Factors associated with type 2 diabetes mellitus in older adults living in Coastal Areas: Implications for community nursing practice

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Abstract

Background: Indonesia's growing older adult population is experiencing a rising burden of type 2 diabetes mellitus (T2DM). Coastal populations face unique risks, including limited health service access, dependence on fisheries-based livelihoods, and dietary patterns high in salt and low in fresh produce. These factors may heighten vulnerability to T2DM, yet remain underexplored.
Purpose: This study aimed to examine determinants of T2DM among older adults living in a coastal community.
Methods: A cross-sectional study was conducted with 86 older adults selected using purposive sampling between October 30 and December 14, 2024. Data were collected using demographic questionnaires, the Mini Nutritional Assessment (MNA), the Geriatric Depression Scale (GDS), and the Physical Activity Scale for the Elderly (PASE). Chi-square tests assessed associations between independent variables and T2DM, and variables with $p < 0.25$ were entered into multivariable logistic regression to identify significant predictors.
Results: Comorbidity ($p < 0.001$), nutritional status ($p = 0.001$), physical activity ($p < 0.001$), and depression ($p < 0.001$) were significantly associated with T2DM. In multivariable analysis, lower physical activity emerged as the strongest predictor (OR = 4.13, 95% CI: 1.18–14.48; Wald = 4.92; $p = 0.027$). Comorbidity (OR = 3.61), depression (OR = 3.64), and nutritional status (OR = 3.28) also remained significant independent factors.
Conclusion: T2DM among older adults in coastal areas was more likely in those with comorbidities, depressive symptoms, altered nutritional status, and especially low physical activity. These findings highlight the need for community-based nursing interventions emphasizing physical activity promotion, nutritional counseling, and depression screening to mitigate T2DM risk in vulnerable coastal populations

Keywords: community; older adults; T2DM

Jurnal Keperawatan Padjadjaran (JKP)

Volume 13(2), 219-228

http://dx.doi.org/10.24198/jkp.v13i2.2767

Article Info

Received : March 15, 2025
Revised : August 17, 2025
Accepted : August 28, 2025
Published : August 30, 2025

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Citation

Zi, L. O. H., Susanty, S., & Suhadi, S. (2025). Factors associated with type 2 diabetes mellitus in older adults living in Coastal Areas: Implications for community nursing practice. *Jurnal Keperawatan Padjadjaran, 13*(2), 219-228. http://dx.doi.org/10.24198/jkp.v13i2.2767

Website

http://jkp.fkep.unpad.ac.id/index.php/jkp

E-ISSN: 2442-7276
P-ISSN: 2338-5324

Introduction

Global life expectancy is expected to increase from 73.6 years in 2022 to 78.1 years in 2050 (Institute for Health Metrics and Evaluation (IMHE), 2024). Life expectancy for female reaches 78.3 years, higher than for male (68.4 years) (Dattani & Rodés-Guirao, 2023). In Indonesia, increasing life expectancy has led to an increase in the elderly population, which has a significant impact on the health, social and economic aspects of the country (Central Bureau of Statistics (BPS), 2023). This reflects the success of the health sector accompanied by improved health services for older adults (Ministry of Coordinating Human Development and Culture of the Republic

of Indonesia, 2021). Aging population, if managed properly, can be a demographic bonus if older adults remain healthy, active and productive. The main challenge faced is how to maintain the quality of life of the elders, considering that increasing age is often accompanied by physical and health decline (Central Bureau of Statistics (BPS), 2021, 2023).

Individuals who are 60 years old and above, commonly referred to as the older adults, who are experience the aging process (World Health Organization (WHO), 2024a), which includes both physical decline (Malik et al., 2024; Susanty et al., 2023) and changes in mental health (Susanty et al., 2022; Susanty et al., 2025). The World Health Organization (WHO) reported that, as of 2020, the global elderly population reached 1 billion and is expected to increase to 1.4 billion by 2050 (World Health Organization (WHO), 2024a). Southeast Asia is witnessing a similar trend, with the percentage of elderly individuals at 9.8% in 2017, projected to rise to 13.7% in 2030 and 20.3% in 2050 (World Health Organization (WHO), 2025). By 2022, the percentage of elderly individuals grew to 10.48%, and by 2023, it had risen to 11.75% (Central Bureau of Statistics (BPS), 2023). In Southeast Sulawesi Province, the elderly population stood at 7.67% in 2022, with 66.61% living in rural areas and 33.39% in urban locations; regarding gender, elderly males represented 49.21% while elderly females accounted for 50.79% (Central Bureau of Statistics (BPS) Southeast Sulawesi Province, 2022).

