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PHYSICAL ACTIVITY AND RISK OF DIABETES MELLITUS AMONG INDONESIAN OLDER ADULTS: A CROSS-SECTIONAL ANALYSIS USING 2023 SKI DATA

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ABSTRACT

Introduction: Diabetes mellitus (DM) is a growing health concern among older adults in Indonesia, with physical inactivity recognized as a modifiable risk factor. This study examined the association between moderate physical activity and diabetes prevalence among individuals aged ≥60 years. **Methods:** A cross-sectional analysis was conducted using 2023 Indonesia Health Survey (SKI) data, including 97,339 older adults. Diabetes status was based on self-reported physician diagnosis. Descriptive statistics and chi-square tests were used to examine associations between DM and sociodemographic, behavioral, and lifestyle variables. Statistical significance was set at $p < 0.05$. **Results:** The prevalence of DM was 6.1%. Diabetes status differed significantly by age, sex, education, employment status, region, dietary intake of sweet/processed products, and physical activity ($p < 0.001$). Older adults reporting no moderate physical activity had a higher proportion of DM (2.9%) compared to those who were physically active (3.2%) ($p < 0.001$). **Conclusion:** Moderate physical activity is associated with diabetes among Indonesian elderly individuals. Promoting physical activity remains an important strategy for prevention and healthy aging.

Keywords: diabetes mellitus, health behavior, Indonesia Health Survey (SKI), older adults, physical activity.

AKTIVITAS FISIK DAN RISIKO DIABETES MELITUS PADA LANSIA DI INDONESIA: ANALISIS CROSS-SECTIONAL MENGGUNAKAN DATA SKI 2023

ABSTRAK

Pendahuluan: *Diabetes melitus (DM) merupakan masalah kesehatan yang terus meningkat pada populasi lansia di Indonesia, dengan kurangnya aktivitas fisik dikenal sebagai salah satu faktor risiko yang dapat dimodifikasi. Penelitian ini bertujuan untuk menganalisis hubungan antara aktivitas fisik sedang dan prevalensi diabetes pada individu berusia ≥60 tahun.* ***Metode:*** *Analisis cross-sectional dilakukan menggunakan data Survei Kesehatan Indonesia (SKI) tahun 2023 yang melibatkan 97.339 lansia. Status diabetes ditentukan berdasarkan diagnosis dokter yang dilaporkan sendiri oleh responden. Statistik deskriptif dan uji chi-square digunakan untuk menganalisis hubungan antara DM dengan variabel sosiodemografi, perilaku, dan gaya hidup. Tingkat signifikansi statistik ditetapkan pada p < 0,05.* ***Hasil:*** *Prevalensi DM sebesar 6,1%. Status diabetes menunjukkan perbedaan yang signifikan berdasarkan usia, jenis kelamin, tingkat pendidikan, status pekerjaan, wilayah tempat tinggal, konsumsi makanan/minuman manis dan olahan, serta aktivitas fisik (p < 0,001). Lansia yang*

tidak melakukan aktivitas fisik sedang memiliki proporsi DM lebih tinggi dibandingkan dengan lansia yang aktif secara fisik (p < 0,001). ***Kesimpulan:*** *Aktivitas fisik sedang berhubungan dengan kejadian diabetes pada lansia di Indonesia. Peningkatan aktivitas fisik tetap menjadi strategi penting dalam pencegahan diabetes dan mendukung proses penuaan yang sehat.*

Kata Kunci: *aktivitas fisik, diabetes melitus, lansia, perilaku kesehatan, Survei Kesehatan Indonesia (SKI)*

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INTRODUCTION

Diabetes mellitus (DM), particularly type 2 diabetes mellitus (T2DM), is a chronic metabolic disorder characterized by elevated blood glucose levels resulting from insulin resistance or inadequate insulin secretion (Bellary et al., 2021; Goyal et al., 2023). Globally, DM remains a major public health challenge, contributing substantially to morbidity, mortality, and reduced quality of life. Beyond persistent hyperglycaemia, DM is a leading risk factor for cardiovascular disease, kidney failure, stroke, blindness, and lower-limb amputations, collectively imposing considerable clinical and economic burdens on individuals and health systems. In 2019, an estimated 463 million adults were living with diabetes, a number projected to rise to nearly 700 million by 2045 if current trends continue. This increase is driven by rapid urbanization, population aging, sedentary lifestyles, unhealthy dietary patterns, and rising obesity prevalence, which contribute to impaired glucose regulation (Harding et al., 2024; Khardori, 2021; Verma et al., 2021). The burden of DM is particularly pronounced in low- and middle-income countries (LMICs), where health systems are less equipped to manage chronic diseases, thereby exacerbating inequities in long-term care.

