physical activity among overweight or obese individuals reduced the risk of DM by 6.4% in men and 10% in women (Ko, Lee, & Kim, 2020).

Physiologically, regular exercise and physical activity can increase insulin sensitivity. Aerobic exercises such as walking, cycling, and swimming have been shown to increase glucose uptake by muscles up to fivefold. Consistent physical activity can improve muscle perfusion, increase oxidative capacity, improve fat metabolism, and strengthen insulin signaling pathways at the molecular level. These positive effects are reversible if physical activity decreases (Colberg et al., 2016).

Relationship between Emotional Mental Health and Type 2 DM Incidence in Indonesian Women

In various studies in Indonesia, emotional mental health disorders are often equated with psychological stress (Idaiani, Sapardin, & Sulistiowati, 2015). Riskesdas 2018 utilized the Self Reporting Questionnaire (SRQ-20) from WHO to identify mental health problems, which consists of 20 items related to stress symptoms experienced over the past month (Kemenkes RI, 2019b). Based on the findings in this study, the most common symptoms experienced by women with type 2 diabetes were headache (42.7%), sleep disturbances (31.7%), fatigue (28.4%), loss of appetite (19.7%), anxiety and tension (17.3%), and stomach complaints (15.4%). The overall proportion of identified emotional mental health disorders in Indonesian women in this study was relatively low, less than 10%, approaching the national figure of 9.9% according to Riskesdas 2018.

In the context of diabetes, the analysis results indicate that emotional mental health disorders are associated with an increased likelihood of Type 2 DM. Women with such disorders had a 1.65 times higher likelihood of suffering from Type 2 DM compared to emotionally healthy women. This result aligns with a longitudinal study in Australia, which found that moderate to high levels of stress increased the risk of Type 2 DM by 2.3 times after three years (Harris et al., 2017). That study also concluded that only a small proportion (<20%) of the effect of stress was mediated by other factors such as hypertension, smoking habits, and physical activity levels. Nevertheless, not all studies show consistent relationships. A meta-analysis by [Author/Year, if missing, please add] did not find a significant relationship between job stress and Type 2 DM in women, although the discussion mentioned that job pressure could still be a potential risk factor (Sui et al., 2016). Similar findings were observed in a local study in Surakarta City, which found no significant association between stress and Type 2 DM, concluding that stress is not the sole contributor to diabetes incidence (Kurniawati & Wijayanti, 2021).

Biologically, the stress response is mediated by the activation of the hypothalamus-pituitary-adrenal (HPA) axis, leading to increased release of cortisol and glucocorticoid hormones from the adrenal cortex (Hackett & Andrew Steptoe, 2017). Cortisol facilitates the release of glucose and fatty acids into the bloodstream to meet energy demands during stress (Joseph & Sherita H. Golde, 2018). If stress exposure is continuous, chronic allostatic load will occur, ultimately leading to glucose metabolism dysregulation and an increased risk of diabetes (Hackett & Andrew Steptoe, 2017; Joseph & Sherita H. Golde, 2018).

Relationship between Fruit and Vegetable Consumption and Type 2 DM Incidence in Indonesian Women

Based on the Ministry of Health standards in the 2018 Riskesdas Report, adequate consumption of fruits and/or vegetables is defined as consuming at least five portions per day for seven consecutive days. However, the findings of this study indicate that most Indonesian women have not yet reached this level of consumption. This finding is consistent with similar research utilizing 2018 Riskesdas data, which reported that 86.3% of the adult population in Riau Province had inadequate fruit and vegetable consumption (Hanjaya & Sarbini, 2021).

The limitations of this study prevent an analysis of economic factors and food accessibility as potential causes for the low consumption rates. However, based on residential area, this study found that women living in urban areas tended to have lower fruit and vegetable consumption compared to those living in rural areas, which aligns with data from the Central Statistics Agency (BPS) (Idris, 2020).

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Interestingly, this study found an association that is inconsistent with commonly accepted theory: low fruit and vegetable consumption was inversely associated with a lower likelihood of Type 2 Diabetes Mellitus (DM) in Indonesian women. Similar findings were also reported in another study based on Riskesdas 2018, where low fruit and vegetable consumption appeared to be protective against the incidence of diabetes in the elderly population (Milita, Handayani, & Setiaji, 2021), as well as in an analysis of 2013 Riskesdas data (Rosha, Kumalaputri, & Suryaputri, 2019). Although this study found that the proportion of fruit and vegetable consumption behavior was higher in the group of women with DM, this cannot be directly interpreted as an increase in consumption post-diagnosis. This is because the respondents' awareness of their DM diagnosis was unknown, and their eating habits had likely not changed at the time of data collection.

Results inconsistent with this theory were also found in a long-term prospective cohort study, which reported that fruit juice consumption was actually associated with an increased risk of Type 2 DM (Muraki et al., 2013). That study also found that replacing juice with whole fruits, especially blueberries, grapes, apples, bananas, and grapefruits, could reduce the risk of the disease. Various types of fruits and vegetables are known to have different effects on the risk of Type 2 DM. Green leafy vegetables, yellow vegetables, and temperate fruits like apples are considered more protective, while fruits with a high glycemic index such as bananas show a higher risk, especially in men (Alperet, Butler, Koh, Yuan, & van Dam, 2017). Fruit ripeness also affects fructose and glucose content, so excessive consumption of ripe fruits and sugary fruit juices needs to be limited to prevent blood glucose spikes.

Regular fruit consumption, whether daily or several times a week, has been reported to reduce the risk of Type 2 DM in both women and men (Agrawal, 2014). A study in Shanghai showed that a traditional diet high in carbohydrates, low in fat, plant-based, and rich in vegetables and legumes, when combined with physical activity, significantly reduced the risk of DM by up to 45% (Yu et al., 2018). Nevertheless, different results reported that fruit consumption was not associated with the incidence of Type 2 DM in Chinese women (Villegas et al., 2008). The explanation for this result was not definitively stated, but it is suspected that the high fructose content in some fruits may reduce the protective effect of antioxidants and fiber.

Conclusion

Based on 2018 Riskesdas data, Indonesian women with central obesity, in pre-elderly age groups, having insufficient physical activity, or impaired emotional mental health, showed an increased likelihood of experiencing Type 2 Diabetes Mellitus. Interestingly, low fruit and vegetable consumption appeared to be inversely associated with DM incidence, warranting further investigation. These findings underscore the complex etiology of DM and indicate the importance of adopting healthy lifestyles and engaging in early screening, particularly through waist circumference measurements, as targeted prevention and control efforts for Indonesian women.

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