Older individuals frequently face intricate health issues, one of which is diabetes mellitus, necessitating continuous management to avert complications. Diabetes mellitus (DM) is a metabolic disorder defined by elevated blood glucose levels resulting from irregularities in insulin secretion or function (World Health Organization (WHO), 2024b). As per the American Diabetes Association, an individual is diagnosed with DM if their fasting blood glucose concentration is ≥ 126 mg/dL or the glucose level two hours post-meal is ≥ 200 mg/dL. DM arises when the pancreas fails to produce sufficient insulin or when the body is unable to effectively utilize the insulin produced (American Diabetes Association (ADA), 2013; World Health Organization (WHO), 2024b). According to a report by the International Diabetes Federation (IDF), the incidence of DM among individuals aged 60 and above stands at 17%, with projections estimating it will rise to 25% by 2045, and 90% of the elderly population worldwide is affected by type 2 DM (Internationa Diabetes Federation, 2021). In Indonesia, the prevalence of DM among older adults was reported 5.39% (Oktaviyani et al., 2022). Furthermore, the 2023 Indonesian Health Survey Report highlighted that DM in older adults was 18.1%, while type 2 DM was 51.7% (Ministry of Health of the Republic of Indonesia, 2023).

Several factors have been identified as associated with diabetes mellitus (DM), including age, sex, educational level, marital status, place of residence, and employment status (Oktaviyani et al., 2022). Socioeconomic and biodemographic characteristics such as lower educational attainment, family history of diabetes, obesity, and higher socioeconomic background have also been linked to increased risk of DM (Das & Kar, 2023). Among older adults, the presence of DM elevates the risk of serious health problems, including cardiovascular disease, visual impairment, and cognitive decline, particularly Alzheimer's disease and other forms of dementia (Chentli et al., 2015). Older adults living in coastal communities may face additional challenges, such as limited access to healthcare services and lifestyle patterns shaped by fisheries-based livelihoods and dietary practices, which may further increase their vulnerability to type 2 diabetes mellitus (T2DM). This study aimed to analyze the determinant factors associated with T2DM among older adults living in coastal areas.

Materials and Methods

Design

This quantitative study employed an observational analytical design with a cross-sectional approach

Sample and setting

The study population consisted of older adults aged 60 years and above residing in Buton, Indonesia, totaling 627 individuals (Central Statistics Agency of South Buton Regency, 2024). Among them, 298 were diagnosed with type 2 diabetes mellitus (T2DM). The sample was determined using purposive sampling, considering the characteristics of the target population. The sample size was calculated using Slovin's formula, assuming a 95% confidence level ($\alpha = 0.05$) and a 10% margin of error ($e = 0.10$), resulting in 86 participants. This estimate was cross-validated with Cochran's formula for proportions ($p = 0.5$) and finite-population correction, which produced a similar requirement of 86 participants. Eligible respondents were identified through records of older adults who had received services at Primary Health Centers via the Integrated Development Post, Elderly Service Post, and the Chronic Disease Management Program. Inclusion criteria were older adults aged ≥60 years, diagnosed with T2DM, willing to participate, cooperative, and able to communicate verbally. Exclusion criteria included those under 60 years, unwilling to participate, uncooperative, or unable to communicate verbally. Recruitment was carried out in collaboration with community health workers, and respondents were enrolled sequentially until the target sample size was achieved.

Instruments

Data were collected using anthropometric measurements, respondent characteristic forms, and validated questionnaires assessing nutritional status, physical activity, and depression. Weight and height were measured with a flexible measuring

tape and standardized equipment. Respondent characteristics, including age, gender, marital status, education level, employment status, and family medical history, were obtained from medical records and confirmed through direct interviews with participants.

Nutritional status was assessed using the Mini Nutritional Assessment (MNA), developed by Guigoz, et al., (1994). The instrument has demonstrated high reliability (Cronbach's α = 0.83), sensitivity (96%), and specificity (98%) (Vellas et al., 2009). It consists of 15 items with a maximum score of 30. Scores between 17–30 indicate good nutrition, while scores <17 indicate malnutrition (Audaya et al., 2022).

Depression was measured using the Geriatric Depression Scale–Short Form (GDS-SF), developed by Yesavage et al., (1982). The GDS-SF has demonstrated strong psychometric properties (sensitivity 92%, specificity 89%) and good reliability in the Indonesian version (Cronbach's α = 0.80) (Susanty et al., 2024). The 15-item scale uses dichotomous ("Yes/No") responses, with higher scores indicating greater depressive symptoms.

Physical activity was measured using the Physical Activity Scale for the Elderly (PASE), developed by Washburn et al., (1993). The PASE demonstrated excellent reliability (Cronbach's α = 0.94) and consists of 10 items covering leisure, household, and volunteer activities. Responses are scored on a 4-point Likert scale (0–3). Scores ≥15 were categorized as good physical activity, while scores <15 indicated poor activity levels (Sari, 2022).

Data analysis

Data were analyzed using IBM SPSS Statistics for Mac, version 23.0 (IBM Corp., Armonk, NY, USA). Univariate analysis was performed to describe respondent characteristics, including age, family history of disease, gender, education level, employment status, and marital status, as well as independent variables (comorbidity, nutritional status, physical activity, and depression) and the dependent variable (type 2 diabetes mellitus). Results are presented as frequency distributions and percentages. Bivariate analysis was conducted using the Chi-square test with a significance level of α = 0.05 and a 95% confidence interval to assess associations between independent variables and T2DM. Variables with $p < 0.25$ were entered into multivariable analysis. Binary logistic regression was then used to identify independent predictors of T2DM.

