

HbA1c and Peripheral Sensory Loss in Relation to Diabetic Foot Screening Findings

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DOI : 10.22487/hjt.v12i4.2192

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Page : 602-610

Article History:

Received: 2026-01-20

Revised: 2026-09-29

Accepted: 2026-10-03

Published by:

Tadulako University,
Managed by Faculty of
Medicine.

Website :

<https://jurnal.fk.untad.ac.id/index.php/hjt/index>



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Abstract

Background: Diabetic foot screening complements glycemic monitoring in identifying complications and care needs among people with diabetes. **Objectives:** To examine associations of HbA1c and peripheral sensory loss with abnormal foot screening findings among Persadia members at PKU Muhammadiyah Gamping Hospital. **Methods:** This quantitative cross sectional study included 36 participants selected by total sampling. HbA1c measurement, 10 g monofilament examination, and standardized foot observation were performed. HbA1c was categorized as $<7\%$ or $\geq 7\%$. Frequencies, contingency tables, odds ratios with 95% confidence intervals, and two sided Fisher exact tests were analyzed. **Results:** Twenty seven participants had HbA1c $<7\%$, and 13 had abnormal foot screening findings. Abnormal findings occurred in 4 of 9 participants with HbA1c $\geq 7\%$ and 9 of 27 with HbA1c $<7\%$ (OR 1.60; 95% CI 0.34–7.46; $p=0.693$). Recalculation of the reported sensory loss table yielded OR 3.09 (95% CI 0.71–13.47; $p=0.153$), although the sensory loss table requires reconciliation with the descriptive neuropathy counts. **Conclusions:** Neither HbA1c category nor peripheral sensory loss showed a statistically significant association with abnormal foot screening findings. Glycemic monitoring and standardized foot assessment remain complementary components of diabetes care.

Keywords: Diabetic foot; Glycated hemoglobin; Peripheral neuropathy; Screening; Sensory loss.

Introduction

Diabetes requires sustained glycemic management and surveillance for complications. The International Diabetes Federation estimated 589 million adults aged 20 to 79 years with diabetes globally in 2024, including approximately 20.4 million in Indonesia; its projection for 2050 is 853 million globally¹. The World Health Organization reported 830 million people with diabetes in 2022 and a prevalence of 14% among adults aged at least 18 years². These estimates refer to different years and populations and should not be treated as interchangeable. Recent public

health literature emphasizes earlier detection and continuity of diabetes care³.

Diabetic foot disease involves interacting neurological, vascular, and mechanical factors. A clinical review describes loss of protective sensation, peripheral artery disease, and repeated pressure as important contributors to ulceration⁴. Diabetic neuropathy involves metabolic and vascular mechanisms affecting peripheral nerves⁵. Current American Diabetes Association recommendations support regular sensory and foot assessment⁶, while the International Working Group on the Diabetic Foot provides practical screening and prevention guidance^{7,8}. A hospital study in

Indonesia reported neuropathy among the complications of type 2 diabetes, supporting the relevance of local screening research⁹.

HbA1c describes glycemic exposure over approximately the preceding two to three months. Current recommendations use individualized glycemic goals¹⁰, particularly in older adults with differing functional and health status¹¹. Prospective evidence from UKPDS links glycemia with vascular complications¹², but an HbA1c category measured at one assessment does not establish the temporal pathway to nerve injury or ulceration. A neuropathy position statement also distinguishes clinical diagnosis from individual screening findings¹³. The gap addressed here is how a routinely available glycemic category relates to contemporaneous foot observations in a local diabetes association.

Monofilament testing offers a practical assessment of protective sensation, although diagnostic performance depends on the examination protocol and reference standard¹⁴. The PODUS collaboration evaluated prognostic factors using longitudinal data, illustrating the additional evidence needed for prediction of future ulcers¹⁵. This study instead aimed to describe HbA1c categories, peripheral sensory screening, and foot observation findings and to examine their bivariate associations among Persadia members at PKU Muhammadiyah Gamping Hospital. Its contribution is the combined assessment of laboratory and clinical screening variables in this community affiliated setting.

The findings are intended to inform the organization of foot assessment within continuing diabetes care. Evidence from *Healthy Tadulako Journal* addresses diabetes control behavior in Palu¹⁶, dietary compliance in Purwokerto¹⁷, and education addressing anxiety among patients with diabetic ulcers¹⁸. These distinct studies support attention to behavioral and patient education needs

alongside clinical examination. The present research concerns screening findings rather than the development, severity, or healing of confirmed ulcers.

