Association of Physical Activity, Sleep Quality, and Vegetable and Fruit Consumption with the Risk of Diabetes Mellitus: A Case-Control Study in Biak Numfor, Papua, Indonesia

Febry Istyanto*, Sophian Aswar

D-III Keperawatan Kampus Biak, Politeknik Kesehatan Kemenkes Jayapura, Papua, Indonesia

*Correspondence Address: febryistyanto@gmail.com

Article Info	ABSTRACT
	Diabetes Mellitus (DM) is a major metabolic disorder marked by elevated blood glucose levels, which can result in severe health complications. In Indonesia, DM ranks among the top non-communicable diseases (NCDs), highlighting a significant public health crisis. Specifically, the Biak Numfor District in Papua is experiencing a marked rise in DM cases, threatening community health. Recent studies indicate that lifestyle modifications, dietary practices, and limited healthcare access significantly contribute to the rising urgency of addressing diabetes mellitus (DM) in specific regions. This research seeks to evaluate the risk factors influencing the incidence of DM through a multiple linear regression analysis model. Data was gathered from both diagnosed DM patients and a healthy control group in the Subdistrict of Sumberker, with 35 cases and 35 controls selected from each population. In this study, DM is the dependent variable, while the independent variables include physical activity, sleep quality, and the consumption of vegetables and fruits.Multiple linear regression analysis was used to determine the contributing factors to the incidence of DM in units. The results showed that regular physical activity contributed -0.26 units (P Value < 0.001); poor sleep quality contributed 1.7 units (P Value = 0.039). Meanwhile, regular vegetable consumption contributed -5.335 units (P Value = 0.004), and regular fruit consumption contributed -5.08 units (P Value = 0.002). This study concludes that regular physical activity and vegetable and fruit consumption lower the risk of developing DM, while poor sleep quality increases it.

INTRODUCTION

Diabetes Mellitus, commonly known by the abbreviation DM, is a non-communicable disease (NCD) whose prevalence continues to rise globally, including in Indonesia (Kemenkes RI, 2018, 2019). This disease is characterized by disturbances in glucose metabolism caused by the body's inability to produce insulin adequately or the body's inability to use insulin effectively(Zheng, Ley and Hu, 2018; Ingrosso *et al.*, 2023). The impact of this disease is not limited to a decrease in individual quality of life, but also contributes to the economic burden and public health overall(Istyanto, 2023).

Biak Numfor Regency, as one of the regions in Papua, is experiencing an increase in the prevalence of DM, which requires special attention from various related parties(Dinas Kesehatan Biak Numfor, 2023; Parrangan, 2023). The risk factors contributing to the incidence of DM are diverse and involve interactions between genetic, lifestyle, and environmental factors. Several identified risk factors include obesity, infrequent fasting, lack of physical activity, unhealthy dietary patterns, and a family history of diabetes(Istyanto, 2023; Istyanto and Virgianti, 2023; Faswita, 2024).

The causes of diabetes mellitus are influenced by various factors, including genetic and environmental aspects. Unhealthy lifestyles, characterized by insufficient physical activity, poor sleep quality, and unbalanced diets, significantly contribute to the disease. Regular physical activity enhances insulin sensitivity and helps maintain normal blood glucose levels, while good sleep quality regulates metabolism and hormonal control related to appetite and weight management. Additionally, adequate intake of fruits and vegetables provides essential nutrients and supports the immune system, reducing the risk of metabolic diseases, including diabetes.

This study aims to investigate the relationship between physical activity, sleep quality, and fruit and vegetable consumption on the incidence of diabetes mellitus. This study is necessary because no previous research has examined this model with these variables in the Biak region, particularly using statistical analysis with multiple linear regression models.

METHODS

The research method used in this study is quantitative analytical observational research with a case-control epidemiological design. A case-control design was chosen for this study because it is particularly useful for investigating the association between potential risk factors (e.g., physical activity, sleep quality, fruit and vegetable consumption) and the incidence of diabetes mellitus. Before data collection in this study, informed consent was obtained from the respondents.

This design allows for the efficient identification of associations in populations where the outcome is less common, and it permits the analysis of multiple risk factors. Cases were identified as individuals diagnosed with diabetes mellitus, while controls were selected from the same population but without a diabetes diagnosis. Controls were matched on key variables such as age and gender to minimize confounding. This research was conducted in the Sumberker District, Biak Numfor Regency, in 2024. The population that served as the subjects of the study consisted of residents living in the Sumberker District. A sample of 70 respondents was obtained using the Fixed Disease Sampling (FDS) technique with a ratio of 1:1. In this case, there were 35 respondents with diabetes mellitus (DM) and 35 respondents with control status. The dependent variable in this study is diabetes mellitus, while the independent variables consist of four aspects: physical activity, sleep quality, vegetable consumption, and fruit consumption.