Ethical consideration

Ethic research was perform from the South Buton District Health Service (No. 546/UN29.15.1.2/KM/2024), the Regional Research and Innovation Agency of Southeast Sulawesi Province (No. 070/3992/X/2024), and obtaining ethical approval from the Health Research Ethics Commission of the Association of Indonesian Public Health in Southeast Sulawesi (No. 060/UN29.15.1.2/KR/2025). We ask for consent from each participant in accordance with ethical research guidelines; informed consent was obtained prior to data collection, and participants were assured of confidentiality and their right to withdraw at any time. The total questionnaire consists of 43 items questions, with a duration of 25-30 minutes.

Results

Characteristics of respondents

Most respondents were in the young-old age group (60–69 years) and the majority were women. Many participants had low educational attainment, were unemployed, and relied on informal sources of livelihood. More than half demonstrated normal nutritional status, while low levels of physical activity were common. These demographic and socioeconomic characteristics reflect the typical profile of older adults residing in coastal communities, where reliance on fisheries, limited education, and restricted access to health services contribute to health vulnerabilities (Table 1).

The Chi-square test results indicated significant associations between several variables and the presence of type 2 diabetes mellitus in older adults. Comorbidity was significantly related to T2DM ($p < 0.001$), as were nutritional status ($p = 0.001$), physical activity ($p < 0.001$), and depression ($p < 0.001$). These findings suggest that older adults with comorbid conditions, poor nutritional status, lower physical activity, and depressive symptoms were more likely to experience T2DM (Table 2).

Multivariate logistic regression analysis

Multivariable logistic regression analysis demonstrated that comorbidity, nutritional status, physical activity, and depression were independently associated with the presence of type 2 diabetes mellitus in older adults. Among these, physical activity emerged as the strongest predictor. Older adults with low levels of physical activity had more than four times higher odds of developing T2DM compared with those who were more active (OR = 4.13, 95% CI: 1.18–14.48; Wald = 4.92; $p = 0.027$). Comorbidity (OR = 3.61, 95% CI: 1.06–12.29), nutritional status (OR = 3.28, 95% CI: 1.04–10.36), and depression (OR = 3.64, 95% CI: 1.12–11.77) also showed significant associations, highlighting the multifactorial nature of T2DM risk in this population. These findings underscore the importance of addressing not only physical activity but also comorbid conditions, nutrition, and mental health when designing community-based nursing interventions to reduce the burden of T2DM in older adults living in coastal communities (Table 3).

Table 1. Characteristics of respondent

Variable	Frequency (n)	Percentage (%)
Age		
60-69	79	91,9
70-79	5	5,8
≥ 80	2	2,3
Gender		
Male	25	29,1
Female	61	70.9
Family Medical History		
There are Sufferers	30	34,9
There are No Sufferers	56	65,1
Level of Education		
Not school	8	9,3
Elementary School	27	31,4
Junior High School	25	29,1
High School	22	25,6
University	4	4,7
Employment Status		
Working	35	40,7
Not Working	51	59,3
Marital status		
Married	41	47,7
Divorced	45	52,3
Not Married	-	-
Comorbidity		
Yes	42	48,8
No	44	51,2
Nutritional status		
Normal	46	53,5
Malnutrition	40	46,5
Physical Activity		
Poor	46	53,5
Good	40	46,5
Depression		
Yes	36	41,9
Normal	50	58,1

Discussion

Characteristics of respondent

The majority of respondents in this study were in the young-old age group (60–69 years), comprising 79 participants (91.9%), with a predominance of females (70.9%). This finding underscores the vulnerability of older adults in the early stages of aging to type 2 diabetes mellitus (T2DM). Our results are consistent with Azadbakht et al. (2020), who reported a mean age of 68.38 years (SD = 6.78) with more than half of participants being female (53.6%). The transition into the young-old stage is often accompanied by metabolic changes, including reduced pancreatic β-cell function, diminished mitochondrial activity in skeletal muscle, and increased insulin resistance. Advancing age is also associated with declining physical activity, sarcopenia, and impaired glucose regulation, all of which further heighten T2DM risk (Bellary et al., 2021). In women, hormonal changes during menopause, particularly declining estrogen and progesterone levels, exacerbate insulin

Table 2. Bivariate Analysis

Variable	Type 2 Diabetes Mellitus				Total		p value
	Yes		No				
	n	%	n	%	n	%	
Comorbidity							
Yes	31	73,8	11	26,2	42	100	<0.001
No	10	22,7	34	77,3	44	100	
Nutritional status							
Normal	27	67,5	13	32,5	40	100	0.001
Malnutrition	14	30,4	32	69,6	46	100	
Physical Activity							
Poor	34	73,9	12	26,1	46	100	<0.001
Good	7	17,5	33	82,5	40	100	
Depression							
Yes	28	77,8	8	22,2	36	100	<0.001
Normal	13	26,0	37	74,0	50	100	

Table 3. Analysis multivariate

Variables	Wald	Sig.	Exp(B)	95% Confidence Interval	
				Lower	Upper
Comorbidity	4.227	0.040	3.613	1.062	12.294
Nutritional status	4.078	0.043	3.275	1.036	10.360
Physical Activity	4.917	0.027	4.132	1.179	14.482
Depression	4.645	0.031	3.637	1.124	11.766

resistance and contribute to a higher risk of T2DM (Cerdas Pérez, 2023).