Older adults represent one of the most vulnerable groups affected by diabetes. Aging is associated with a progressive decline in insulin sensitivity and pancreatic β-cell function, impairing glycaemic control and increasing the likelihood of developing DM. In addition, the accumulation of comorbidities, such as hypertension, dyslipidaemia, chronic kidney disease, cardiovascular disease, and cognitive impairment, further elevates diabetes risk and complicates clinical management in this age group (Bellary et

al., 2021; Landstra & de Koning, 2021; Tomic et al., 2022).

In Indonesia, diabetes mellitus is one of the fastest-growing non-communicable diseases. National health data indicate an increasing prevalence, particularly among older adults, a trend that aligns with rising life expectancy and demographic shifts (Asri et al., 2025; Nasution et al., 2021; Rukmini et al., 2021; Santoso et al., 2023). Among the various modifiable determinants, physical inactivity is recognized as one of the most influential behavioural risk factors. Regular physical activity enhances insulin sensitivity, reduces adiposity, and supports glucose homeostasis, making it essential for the prevention and management of diabetes.

Despite this evidence, many Indonesian older adults remain physically inactive. Contributing factors include urbanization, limited access to safe exercise environments, and an increasing shift toward sedentary lifestyles (Hasina et al., 2022; Rachmah et al., 2019; Li et al., 2021; Singh, 2023). However, population-level studies examining the association between physical activity and diabetes among Indonesian older adults remain scarce, and existing studies are often regional, clinic-based, or lacking in age-stratified analyses (Nasution et al., 2021).

Global evidence consistently identifies physical inactivity as a major behavioural risk factor for diabetes (Linder et al., 2021; Seifu et al., 2020; Silva et al., 2019), yet few studies have focused specifically on elderly populations in Southeast Asia, including Indonesia. Moreover, previous national analyses have not consistently accounted for complex survey designs or examined behavioural contexts unique to older adults. Thus, there is a critical need for research utilizing nationally representative data to better inform targeted policy and intervention strategies.

Therefore, this study aimed to examine the association between physical activity and the risk of diabetes mellitus among older adults in Indonesia using data from the 2023 Indonesia Health Survey (SKI).

METHODS

Study Design and Data Source

This study employed a cross-sectional design using secondary data from the 2023 Indonesia Health Survey (Survei Kesehatan Indonesia/SKI). The SKI is a nationally representative health survey conducted by the Ministry of Health of the Republic of Indonesia, designed to collect comprehensive health and demographic data from Indonesian households. The survey utilized a stratified, multistage cluster sampling design to ensure representation across provinces and rural-

urban areas. Full details of the survey methodology and access to the microdata can be found at https://www.badankebijakan.kemkes.go.id/data-mikro-ski/.

Study Population

The target population for this analysis was elderly individuals aged ≥ 60 years. After applying the inclusion and exclusion criteria, 97,339 respondents were included in the final analysis.

Inclusion and Exclusion Criteria

The inclusion criteria were as follows: individuals aged ≥60 years at the time of the survey. Individuals with complete information on diabetes mellitus status and relevant independent variables were included. The exclusion criteria were individuals with missing or incomplete data on diabetes status. Respondents who answered “don’t know” or “refused to answer” to any of the key variables included in the analysis.

Variables and Measurements

The primary outcome was diabetes mellitus (DM), derived from the self-reported response to the question: “Have you ever been diagnosed with diabetes mellitus by a health professional?” Responses were coded as “Yes” for diagnosed cases and “No” otherwise. The following independent variables were included in the analysis: Age Group: Categorized into three groups: 60-69, 70-79, and 80-112 years. Sex: Recorded as male or female. Marital Status: Classified as single (never married), married, or divorced/widowed. Educational level was categorized as none (no formal education), elementary school, junior high school, senior high school, and college. Employment Status: Respondents were classified as either "working" or "not working" at the time of the survey. Region of Residence: Classified as urban or rural based on the official classification used by the Central Bureau of Statistics. Consumption of Sweet Foods and Beverages: Measured by frequency of consumption of sugar, syrup, confectionery, and processed sweet products, categorized as more than once a day, once a day, 3-6 times a week, 1-2 times a week, less than three times a week, and never. Physical Activity: Determined by asking whether respondents engaged in moderate physical activity for at least 10 continuous minutes per session. Responses were categorized as “Yes” or “No.”