The dependent variable in this study is Diabetes Mellitus, categorized into two groups: cases and controls. Blood glucose levels for both cases and controls are measured based on the results of routine examinations. The independent variables in this study consist of physical activity, measured in minutes per week. Sleep quality is assessed using the Pittsburgh Sleep

Quality Index (PSQI) questionnaire. Vegetable and fruit consumption is measured by the average amount of vegetables and fruits consumed per week.

Statistical analyses will be conducted using multiple linear regression analyses (MLRA) to assess the relationship between the variables of interest (physical activity, sleep quality, and consumption of fruits and vegetables) and the incidence of diabetes mellitus. Statistical significance will be set at $p < 0.05$.

RESULTS

Table 1. Multiple Linear Regression Analysis (MLRA)

Diabetes Mellitus	Koefisien	*p-Value*	CI 95% (Min-Max)	
Physical Activity	-.2562283	0.000	-.3733658	-.1390907
Sleep Quality	1.69936	0.039	.0849183	3.313802
Vegetable Consumption	-5.335185	0.004	-8.883647	-1.786723
Fruit Consumption	-5.709838	0.002	-9.19788	-2.221797
R Squared Regression	0,7523 (75,23%)			
Adjusted R Squared Regression	0,7370 (73,70%)			

Source: Primary Data (Processed), 2024

Based on Table 1, Here's a concise summary of the multivariate regression analysis regarding the relationship between physical activity, sleep quality, and vegetable and fruit consumption on diabetes mellitus:

Regression Results

1. Physical Activity
   Increased physical activity is significantly associated with a reduced risk of diabetes.
2. Sleep Quality
   Poor sleep quality is significantly associated with an increased risk of diabetes.
3. Vegetable Consumption
   Higher vegetable consumption is significantly linked to a reduced risk of diabetes.
4. Fruit Consumption
   Higher fruit consumption is also significantly associated with a reduced risk of diabetes.

R Squared: 75.23%, indicating that the model explains a substantial portion of the variance in diabetes occurrence.

DISCUSSION

The results of the multivariate regression analysis reveal important relationships between lifestyle factors namely physical activity, sleep quality, vegetable consumption, and fruit consumption and the incidence of Diabetes Mellitus (DM). In this discussion, each of these factors is examined in detail, and relevant scientific literature is referenced to support the findings.

Increased physical activity is significantly related to a reduced risk of diabetes. Physical activity plays an important role in maintaining metabolic health, particularly through its effects

on body weight, insulin sensitivity, and glucose metabolism(Mukhtar *et al.*, 2025; Podraza-Farhanieh *et al.*, 2025). Engaging in regular physical activity helps with weight management and enhances the body's ability to utilize glucose effectively(Amerkamp *et al.*, 2025). Aerobic activity, which includes various types of physical movements such as walking, running, and swimming, has been shown to have significant positive effects on body health, especially in managing blood glucose levels(Puspasari and Sarita, 2025). Research indicates that by regularly participating in aerobic activities, individuals can experience significant reductions in blood glucose levels. This activity is beneficial not only for those who already have issues with blood sugar levels but also for those who wish to prevent the development of diabetes mellitus (DM) in the future. By lowering blood glucose levels, the risk of complications related to diabetes, such as heart disease, nerve damage, and vision problems, can also be significantly reduced. For example, walking for 10-30 minutes every day can improve insulin sensitivity and help the body use glucose more effectively(Hashimoto *et al.*, 2025). Furthermore, running and swimming, which are more intensive aerobic activities, can provide additional benefits in terms of calorie burning and overall fitness improvement. Thus, engaging in regular physical activity, especially in the form of aerobic exercise, is highly recommended as an effective preventive measure against diabetes mellitus and other health issues.

For instance, in Indonesia, rapid urbanization might lead to reduced availability of open spaces for physical activities, mitigating the potential benefits of exercise within communities. Moreover, variations in access to recreational facilities can considerably impact individuals' ability to engage in physical activities, underscoring the importance of public health initiatives tailored to promote physical activity in urban settings. Highlight the critical role of physical activity in maintaining metabolic health, particularly through its effects on body weight, insulin sensitivity, and glucose metabolism. Engaging in regular physical activity aids in weight management and enhances the body's ability to utilize glucose effectively. However, it is important to consider the contextual factors that may strengthen or moderate this relationship.