Most participants in this study did not report a family history of T2DM (65.1%). Nevertheless, family history remains an established risk factor, as demonstrated in other studies (Alharithy et al., 2018; Hao et al., 2022). Educational attainment among participants was generally low, which is consistent with findings from previous Indonesian studies. Limited education often contributes to low health literacy, impairing diabetes self-management and disease understanding (Rachmawati et al., 2019). In terms of employment, most respondents were unemployed, which is consistent with other studies involving older adults aged 60 years and above (Mutambudzi & Javed, 2016). Lack of employment or retirement may reduce daily physical activity, lowering tissue sensitivity to insulin and increasing T2DM risk. Additionally, a higher proportion of participants were divorced, a factor associated with reduced quality of life, higher stress, and increased vulnerability to depression. Stress and psychological distress can elevate cortisol and adrenaline levels, further contributing to insulin resistance and the development of T2DM (Sari et al., 2021).

Determinant factors

Our findings showed that nearly half of the older adult participants (48.8%) had comorbid conditions. Among those with type 2 diabetes mellitus (T2DM), many experienced multiple coexisting illnesses. This aligns with previous studies reporting a high prevalence of comorbidities such as hypertension, cerebrovascular disease, cardiovascular disease, and chronic kidney disease among older adults with T2DM (Kim et al., 2020). The presence of comorbidities complicates diabetes management, increases treatment burden, and elevates the risk of adverse outcomes, particularly in community-dwelling older adults (Huang, 2016; Markle-Reid et al., 2018). Furthermore, the interaction between T2DM and comorbidities may intensify metabolic dysregulation, resulting in poorer glycemic control and accelerating disease progression (Morley et al., 2017; Thaenpramun et al., 2024). These findings highlight the importance of comprehensive geriatric assessments and integrated, patient-centered care models that address both diabetes and coexisting conditions. Tailored nursing interventions focusing on multimorbidity management, medication adherence, and self-care support are crucial to improving health outcomes and quality of life in older adults with T2DM.

Nearly half of the older adult participants (46.5%) were malnourished, which is consistent with previous studies emphasizing the critical role of malnutrition as a risk factor for type 2 diabetes

mellitus (T2DM) in older adults (Thaenpramun et al., 2024). Malnutrition may exacerbate metabolic dysregulation, impair glucose homeostasis, and accelerate the development and progression of diabetes. It has also been associated with rapid weight loss, poor health status, reduced physical activity, and inadequate food intake. Predictors such as male gender, albuminuria, and poor glycemic control have been linked to higher prevalence of malnutrition among older adults with T2DM (Junaid et al., 2022; Rashid et al., 2025).

At the physiological level, malnutrition can reduce adiponectin production due to fat tissue shrinkage, which disrupts glucose metabolism, promotes insulin resistance, and worsens systemic inflammation. These changes elevate pro-inflammatory cytokines, damage pancreatic β-cells, and contribute to hyperglycemia (Rajamanickam et al., 2020). Consequently, addressing malnutrition is essential for both prevention and treatment of T2DM in older adults. Incorporating routine nutritional assessments into diabetes care and implementing targeted dietary interventions, such as low-glycemic and low-phosphate nutritional strategies, may help reduce the risk and burden of T2DM in this population (Brown, 2020).

More than half of the older adult participants (53.5%) reported low levels of physical activity. Physical inactivity is a well-established risk factor for type 2 diabetes mellitus (T2DM) and has been consistently linked to adverse health outcomes in older adults (Kelly et al., 2016). Previous studies have also shown that physical inactivity contributes to increased medical costs associated with circulatory, endocrine, nutritional, and metabolic diseases (Kikuti-Koyama et al., 2019). Conversely, engaging in regular physical activity improves insulin sensitivity, enhances glucose metabolism, and reduces the risk of cardiovascular disease, which commonly coexists with T2DM in older populations. Promoting health literacy regarding the importance of maintaining regular, age-appropriate physical activity can play a significant role in reducing complications and lowering healthcare costs. These findings highlight the necessity of integrating physical activity promotion into diabetes management and prevention strategies for older adults, particularly those living in resource-limited coastal communities.