Statistical Analysis

All statistical analyses were conducted using IBM SPSS Statistics (version 27.0.1). Descriptive statistics were used to summarize the frequency and percentage distributions of all variables. Bivariate associations between the independent variables and diabetes mellitus

were examined using the chi-squared test for categorical variables.

To account for the complex survey design, including stratification, clustering, and unequal probability of selection. This adjustment ensured that the estimates accurately reflected population-level inferences from the survey data. Statistical significance was set at $p < 0.05$.

Ethical Approval

This study used publicly available de-identified secondary data. Ethical approval for data use was granted through a formal data request and confidentiality agreement (No. FRM/SMKI PUSDATIN/70/0108/2024). Data access was approved by ticket number 240675B7CC9C4327, and all research procedures complied with national ethical standards concerning data confidentiality and the protection of participant information. Public access to the data and approval documentation is available at: https://www.badankebijakan.kemkes.go.id/data-mikro-ski/.

RESULTS

Table 1 shows the frequency distribution of sociodemographic, lifestyle, and health characteristics of the 97,339 older adults. Two-thirds were aged 60-69 years (68.3%), and 6.8% were ≥80 years old. Females comprised 51.0% of the participants. Most were married (68.4%) and had an elementary education or lower (68.7%).

Table 1. Distribution of Demographic Characteristics among Elderly with Diabetes Mellitus in Indonesia (n= 97339)

Variables	Frequency (n)	Percent (%)
Demographic Characteristic		
Age (Years)		
60-69	66.435	68.3%
70-79	24.282	24.9%
80-112	6.622	6.8%
Gender		
Male	47.622	49.0%
Female	49.677	51.0%
Marital Status		
Single	1.222	1.3%
Married	66.554	68.4%
Divorced	29.563	30.4%
Educational Level		
None	25.982	26.7%
Elementary	40.880	42.0%
Junior High School	10.431	10.7%
Senior High School	13.188	13.5%
College	6.858	7.0%
Job		
Doesn't Work	31.329	32.2%
Work	66.010	67.8%
Region		
Urban	52.671	54.1%
Rural	44.668	45.9%
Diagnosed with Diabetes Mellitus (DM)		
Yes	5.927	6.1%
No	91.412	93.9%
Consumption of sugar, syrup, confectionery, and processed products		
More than 1 time a day	15.649	16.1%
1 time a day	22.632	23.3%
3-6 times a week	13.301	13.7%
1-2 times a week	16.209	16.7%
< 3 times a week	14.577	15.0%
Never	14.971	15.4%
Moderate physical activity continuously for at least 10 minutes per session		
Yes	57.170	58.7%
No	40.169	41.3%

The majority were still working (67.8%), and just over half resided in urban areas

(54.1%). The prevalence of self-reported diabetes mellitus was 6.1%. Regarding diet, 39.4% of the participants consumed sugary foods/drinks daily (23.3% once/day and 16.1% more than once/day), whereas 15.4% reported never consuming them. Overall, 58.7% of the participants engaged in moderate physical activity for ≥10 min per session.

Table 2 summarizes the chi-square associations between diabetes mellitus (DM) status and key covariates among 97,339 older adults. DM status was significantly associated with age, sex, marital status, education, employment, place of residence, frequency of sweet/processed food intake, and moderate physical activity (all $p < 0.05$; smallest $p = 0.001$). By age, the largest share of DM cases occurred in the 60-69 group (4.5%, n = 4,358), followed by 70-79 (1.4%, n = 1,338) and ≥80 (0.2%, n = 231) years, while non-DM participants were predominantly 60-69 years (63.8%, n = 62,077). Females showed a slightly higher prevalence of DM than males (3.5% vs. 2.6%; $p = 0.001$). Married individuals accounted for most of the DM cases (4.2%, n = 4,112; $p = 0.034$). Educational level displayed a non-linear pattern (highest count among elementary education, 2.0%, n = 1,966; $p = 0.001$). DM prevalence was higher among those still working than those not working (3.5% vs. 2.6%; $p = 0.001$) and markedly higher among urban than rural residents (4.3% vs. 1.7%; $p = 0.001$).