Poor sleep quality has a significant relationship with an increased risk of developing diabetes, and this correlation is a growing concern in today's fast-paced society. Sleep quality is not just about the number of hours spent in bed; it encompasses various factors, including the depth of sleep, the frequency of awakenings, and the overall restorative nature of the sleep experienced(Nelson, Davis and Corbett, 2022). Proper sleep quality plays a crucial role in maintaining optimal metabolic health, which is essential for the body's ability to effectively process glucose and manage energy(Kurnia, Mulyadi and Rottie, 2017; Novita, Alini and Syahda, 2024). When individuals experience poor-quality sleep, it can lead to various forms of metabolic dysfunction(Putra and Salsabila, 2025). One of the key physiological responses to sleep deprivation is an increase in the production of stress hormones, particularly cortisol. Elevated cortisol levels are linked to various health issues, including insulin resistance, which can impair the body's ability to utilize insulin effectively. Insulin sensitivity is critical for maintaining healthy blood sugar levels, and its decline can significantly increase the likelihood of developing type 2 diabetes. This comprehensive approach may involve lifestyle changes, such as establishing a regular sleep routine, creating a sleep-friendly environment, and incorporating relaxation techniques to enhance sleep quality and, consequently, metabolic health.

Additionally, sleep patterns in Indonesia may be influenced by cultural factors and socioeconomic conditions, which can lead to variations in sleep quality across different communities. For example, individuals in urban areas may experience more disturbances due to noise and light pollution, affecting their overall sleep quality.

Higher vegetable consumption is significantly linked to a reduced risk of diabetes. Vegetables are rich in dietary fiber, vitamins, and minerals while being low in calories, which makes them a crucial component of a healthy diet(Slavin and Lloyd, 2012). Fiber, in particular, plays a pivotal role in improving glucose tolerance and lowering insulin resistance. Furthermore, the antioxidants found in vegetables can reduce inflammation, contributing positively to overall metabolic health. Higher fruit consumption is also significantly associated with a reduced risk of diabetes. Like vegetables, fruits are high in dietary fiber, vitamins, and phytochemicals that may help in regulating blood sugar levels. Certain fruits, particularly those with low glycemic indices and high fiber content, can mitigate blood glucose spikes and improve insulin sensitivity(Slavin and Lloyd, 2012). The natural sugars in fruits, when consumed in whole form, are generally absorbed more slowly and lead to better glycemic outcomes.

However, it is essential to recognize that dietary habits are influenced by cultural and contextual factors. In Indonesia, the variety of vegetable consumption can be impacted by changing dietary practices due to urbanization and shifts in traditional eating habits. These shifts may highlight the need for nutrition education initiatives that encourage increased vegetable intake as part of a healthy lifestyle. Access to certain fruits and the evolving preferences in different regions of Indonesia can significantly affect consumption patterns. Therefore, it is important to consider local availability and cultural preferences when discussing fruit consumption and diabetes risk.

CONCLUSION

The findings of this study highlight critical lifestyle factors affecting the incidence of Diabetes Mellitus (DM). Engaging in physical activity and the regular consumption of vegetables and fruits are associated with a protective effect against the development of DM. Conversely, poor sleep quality is identified as a significant risk factor.

Given the findings of this study, it may be beneficial for future public health initiatives to focus on promoting physical activity and dietary habits that include higher vegetable and fruit consumption. Additionally, improving sleep quality could be an essential area of intervention. These suggestions are informed by the evidence demonstrated in this research and warrant further exploration within specific populations to tailor effective health promotion strategies aimed at reducing the prevalence of Diabetes Mellitus.

REFERENCES

Amerkamp, J. *et al.* (2025) 'Optimizing the lifestyle of patients with type 2 diabetes mellitus - Systematic review on the effects of combined diet-and-exercise interventions', *Nutrition, Metabolism and Cardiovascular Diseases*, 35(5), p. 103746. Available at: https://doi.org/10.1016/j.numecd.2024.09.016.

Dinas Kesehatan Biak Numfor (2023) 'Profil Kesehatan Kabupaten Biak Numfor Tahun 2022'.

Faswita, W. (2024) 'Hubungan Aktivitas Fisik Dengan Kadar Gula Darah Pada Pasien Diabetes Mellitus Tipe 2 di Puskesmas Binjai Estate', *Jurnal Ilmiah Keperawatan IMELDA*, 10(1), pp. 110–116. Available at: https://doi.org/10.52943/jikeperawatan.v10i1.1632.

Hashimoto, K. *et al.* (2025) 'Positive impact of a 10-min walk immediately after glucose intake on postprandial glucose levels', *Scientific Reports*, 15(1), p. 22662. Available at: https://doi.org/10.1038/s41598-025-07312-y.