Depression was reported by 41.9% of older adult participants, consistent with evidence showing a strong link between depression and type 2 diabetes mellitus (T2DM) in older populations (Gao et al., 2025). Depression in individuals with T2DM can worsen glycemic control, reduce adherence to treatment regimens, and increase the risk of complications (Kim et al., 2019; Sirirak et al., 2022; Yang et al., 2023). The chronic stress of living with diabetes and its associated comorbidities may also contribute to the onset or exacerbation of depressive symptoms (Joseph & Golden, 2017). While some studies note that depression is more common among those with shorter disease duration and insulin-based therapy, older patients often present lower rates of depression compared to younger patients (Elnaem et al., 2025). These findings emphasize the importance of integrating routine mental health screening and psychosocial interventions into diabetes care for older adults, as addressing depression may improve both psychological well-being and diabetes outcomes.

This study further demonstrates that comorbidities, nutritional status, physical activity, and depression significantly influence the risk of T2DM in older adults. Among these, physical inactivity emerged as the most influential factor. Many older adults experience joint pain, muscle weakness, and bone deterioration, which limit mobility. Those previously engaged in physically demanding work, such as fishing or farming, often become less active after retirement due to loss of physical ability and social roles. Similar to earlier reports, inactivity is a major contributor to chronic disease (Booth et al., 2012). In coastal communities, this decline is compounded by seasonal livelihoods, environmental barriers, limited elderly-friendly exercise facilities, and low awareness of the benefits of physical activity. These findings underscore the need for community-based nursing interventions that promote safe and accessible physical activity, while also addressing nutrition and mental health, to reduce the burden of T2DM among older adults in coastal settings.

Nursing implication

This study contributes to nursing knowledge by providing new insights into how coastal living conditions shape risk factors for type 2 diabetes mellitus in older adults. The findings expand nursing theory by applying the Health Believe Model within a unique coastal context, highlighting how occupational transitions, limited health access, and sociocultural habits influence health behaviors. From a practice perspective, this study emphasizes the importance of community-based nursing intervention tailored to coastal populations, such as targeted health education, elderly-friendly physical activity programs, and psychosocial support strategies. Moreover, it underscores the critical role of nurses as advocates and health promoters in resource-limited coastal settings, bridging gaps between health services and vulnerable elderly communities. By integrating these elements, the study enriches nursing practice with evidence-based strategies for chronic disease prevention and exercise facilities, and high-salt diets further increase vulnerability. These findings justify the term coastal community by contextualizing T2DM risk within the unique socioeconomic management in under-researched populations.

Strengths and limmitations

This study provides novel insights into the influence of comorbidities, nutrition, physical activity, and

psychological factors on type 2 diabetes mellitus among older adults in coastal communities. The focus on a coastal population is a strength, as this group is often underrepresented in previous research despite facing unique health vulnerabilities. The study also applied standardized instruments and involved direct community engagement, which increases the reliability and contextual relevance of the findings. However, the study has several limitations. First, the cross-sectional design does not allow for causal inferences between risk factors and diabetes incidence. Second, the sample size, although adequate, was limited to one coastal district, which may reduce generalizability to other coastal or inland populations. Third, self-reported measures of diet, physical activity, and psychological status may be subject to recall and reporting bias. Despite these limitations, the study provides important preliminary evidence to guide nursing practice and future research.

Conclusions

This study identified comorbidity, nutritional status, physical activity, and depression as significant factors associated with type 2 diabetes mellitus (T2DM) among older adults in South Buton Regency. Physical inactivity emerged as the strongest predictor, reflecting the influence of occupational transitions and environmental constraints unique to coastal communities. Strengthening early detection through routine screening and comprehensive interventions—such as education on balanced nutrition, promotion of physical activity, and stress management—is essential. Cross-sector collaboration should also be reinforced by optimizing existing programs, including the Integrated Service Post for Non-Communicable Diseases, Elderly Service Post, Home Care, and the Chronic Disease Management Program, to ensure continuous monitoring and support for older adults. These findings provide novel evidence on the critical role of physical activity in preventing and managing T2DM in coastal populations and highlight the need for community-based nursing strategies tailored to this vulnerable group.

Declaration of Interest

There is no conflict of interest

Acknowledgment

The authors would like to express their gratitude to all volunteers who participated in this study and health workers at the Sampolawa PHCs who facilitated the data collection process in this study.

Funding. None

Data Availability. The datasets generated during and/or analyzed during the current study are available from the corresponding author on reasonable request.

References

Alharithy, M. K., Alobaylan, M. M., Alsugair, Z. O., & Alswat, K. A. (2018). Impact of family history of diabetes on diabetes control and complications. *Endocrine Practice, 24(*9), 773-779. https://doi.org/https://doi.org/10.4158/EP-2018-0071

American Diabetes Association (ADA). (2013). Diagnosis and Classification of Diabetes Mellitus. Diagnosis and Classification of Diabetes Mellitus

Audaya, I. R., Febriana, D., Yanti, S. V., & Hadi, N. (2022). Measurement of nutritional status in elderly with hypertension. *Idea Nursing Journal, 13*(1), 54-64.