Table 2. Bivariate Analysis of Demographic Characteristics Associated with Diabetes Mellitus using Chi-squared Test (n= 97.339)

Variables	Diabetes Mellitus				p-value
	Yes (n=5.927)		No (n=91.412)		
	n	(%)	n	(%)	
Demographic Characteristic					
Age (Years)					0.001*
60-69	4.358	(4.5)	62.077	(63.8)	
70-79	1.338	(1.4)	2.294	(23.6)	
80-112	231	(0.2)	6.391	(6.6)	
Gender					0.001*
Male	2.517	(2.6)	45.145	(46.4)	
Female	3.410	(3.5)	46.267	(47.5)	
Marital Status					0.034*
Single	56	(0.1)	1.166	(1.2)	
Married	4.112	(4.2)	62.442	(64.1)	
Divorced	1.759	(1.8)	27.804	(28.6)	
Education Level					0.001*
None	1.062	(1.1)	24.920	(25.6)	
Elementary	1.966	(2.0)	38.914	(40.0)	
Junior High School	794	(0.8)	9.637	(9.9)	
Senior High School	1.265	(1.3)	11.923	(12.2)	
College	840	(0.9)	6.018	(6.2)	
Job					0.001*
Doesn't Work	2.545	(2.6)	28.784	(29.6)	
Work	3.382	(3.5)	62.628	(64.3)	
Region					0.001*
Urban	4.233	(4.3)	48.438	(49.8)	
Rural	1.694	(1.7)	42.974	(44.1)	
Consumption of sugar, syrup, confectionery, and processed products					0.001*
More than 1 time a day	543	(0.6)	1.206	(15.5)	
1 time a day	937	(1.0)	21.695	(22.3)	
3-6 times a week	634	(0.7)	12.667	(13.0)	
1-2 times a week	981	(1.0)	15.228	(15.6)	
< 3 times a week	1.183	(1.2)	13.394	(13.8)	
Never	1.649	(1.7)	12.322	(13.7)	
Moderate physical activity continuously for at least 10 minutes per session					0.001*
Yes	3.104	(3.2)	54066	(55.5)	
No	2.823	(2.9)	37346	(38.4)	

*p<0,05

Sweet/processed food intake was also associated with DM (p = 0.001), with notable DM proportions among those reporting "never" intake, consistent with potential post-diagnosis dietary restriction. Moderate physical activity (≥10 min/session) was related to DM status (p = 0.001); a larger share of non-DM participants reported being physically active, although the bivariate patterns should be interpreted cautiously. These findings underscore meaningful group differences and motivate multivariate adjustments to assess independent associations.

DISCUSSION

This study identified several factors associated with the prevalence of diabetes mellitus (DM) among older adults in Indonesia. The findings showed significant associations between DM and age, sex, educational level, employment status, region of residence, dietary behavior, and physical activity. These results are consistent with prior evidence and contribute to a broader understanding of diabetes-related disparities among elderly populations.

The association between age and DM observed in this study aligns with previous literature indicating that metabolic and physiological changes accompanying aging, such as reduced insulin sensitivity and impaired β-cell function, may increase vulnerability to diabetes (Chen et al., 2021; Silva et al., 2019). Interestingly, the higher prevalence in the younger segment of the elderly population (60-69 years) may reflect greater healthcare utilization, earlier diagnosis, and potential survival bias, in which individuals with diabetes may have higher mortality before reaching older ages.

The slightly higher prevalence of DM among females compared with males is in accordance with earlier studies reporting increased susceptibility among older women. Factors such as postmenopausal hormonal changes, altered fat distribution, and longer life expectancy may contribute to this pattern (Cassidy et al., 2020; Ciarambino et al., 2022; Saimi et al., 2024). Sociocultural differences, including reduced engagement in physical activity among older women in some communities, may also play a role. However, differences observed in this national dataset may partly reflect enhanced detection or reporting among women.

Educational attainment demonstrated an inverse association with DM prevalence, supporting literature emphasizing the role of health literacy in adopting healthy behaviors, accessing care, and understanding disease risks (Hill-Briggs et al., 2020; Indrahadi et al., 2021). Individuals with lower education may have

limited access to diabetes-related knowledge and fewer opportunities for preventive behaviors, making them more susceptible to metabolic disorders.

Employment status was also associated with DM, with higher prevalence among those who were still working. This finding may reflect work-related stress, irregular schedules, or reduced opportunities for self-care among older adults who continue working. Conversely, those who are no longer working may have greater flexibility to engage in physical activity, prepare healthier foods, or attend health services (Kobos et al., 2021; Liu et al., 2023).

The urban-rural disparity in diabetes prevalence observed in this study mirrors findings from previous research in Indonesia and other countries (Anza-Ramirez et al., 2022; Liu et al., 2022). Urban environments are often characterized by more sedentary lifestyles, increased availability of processed foods, higher population density, and greater exposure to environmental stressors. While healthcare access is generally better in urban areas, improved detection may partly explain higher diagnosed prevalence.