Ingrosso, D.M.F. *et al.* (2023) 'Stress and Diabetes Mellitus: Pathogenetic Mechanisms and Clinical Outcome', *Hormone Research in Paediatrics*, 96(1), pp. 34–43. Available at: https://doi.org/10.1159/000522431.

Istyanto, F. (2023) *KONSEP DASAR EPIDEMIOLOGI*. 1st edn. Kab. Nganjuk, Jawa Timur: CV. Dewa Publishing. Available at: https://dewapublishing.com/book/konsep-dasar-epidemiologi/.

Istyanto, F. and Virgianti, L. (2023) 'Manfaat Dan Potensi Puasa Dalam Mencegah Risiko Penyakit Tidak Menular', 1(2).

Kemenkes RI (2018) 'Hasil Utama Riskesdas 2018'. Kementerian Kesehatan Republik Indonesia, Badan Penelitian dan Pengembangan Kesehatan. Available at: https://kesmas.kemkes.go.id/assets/upload/dir_519d41d8cd98f00/files/Hasil-riskesdas-2018_1274.pdf.

Kemenkes RI (2019) 'Buku Pedoman Manajemen Penyakit Tidak Menular'. Direktorat Jenderal Pencegahan dan Pengendalian Penyakit. Available at: https://p2ptm.kemkes.go.id/uploads/VHcrbkVobjRzUDN3UCs4eUJ0dVBndz09/2019/03/Buku_Pedoman_Manajemen_PTM.pdf.

Kurnia, J., Mulyadi, N. and Rottie, J. (2017) 'Hubungan Kualitas Tidur Dengan Kadar Glukosa Darah Puasa Pada Pasien Diabetes Melitus Tipe 2 di Rumah Sakit Pancaran Kasih GMIM Manado', *Jurnal Keperawatan*, 5(1). Available at: https://doi.org/10.35790/jkp.v5i1.14946.

Mukhtar, D. *et al.* (2025) 'The Impact of Resistance Training on Metabolic Health and Disease Prevention in Aging Populations', *Journal of the American Institute*, 2(4), pp. 534–546. Available at: https://doi.org/10.71364/5hg73n74.

Nelson, K.L., Davis, J.E. and Corbett, C.F. (2022) 'Sleep quality: An evolutionary concept analysis', *Nursing Forum*, 57(1), pp. 144–151. Available at: https://doi.org/10.1111/nuf.12659.

Novita, W., Alini and Syahda, S. (2024) 'Hubungan Kualitas Tidur Dengan Kadar Gula Darah Penderita Diabetes Melitus Tipe 2 di Desa Tarai Bangun Wilayah Kerja UPT Puskesmas Tambang', *Jurnal Pahlawan Kesehatan*, 1(1), pp. 222–229. Available at: http://journal.universitaspahlawan.ac.id/index.php/jpk/article/view/26587 (Accessed: 3 August 2024).

Parrangan, D. (2023) *Deteksi PTM, Dinkes Papua Kunjungi Biak Numfor*, *rri.co.id - Portal berita terpercaya*. Available at: https://www.rri.co.id/papua/kesehatan/193415/deteksi-ptm-dinkes-papua-kunjungi-biak-numfor (Accessed: 8 May 2023).

Podraza-Farhanieh, A. *et al.* (2025) 'Physical training reduces cell senescence and associated insulin resistance in skeletal muscle', *Molecular Metabolism*, 95, p. 102130. Available at: https://doi.org/10.1016/j.molmet.2025.102130.

Puspasari, S. and Sarita, F.R. (2025) 'The Effect of Aerobic Exercise on Blood Glucose Levels Among Patients with Type 2 Diabetes Mellitus: A Quasi-Experimental Study', *Medical-

Surgical Journal of Nursing Research, 4(1), pp. 23–30. Available at: https://doi.org/10.70331/jpkmb.v4i1.49.

Putra, A. and Salsabila, D. (2025) 'Relationship between sleep quality and the risk of metabolic syndrome in healthcare workers in hospitals', *TAMBUN-Thematic Analysis in Medical and Biomedical Understanding for the Nation*, 1(1), pp. 21–27. Available at: https://ejournal.cria.or.id/index.php/medical/article/view/298 (Accessed: 21 August 2025).

Slavin, J.L. and Lloyd, B. (2012) 'Health Benefits of Fruits and Vegetables1', *Advances in Nutrition*, 3(4), pp. 506–516. Available at: https://doi.org/10.3945/an.112.002154.

Zheng, Y., Ley, S.H. and Hu, F.B. (2018) 'Global aetiology and epidemiology of type 2 diabetes mellitus and its complications', *Nature Reviews. Endocrinology*, 14(2), pp. 88–98. Available at: https://doi.org/10.1038/nrendo.2017.151.