Azadbakht, M., Taheri Tanjani, P., Fadayevatan, R., Froughan, M., & Zanjari, N. (2020). The prevalence and predictors of diabetes distress in elderly with type 2 diabetes mellitus. *Diabetes Research and Clinical Practice, 163,* 108133. https://doi.org/https://doi.org/10.1016/j.diabres.2020.108133

Central Statistics Agency (BPS). (2021). 2021 Elderly Population Statistics. https://www.bps.go.id/id/publication/2021/12/21/c3fd9f27372f6ddcf7462006/statistik-penduduk-lanjut-usia-2021.html

Central Statistics Agency (BPS). (2023). Elderly population statistics 2023.

Central Statistics Agency (BPS) of South Buton Regency. (2024). South Buton Regency in Figures 2024. https://buselkab.bps.go.id/id/publication/2024/02/28/d3deea151ec4d9d2f7781fc5/kabupaten-buton-selatan-dalam-angka-2024.html

Central Statistics Agency of Southeast Sulawesi Province. (2022). Statistics of the Elderly Population of Southeast Sulawesi Province 2022. https://sultra.bps.go.id/id/publication/2023/11/24/b6ea2ca510db17be44808d3c/statistik-penduduk-lanjut-usia--provinsi-sulawesi-tenggara-2022.html

Bellary, S., Kyrou, I., Brown, J. E., & Bailey, C. J. (2021). Type 2 diabetes mellitus in older adults: Clinical considerations and management. *Nature Reviews Endocrinology, 17*(9), 534-548. https://doi.org/10.1038/s41574-021-00512-2

Booth, F. W., Roberts, C. K., & Laye, M. J. (2012). Lack of exercise is a major cause of chronic diseases. *Compr Physiol, 2*(2), 1143-1211. https://doi.org/10.1002/cphy.c110025

Brown, R. B. (2020). Diabetes, diabetic complications, and phosphate toxicity: A scoping review. *Current diabetes reviews, 16*(7), 674-689. https://doi.org/10.2174/1573399815666191104113236

Cerdas Pérez, S. (2023). Menopause and diabetes. *Climacteric, 26*(3), 216-221. https://doi.org/10.1080/13697137.2023.2184252

Chentli, F., Azzoug, S., & Mahgoun, S. (2015). Diabetes mellitus in elderly. *Indian Journal of Endocrinology and Metabolism, 19*(6), 744-752. https://doi.org/10.4103/2230-8210.167553

Das, U., & Kar, N. (2023). Prevalence and risk factor of diabetes among the elderly people in West Bengal: Evidence-based LASI 1st wave. *BMC Endocrine Disorders, 23*(1), 170. https://doi.org/10.1186/s12902-023-01421-3

Dattani, S., & Rodés-Guirao, L. (2023). Why do women live longer than men? https://ourworldindata.org/why-do-women-live-longer-than-men

Elnaem, M. H., Bukhori, N. A. S., Tengku Mohd. Kamil, T. K., Rahayu, S., Ramatillah, D. L., & Elrggal, M. E. (2025). Depression and anxiety in patients with type 2 diabetes in Indonesia and Malaysia: Do age, diabetes duration, foot ulcers, and prescribed medication play a role? *Psychology, Health & Medicine, 30*(3), 555-571. https://doi.org/10.1080/13548506.2025.2450545

Gao, P., Yang, F., Ma, Q., Ma, B., Jing, W., Liu, J., Guo, M., Li, J., Wang, Z., & Liu, M. (2025). Prevalence and risk factors of type 2 diabetes mellitus among depression inpatients from 2005 to 2018 in Beijing, China. Health Data Science.

Guigoz, Y., Vellas, B. and Garry, P.J. (1994). Mini Nutritional Assessment: A practical assessment tool for grading the nutritional state of elderly patients. *Facts and Research in Gerontology, 4 (Suppl.2),* 15-59

Hao, Z., Huang, X., Liu, X., He, F., & Shao, H. (2022). Association analysis between different diabetic family history and gender with diagnosed age of type 2 diabetes mellitus: A cross-sectional study in Tianjin, China. *INQUIRY, 59,* 00469580221086364. https://doi.org/10.1177/00469580221086364

Huang, E. S. (2016). Management of diabetes mellitus in older people with comorbidities. *BMJ, 353*, i2200. https://doi.org/10.1136/bmj.i2200

Institute for Health Metrics and Evaluation (IMHE). (2024). Global life expectancy to increase by nearly 5 years by 2050 despite geopolitical, metabolic, and environmental threats: Reports new global study. Institute for Health Metrics and Evaluation. https://www.healthdata.org/news-events/newsroom/news-releases/global-life-expectancy-increase-nearly-5-years-2050-despite.