Materials and Methods

Study Design

This quantitative correlational study used a cross sectional design at Persadia, PKU Muhammadiyah Gamping Hospital. HbA1c categories, peripheral sensory screening results, and foot observation findings were considered within the same study assessment. The reported dataset is identified as primary data from 2025. The design examines contemporaneous associations; no predictive model, temporal mediation analysis, or intervention effect was evaluated. Reporting follows the distinction between design, measurements, and observed outcomes emphasized by STROBE¹⁹.

Sample

The study included 36 people with diabetes who were members of Persadia at PKU Muhammadiyah Gamping Hospital. Total sampling was used among members meeting the stated eligibility criteria: diabetes, membership, an HbA1c examination, and willingness to participate. Participants unable to complete the examinations or with medical conditions preventing assessment were excluded. The analyzed sample included adults in the recorded age categories of 20 to 40 years, 40 to 60 years, and above 60 years. Accordingly, the population is described as adults with diabetes, predominantly older adults, rather than exclusively elderly participants.

Data Collection Technique

Data were obtained through structured interviews, laboratory records, and clinical examination. Demographic variables comprised age, sex, and education. Smoking, diabetes medication consumption, and physical activity were recorded as categorical interview

variables. Medication consumption is retained as a recorded yes or no response, and activity as a report of weekly activity; these categories do not quantify adherence, drug exposure, exercise intensity, or total weekly exercise duration.

HbA1c was obtained from laboratory results and classified as below 7% or at least 7%. These are analytical categories, not a declaration that the same treatment target is suitable for every participant^{10,11}. Accurate interpretation requires attention to the laboratory method and clinical factors affecting HbA1c, as described in the assay literature²⁰. Medication responses were recorded separately from HbA1c and were not used to infer adequate treatment, treatment withdrawal, or nonadherence.

Peripheral sensation was assessed with a 10 g monofilament. The recorded rule classified a participant as having a positive sensory screen if at least one tested point was not perceived. This binary result is described as peripheral sensory loss, rather than a graded neuropathy severity score or a definitive electrophysiological diagnosis. Published neuropathy guidance and diagnostic accuracy research provide the clinical rationale for sensory testing^{13,14}; they do not establish that a specific standardized protocol was followed in the present study.

Foot observation classified a participant as having an abnormal screening finding when at least one abnormality was recorded; the comparator had no recorded abnormality. The outcome is consistently named abnormal foot screening findings. It is not assigned an IWGDF risk grade, Wagner grade, incident ulcer diagnosis, or amputation outcome. Standardized foot risk assessment additionally considers protective sensation, vascular status, deformity, and ulcer history^{7,8}. The present operational outcome should be interpreted within its recorded observational definition.

Data Analysis Technique

Frequencies and percentages summarize the sample. For the two available 2×2 tables, row percentages describe the proportion with abnormal foot findings within each exposure category. Pearson chi square statistics without continuity correction and expected frequencies were recalculated. One of four expected frequencies was below five in each comparison, so a two sided Fisher exact test is used for inference. The significance threshold was 0.05. Unadjusted odds ratios (ORs) accompany approximate 95% confidence intervals (CIs), calculated by exponentiating the log OR plus or minus 1.96 times the square root of the sum of the reciprocals of the four cell frequencies. Estimates and uncertainty are reported in accordance with SAMPL priorities²¹.

Recalculations use the cell counts explicitly reported in the manuscript and do not reconstruct individual records. The sensory loss comparison is identified as provisional because its exposure totals differ from the descriptive neuropathy totals. The HbA1c versus neuropathy comparison cannot be recalculated without its contingency table; the previously stated $p = 0.001$ is therefore not used as a study finding. No covariate adjusted estimates or mediation effects are asserted.

Ethical Consideration

Ethical approval was obtained from the Research Ethics Commission of PKU Muhammadiyah Yogyakarta Hospital under reference 00263/KT.7.4/VII/2025. Participants received an explanation of the objectives and procedures and signed informed consent before data collection. Participant information was kept confidential and used for research purposes.

Result

Thirty six participants were analyzed. Twenty six (72.2%) were above 60 years, nine (25.0%)

were in the recorded 40 to 60 year category, and one (2.8%) was in the recorded 20 to 40 year category. Women comprised 30 participants (83.3%). The distribution describes the recruited membership and does not estimate a

sex specific relative risk of diabetes or foot disease. Table 1 reports the available characteristics using the full sample denominator.