An association was also found between the frequency of sweet or processed food consumption and DM. However, the higher proportion of DM cases among participants reporting lower intake may reflect behavioral modification following diagnosis (reverse causation), where individuals reduce sugar consumption after learning they have diabetes.

Consistent with global evidence, this study found that lower levels of moderate physical activity were associated with a higher prevalence of DM (Linder et al., 2021; Ismaila, 2022). Reduced physical activity may impair insulin sensitivity, increase adiposity, and contribute to metabolic dysfunction. Nonetheless, given the cross-sectional nature of the data, it is not possible to determine whether lower activity preceded diabetes or resulted from disease-related limitations.

A major strength of this study is the use of a large, nationally representative dataset, enabling population-level assessment of diabetes-related factors among older adults in Indonesia. The inclusion of multiple sociodemographic and behavioral variables enhances the relevance of the findings for public health planning. However, several limitations should be considered. First, the cross-sectional design does not allow for causal inference, and the observed associations may reflect underlying reverse causation. Second, diabetes status was based on self-reported physician diagnosis, potentially leading to underreporting, especially among individuals with limited access to

healthcare. Third, physical activity was measured using a simplified single-item question, which may not capture duration, frequency, or intensity accurately. Fourth, important confounders such as BMI, waist circumference, and family history of diabetes were unavailable. Finally, although multivariable regression would have strengthened the analysis, such modeling could not be conducted due to limitations of the accessible SKI dataset, including incomplete microdata structure and absence of required sampling design variables. As a result, the findings reflect unadjusted associations and should be interpreted cautiously.

Another important limitation of this study is the inability to perform survey-adjusted multivariable logistic regression. The SKI dataset available for this analysis did not include the complete microdata structure required for complex-sample regression modelling (e.g., sampling weights, primary sampling units, and strata identifiers), nor did it provide access to essential covariates needed for adjustment. As a result, this study relied on descriptive and bivariate (chi-squared) analyses, which are appropriate for identifying initial group differences but cannot estimate adjusted associations or control for potential confounding factors. Consequently, the observed relationships, particularly between physical activity and diabetes mellitus, should be interpreted with caution, as they may be influenced by unmeasured or uncontrolled confounders. Future research using full SKI microdata or longitudinal datasets is needed to conduct adjusted regression analyses and provide more robust inferential evidence.

The study highlights key demographic and behavioral factors linked with diabetes among Indonesian older adults, emphasizing the need for targeted interventions. Strategies aimed at promoting physical activity, enhancing health literacy among low-education groups, and addressing urban lifestyle risks may help mitigate the burden of diabetes in this population. Strengthening early screening in primary care and community settings, particularly in urban areas and among working older adults, is also important. Future research should utilize complete SKI microdata or longitudinal datasets to conduct survey-adjusted multivariable regression analyses and provide more robust estimations of adjusted associations. Studies incorporating objective measures such as BMI, HbA1c levels, and accelerometer-based physical activity assessments are needed to improve accuracy and causal interpretation. Evaluations of community-based, culturally appropriate physical activity and dietary interventions for older adults would also be valuable.

CONCLUSION

Using nationally representative data from the 2023 Indonesia Health Survey (SKI), this study found that diabetes mellitus (DM) prevalence among older adults in Indonesia was 6.1 percent. Several sociodemographic and behavioral factors, including age, sex, education, employment status, region of residence, dietary habits, and physical activity, were significantly associated with DM. These findings highlight important patterns of diabetes distribution within the elderly population; however, the results reflect unadjusted associations and should be interpreted with caution due to the study's cross-sectional design and measurement limitations.

The observed association between lower physical activity and higher diabetes prevalence suggests that promoting regular activity may support healthier aging, although longitudinal data and more comprehensive measures are needed to clarify temporal relationships and confirm causal pathways. Future research should incorporate objective biomarkers, survey-adjusted regression modeling, and prospective designs to better understand the determinants of diabetes in older adults. Strengthening evidence in these areas will help inform more targeted and effective public health strategies for Indonesia's aging population.

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DATA AVAILABILITY STATEMENT

Data were derived from the 2023 Indonesia Health Survey (SKI) managed by the Ministry of Health. Access is restricted and available upon formal request via the Ministry's repository: https://www.badankebijakan.kemkes.go.id/data-mikro-ski/.

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