International Diabetes Federation. (2021). IDF Diabetes Atlas. https://diabetesatlas.org/idfawp/resource-files/2021/07/IDF_Atlas_10th_Edition_2021.pdf

Joseph, J. J., & Golden, S. H. (2017). Cortisol dysregulation: The bidirectional link between stress, depression, and type 2 diabetes mellitus. *Ann N Y Acad Sci, 1391*(1), 20-34. https://doi.org/10.1111/nyas.13217

Junaid, O. A., Ojo, O. A., Adejumo, O. A., Junaid, F. M., Ajiboye, K. J., Ojo, O. E., Akitikori, T. O., Kolawole, A. B., & Ikem, T. R. (2022). Malnutrition in elderly patients with type 2 diabetes mellitus in a Nigerian tertiary hospital: A cross-sectional study. *Dialogues in Health, 1,* 100030. https://doi.org/https://doi.org/10.1016/j.dialog.2022.100030

Kelly, J., Edney, K., Moran, C., Srikanth, V., & Callisaya, M. (2016). Gender differences in physical activity levels of older people with type 2 diabetes mellitus. *Journal of Physical Activity and Health, 13*(4), 409-415. https://doi.org/10.1123/jpah.2015-0147

Ministry of Health of the Republic of Indonesia. (2023). 2023 Indonesian Health Survey (SKI) in Figures. https://www.badankebijakan.kemkes.go.id/ski-2023-dalam-angka/

Coordinating Ministry for Human Development and Culture of the Republic of Indonesia. (2021). The government strives for health protection for the elderly: The elderly can age healthily. https://www.kemenkopmk.go.id/pemerintah-upayakan-perlindungan-kesehatan-bagi-lansia-agar-lansia-dapat-menua-dengan-sehat

Kikuti-Koyama, K. A., Monteiro, H. L., Ribeiro Lemes, Í., de Morais, L. C., Fernandes, R., Turi-Lynch, B., & Codogno, J. (2019). Impact of type 2 diabetes mellitus and physical activity on medication costs in older adults. *The International Journal of Health Planning and Management, 34*(4), e1774-e1782. https://doi.org/https://doi.org/10.1002/hpm.2892

Kim, H. J., An, S. Y., Han, S. J., Kim, D. J., Hong, C. H., Kim, Y. H., Shin, D. H., Kim, N. H., Seo, J. A., Ahn, Y. B., Ko, S. H., Cho, Y. W., Park, S. W., Kim, S. K., Kim, K. W., Kim, C. S., & Lee, K. W. (2019). The association of diabetes duration and glycemic control with depression in elderly men with type 2 diabetes mellitus. *J Res Med Sci, 24,* 17. https://doi.org/10.4103/jrms.JRMS_43_18

Kim, Y. T., Chung, H. J., Park, B. R., Kim, Y. Y., Lee, J. H., Kang, D. R., Kim, J.-Y., Lee, M. Y., & Lee, J. Y. (2020). Risk of cardiovascular disease and chronic kidney disease according to 2017 blood pressure categories in diabetes mellitus. *Hypertension, 76*(3), 766-775. https://doi.org/10.1161/HYPERTENSIONAHA.120.15320

Malik, F. A., Susanty, S., & Rustam, M. (2024). The relationship between adults, elderly, and smoking history with the incidence of adhesive capsulitis shoulder. *JKG (Jurnal Keperawatan Global),* 30-39. https://doi.org/10.37341/jkg.v9i1.901

Markle-Reid, M., Ploeg, J., Fraser, K. D., Fisher, K. A., Bartholomew, A., Griffith, L. E., Miklavcic, J., Gafni, A., Thabane, L., & Upshur, R. (2018). Community program improves quality of life and self-management in older adults with

diabetes mellitus and comorbidity. *Journal of the American Geriatrics Society, 66*(2), 263-273. https://doi.org/https://doi.org/10.1111/jgs.15173

Morley, J. E., Abbatecola, A. M., & Woo, J. (2017). Management of comorbidities in older persons with type 2 diabetes. *Journal of the American Medical Directors Association, 18*(8), 639-645. https://doi.org/10.1016/j.jamda.2017.05.006

Mutambudzi, M., & Javed, Z. (2016). Job strain as a risk factor for incident diabetes mellitus in middle and older age U.S. workers. *The Journals of Gerontology: Series B, 71*(6), 1089-1096. https://doi.org/10.1093/geronb/gbw091

Oktaviyani, P., Salman, S., Happy Nurmalita Sari, M., Frisilia, M., Munazar, M., Satria, A., & Maretalinia, M. (2022). Prevalence and risk factors of hypertension and diabetes mellitus among Indonesian elderly. *Makara Journal of Health Research.* https://scholarhub.ui.ac.id/mjhr/vol26/iss1/2

Rachmawati, U., Sahar, J., & Wati, D. N. K. (2019). The association of diabetes literacy with self-management among older people with type 2 diabetes mellitus: A cross-sectional study. *BMC nursing, 18,* 1-8. https://doi.org/10.1186/s12912-019-0354-y

Rajamanickam, A., Munisankar, S., Dolla, C. K., Thiruvengadam, K., & Babu, S. (2020). Impact of malnutrition on systemic immune and metabolic profiles in type 2 diabetes. *BMC Endocrine Disorders, 20*(1), 168. https://doi.org/10.1186/s12902-020-00649-7