Table 1. Recorded respondent characteristics (N = 36)

Variable	Recorded category	n	%
Age	20 to 40 years	1	2.8
	40 to 60 years	9	25.0
	Above 60 years	26	72.2
Sex	Women	30	83.3
	Men	6	16.7
Education	College	18	50.0
	High school	17	47.2
	Other recorded education category	1	2.8
Medication consumption	No	29	80.6
	Yes	7	19.4
Smoking	No	33	91.7
	Yes	3	8.3
Physical activity	Reported weekly activity	35	97.2
	No reported weekly activity	1	2.8

Note: Percentages use N = 36.

HbA1c was below 7% in 27 participants (75.0%) and at least 7% in nine (25.0%). Abnormal foot screening findings were recorded in 13 participants (36.1%), and no abnormality was recorded in 23 (63.9%). The

descriptive source gives nine positive neuropathy screens, whereas the available sensory loss contingency table totals 11. A single reconciled sensory loss prevalence is therefore not assigned in Table 2.

Table 2. HbA1c categories and foot observation findings (N = 36)

Variable	Category	n	%
HbA1c	Below 7%	27	75.0
	At least 7%	9	25.0
Foot observation	Abnormal screening finding	13	36.1
	No recorded abnormality	23	63.9

Note: Percentages use N = 36.

Abnormal findings occurred in 4 of 9 participants (44.4%) with HbA1c at least 7% and 9 of 27 (33.3%) with HbA1c below 7%. The OR was 1.60 (95% CI 0.34 to 7.46); Fisher $p = 0.693$. Pearson χ^2 was 0.361 with one degree of freedom ($p = 0.548$), reproducing the original HbA1c comparison, but the exact test

is preferred because of the small expected frequency.

The reported sensory loss table contains 6 participants with abnormal findings and 5 without among 11 positive screens, compared with 7 and 18 among 25 negative screens. Recalculation gives OR 3.09 (95% CI 0.71 to 13.47), Fisher $p = 0.153$, and Pearson $\chi^2 = 2.333$

(one degree of freedom; $p = 0.127$). Thus, $p = 0.028$ is not reproduced from those counts. Table 3B provides the calculation transparently

pending confirmation of the underlying neuropathy classification.

Table 3. Association of HbA1c category and peripheral sensory screening with foot observation findings

Variable	Category	Abnormal n (%)	No abnormality n (%)	Total	OR (95% CI)	Fisher exact p	Pearson χ^2 (p)
HbA1c category	At least 7%	4 (44.4)	5 (55.6)	9	1.60 (0.34–7.46)	0.693	0.361 (0.548)
	Below 7%	9 (33.3)	18 (66.7)	27			
	Total	13	23	36			
Peripheral sensory screening	Positive	6 (54.5)	5 (45.5)	11	3.09 (0.71–13.47)	0.153	2.333 (0.127)
	Negative	7 (28.0)	18 (72.0)	25			
	Total	13	23	36			

Data are presented as n (%), with percentages calculated within rows. For HbA1c category, expected counts were 3.25, 5.75, 9.75, and 17.25. For peripheral sensory screening, expected counts were 3.972, 7.028, 9.028, and 15.972. OR, odds ratio; CI, confidence interval.

Figure 1 displays the proportion with abnormal foot findings within each HbA1c category. Counts are shown with denominators so that the unequal group sizes remain explicit. Sensory screening is not plotted before the discrepant category totals are reconciled.

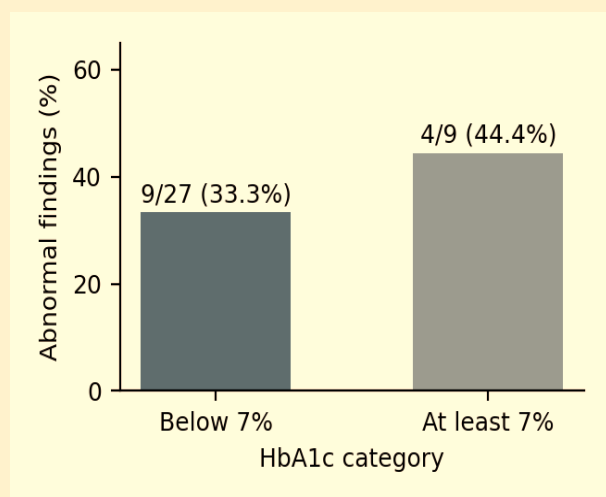


Figure 1. Abnormal foot findings by HbA1c category. Bars show observed proportions, not incident ulcer rates.