Rashid, T., Zia, S., Mughal, S., Baloch, A. A., Abdul Rauf, M. U., & Hasan, S. M. (2025). Prevalence of malnutrition and associated factors among the elderly with type 2 diabetes using MNA form. *Journal of Nutrition and Metabolism, 2025*(1), 2107146. https://doi.org/10.1155/jnme/2107146

Sari, D. K., Wardani, I. M. K., Masyiyah, S., Samah, D. A., Alma, L. R., Katmawanti, S., & Ulfah, N. H. (2021). Correlation of marital status, family income, “grandiose” eating habits and consumption of fried foods with the risk of diabetes in early elderly women (46-55 years). *The Indonesian Journal of Public Health, 6*(2), 111. https//doi.org/10.17977/um044v6i22021p111-122

Sari, W. C. (2022). The relationship between family history, nutritional status, and physical activity with the incidence of hypertension in the elderly in Batu Belah Village, Air Tiris Community Health Center Work Area in 2022. Pahlawan Tuanku Tambusai University].

Sirirak, T., Sangsupawanich, P., Wongpakaran, N., & Srisintorn, W. (2022). The geriatric depression scale predicts glycemic control in older adult with type 2 diabetes mellitus: A longitudinal study. *Healthcare (Basel), 10*(10). https://doi.org/10.3390/healthcare10101990

Susanty, S., Chung, M. H., Chiu, H. Y., Chi, M. J., Hu, S. H., Kuo, C. L., & Chuang, Y. H. (2022). Prevalence of loneliness and associated factors among community-dwelling older adults in Indonesia: A cross-sectional study. *Int J Environ Res Public Health, 19*(8). https://doi.org/10.3390/ijerph19084911

Susanty, S., Mujahid, E., Suyanto, J., Sudayasa, I., & Chuang, Y. (2024). Older adults with predictors factors of depressive symptoms in the community of Indonesia: A cross sectional study. *Advances in gerontology= Uspekhi gerontologii, 37*(5), 525-531. https://doi.org/doi: 10.34922/AE.2024.37.5.006

Susanty, S., Nadirawati, N., Setiawan, A., Haroen, H., Pebrianti, S., Harun, H., Azissah, D., Suyanto, J., Sarasmita, M. A., Chipojola, R., Khwepeya, M., & Banda, K. J. (2025). Overview of the prevalence of loneliness and associated risk factors among older adults across six continents: A meta-analysis. *Archives of Gerontology and Geriatrics, 128,* 105627. https://doi.org/https://doi.org/10.1016/j.archger.2024.105627

Susanty, S., Sarasmita, M. A., Sudarma, I. W., Azissah, D., Suyanto, J., Kamil, S., Budiman, B., & Suharjiman, S. (2023). Animated video development COVID-19 prevention and management for anxiety among older adults in Indonesia. *Geriatr Nurs, 49,* 13-21. https://doi.org/10.1016/j.gerinurse.2022.10.015

Thaenpramun, R., Komolsuradej, N., Buathong, N., & Srikrajang, S. (2024). Association between glycaemic control and malnutrition in older adults with type 2 diabetes mellitus: a cross-sectional study. *British Journal of Nutrition, 131*(9), 1497-1505. https://doi.org/10.1017/S0007114524000175

Vellas, B., Guigoz, P., Garry, P., Ondervoeding, T., Bejaarden, P., Zorgverlener, A., Guigoz, Y., Vellas, B., & Garry, P. (2009). Mini Nutritional Assessment (MNA®). Actualiseren van de bestaande BeST–databank & Aanvullen van de bestaande BeST–databank met nieuwe schalen, 28.

Washburn, R. A., Smith, K. W., Jette, A. M., & Janney, C. A. (1993). The physical activity scale for the elderly (PASE): Development and evaluation. *Journal of Clinical Epidemiology, 46*(2), 153-162. https://doi.org/10.1016/0895-4356(93)90053-4

World Health Organization (WHO). (2024a). Ageing and health. https://www.who.int/news-room/fact-sheets/detail/ageing-and-health

World Health Organization (WHO). (2024b). Diabetes. https://www.who.int/health-topics/diabetes#tab=tab_1

World Health Organization (WHO). (2025). Ageing and health in the South-East Asia Region. https://www.who.int/southeastasia/health-topics/ageing

Yang, H., Wu, F., Gui, M., Cheng, Y., & Zhang, L.

(2023). The role of medication adherence in the association between depressive symptoms and quality of life in older adults with type 2 diabetes mellitus. *BMC Geriatrics, 23*(1), 196. https://doi.org/10.1186/s12877-023-03929-8

Yesavage, J. A., Brink, T. L., Rose, T. L., Lum, O., Huang, V., Adey, M., & Leirer, V. O. (1982). Development and validation of a geriatric depression screening scale: A preliminary report. *Journal of Psychiatric Research, 17*(1), 37-49. https://doi.org/https://doi.org/10.1016/0022-3956(82)90033-4