The sample consisted predominantly of older adults and women, and 36.1% had abnormal foot observation findings. HbA1c category was not statistically associated with these findings in the exact test. The provisional

sensory loss comparison also did not meet the statistical threshold, and its classification totals require verification. The available results do not establish a mediating pathway or predict future ulceration.

Discussion

Interpretation of Key Findings. Abnormal foot observations were present even among participants with HbA1c below 7%, supporting the clinical importance of examining the feet alongside glycemic monitoring. The HbA1c OR of 1.60 has a wide confidence interval and should not be interpreted as evidence of equivalence between categories. The provisional sensory screening OR is compatible with a broad range of associations. A binary monofilament screen addresses protective sensation rather than the full clinical spectrum of diabetic neuropathy^{5,13,14}. The observed data do not demonstrate a biochemical mechanism, causal sequence, or mediation effect.

Comparison with Previous Studies. Handayani and colleagues reported neuropathy and associations of HbA1c with complications in hospital patients with type 2 diabetes⁹; their population and outcome differ from the membership based foot screening assessment

here. Prospective UKPDS findings concern glycemic exposure and vascular outcomes over time¹², while PODUS used longitudinal cohorts to evaluate future ulceration¹⁵. These studies explain why a contemporaneous HbA1c category may provide different information from an accumulated complication history. Hardayanti and colleagues examined diabetes control behavior and glucose levels¹⁶, and Putri and colleagues described dietary compliance¹⁷, providing local context for recording care behaviors without assuming that this study measured their effects.

Clinical and Public Health Implications. Current guidelines recommend integrating glycemic care with sensory assessment, vascular evaluation, inspection, and education^{6,7,8}. A scoping review based on the health belief model addresses behavioral factors in neuropathy detection²². Physical activity and dietary intervention research likewise supports consideration of lifestyle within diabetes care, while emphasizing appropriate outcome measurement²³. Manggasa and colleagues studied education using wound photographs to address anxiety among patients with established ulcers¹⁸; this informs patient communication rather than demonstrating ulcer prevention in the present sample. A Cochrane review distinguishes educational gains from demonstrated reductions in ulcer incidence²⁴. Footwear and home temperature monitoring trials further show that preventive effects depend on the intervention and adherence^{25,26}. These are external clinical considerations; this study did not measure footwear use, anxiety, treatment response, ulcer healing, or amputation.

Advantages and Limitations. The combined laboratory and clinical assessment provides a practical view of screening needs in an accessible diabetes association. Total sampling included 36 eligible members, with clearly reported denominators. The small

sample and cross sectional design limit precision and temporal inference; the unadjusted comparisons do not account for vascular status, diabetes duration, prior ulceration, or foot care behavior. The recorded foot observation rule is broader than an incident ulcer endpoint. Reconciliation of neuropathy coding and confirmation of examination details are necessary to complete the reproducibility record. Accurate assay documentation and transparent observational reporting provide the appropriate framework for those checks^{19,20}.

Recommendations for Future Research. A prospective study should use a prespecified and reproducible sensory examination, a validated foot risk classification, and follow up for incident ulcers. HbA1c measurements should be linked to examination dates, with treatment exposure and activity measured using explicit recall periods and thresholds. Analyses should estimate associations with confidence intervals and account for clinically justified covariates²¹. A larger sample could evaluate whether combined glycemic, neurological, and vascular measures improve risk assessment beyond the individual measurements, using longitudinal prognostic methods such as those evaluated by PODUS¹⁵.

Conclusion

Among 36 Persadia members with diabetes, 13 had abnormal foot observation findings. HbA1c category was not statistically associated with these findings using a two sided Fisher exact test. The recalculated sensory loss comparison is provisional pending reconciliation of the source counts and does not establish a significant association from the available table. These findings highlight the importance of interpreting nonsignificant associations cautiously, particularly in studies with small sample sizes and limited statistical power. The study supports attention to both glycemic monitoring and standardized foot

assessment, without claiming prediction, mediation, or prevention of amputation.

Acknowledgment

The authors thank the Ministry of Higher Education, Science, and Technology (Kemdiktisaintek), Republic of Indonesia, for support through the Fundamental Research Grant Scheme, Decree 0070/C3/AL.04/2025 and contracts 126/C3/DT.05.00/PL/2025 and 0498.17/LL5-INT/AL.04/2025. The authors acknowledge PKU Muhammadiyah Gamping Hospital, participating Persadia members, medical personnel, and the research team for their assistance.

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Conflict of Interest Statement

The author(s) declare no commercial, financial, or personal conflicts of interest related to this research. All authors approved the final manuscript and consented to its publication in *Healthy Tadulako Journal*.

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