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**Original Research Article**

# Educational attainment as a predictor of diabetic foot disease: a quasi-experimental baseline analysis among type 2 diabetics in Kiambu, Kenya

**Onesmus Mugo[1]*, John Gachohi[1], Susan Mambo[2], Elizabeth Mitaki[3]**

[1]Department of Environmental Health and Disease Control, Jomo Kenyatta University of Agriculture and Technology, Juja, Kenya
[2]School of Public Health, Jomo Kenyatta University of Agriculture and Technology, Juja, Kenya
[3]College of Health Sciences, Jomo Kenyatta University of Agriculture and Technology, Juja, Kenya

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***Correspondence:**
Onesmus Mugo,
E-mail: onesblessed53@gmail.com



## ABSTRACT

**Background:** Diabetic foot disease is a chronic complication of diabetes mellitus, often overlooked and missed due to under-reporting of symptoms or the omission of routine foot examinations during diabetic clinic visits. This study sought to evaluate the individual-level factors that predispose to diabetic foot disease among patients with type 2 diabetes.

**Methods:** A quasi-experimental study design was employed. A total of 188 respondents were engaged via the administration of a semi-structured questionnaire to collect data on their individual-level factors, such as sociodemographic characteristics and behavioral habits, like cigarette smoking, alcohol drinking, co-morbid conditions like hypertension, and their foot care practices. Central tendency measures were calculated in descriptive analysis. Univariate and multivariable analyses were carried out to reveal predictors significant at 95% confidence interval ($p<0.05$). Multivariable analysis was preceded by selecting specific variables using multicollinearity tests and forward stepwise selection based on the Akaike information criterion, followed by computing the coefficients to adjust for confounding factors.

**Results:** The level of education was statistically significant, $p=0.004$ and $p=0.006$ at univariate and multivariable analysis, respectively.

**Conclusions:** The study concluded that the level of education was the single most important predictor for diabetic foot disease among type 2 diabetic patients, affecting the behavioral and clinical factors of a type 2 diabetic patient, leading to the development of diabetic foot disease. The study recommended the design of diabetic health education and promotive programs in a language that is cognizant of the low level of education amongst the diabetic patients attending the diabetic clinics.

**Keywords:** Diabetic foot disease, Education attainment, Individual level factors, Type 2 diabetes mellitus

## INTRODUCTION

Diabetic foot disease (DFD) describes infection, ulceration, or degeneration of the foot's tissues in a diabetic's lower extremities that is linked to peripheral artery disease and/or neuropathy.[1] Most risk factors for diabetic foot problems are associated with lifestyle choices and foot care, with health system interventions being effective strategies in the prevention of these medical conditions and the reduction of their severity.[2]

An estimated 15% of diabetic patients may develop diabetic foot disease, which is a devastating part of the disease's progression and causes more than 80,000 amputations annually in America, where certain research suggests a lifetime risk of developing diabetic foot disease of up to 68 per 1,000 people.[3] Data indicate that 40-60% of lower limb non-traumatic amputations worldwide are associated with diabetes.[4] About 25% of diabetics will get diabetic foot disease at some point in their lives, with 70% of ulcers recurring within five years, and foot ulcers can precede up to 85% of amputations in diabetics.[5] After having one lower limb amputated due to diabetes, individuals have a 50% chance of developing a serious lesion in the remaining limb within two years. Additionally, the death rate for these patients is 70% in the five years after the initial amputation and 74% in the two years if they are under renal therapy.[5]

Diabetic foot ulcers are increasingly prevalent in sub-Saharan Africa due to various factors, including delayed diagnoses, low patient awareness, and restricted access to diabetes care. These ulcers negatively impact an individual's physical, mental, and social quality of life while heightening the risk of lower limb amputations. Furthermore, individuals affected by diabetic foot disease face considerable financial burdens and a diminished quality of life regarding their health.[6] The estimated burden of diabetic foot ulceration, a major type of diabetic foot disease, in Africa is between 7.2% and 13.0%.[7] Diabetic foot disease is more common, with approximately 7.2% prevalence rates in Africa (with sub-Saharan Africa having a significant burden), a continent with limited resources and disjointed health systems, which contributes a significant cause of hospitalization and death due to its high burden.[8] Considering the rapidly rising prevalence of diabetes on the continent, it is anticipated that the impact of diabetic foot disease will grow in Africa. The extent of diabetic foot disease in Kenya, particularly at the county level, has not been thoroughly examined in the existing literature. A prevalence of 9.04% was recently documented in Nyeri Level 5 Hospital.[7] The objective of this study was to evaluate the individual-level factors that are associated with the development of diabetic foot disease among type 2 diabetic patients in Kiambu County.

## METHODS

The study was carried out in Kiambu County employing a quasi-experimental design with a quantitative approach. The design comprised two arms: the intervention arm (diabetic patients who received regular diabetic advice at the diabetic clinic plus care-led education as the intervention) and the control arm (diabetic patients who received regular diabetic advice at the diabetic clinic). The quasi-experiment was designed to include one pre-intervention and one post-intervention survey, 6 months apart, with a study period from January 2025 to June 2025. The independent variables included sociodemographic characteristics, clinical factors such as glycemic levels, duration of diabetes mellitus, compliance with diabetic medicines, compliance with scheduled clinic follow-up and behavioral factors such as alcohol drinking and cigarette smoking. The dependent variable was the incidence of diabetic foot disease. The study population included patients diagnosed with type 2 diabetes mellitus who were on follow-up in the diabetes clinics in Kiambu County, and excluded patients who were clinically unstable and bilaterally amputated type 2 diabetic patients. Fleiss 1981 formula was employed for sample size determination.

The study selected Thika Level 5 County Referral Hospital as the intervention site and Kiambu Level 5 County Referral Hospital diabetic clinic as the control site. Systematic random sampling was used to select the study respondents at Thika Level 5 Hospital and Kiambu Level 5 County Referral Hospital, where diabetic clinics are operational daily. Semi-structured questionnaires were utilized to collect data from the research respondents. Two research assistants who speak English and Kiswahili fluently were trained to assist the researcher in collecting data from the study respondents using the questionnaires. The study's validity was established through the use of well-elaborated semi-structured questionnaires to meet the research objectives, pretesting of the tools at a different level 5 hospital, and evaluation by diabetic and statistical experts. Reliability was enhanced by the utilization of trained research assistants and double-checking the information from the respondents to get accurate data. The English interview guide was translated into Swahili to facilitate interviews being conducted in either of the languages amongst the study respondents, as deemed fit by the researcher. Interviews were conducted both in Swahili and English, though the interview guide was in English. The principal researcher randomly went through the filled questionnaires and the recordings to check for completeness and accuracy. The pretesting of tools was also done to identify any problems with the questionnaires and correct them appropriately. Descriptive statistics, such as means, standard deviations, and percentages, were used in SPSS to summarize and describe the data for this study. Univariate and multivariable analyses were utilized to draw inferences about the associations of independent and dependent variables. Multicollinearity tests and forward selection for multivariable modeling, monitoring changes in variable inclusion and conceptual framework input were utilized. The effectiveness of the intervention was measured using double-difference methods in the intervention and control groups.

Ethical approval for this study was obtained from the University of Eastern Africa, Baraton (reference number-B0215102024) with a research license obtained from the National Commission for Science, Technology and Innovation (NACOSTI/P/24/41671). Written informed consent was obtained from all study participants before participation.

## RESULTS

### *Description of the study participants*

The study enrolled 98 participants in the intervention group and 90 participants in the control group from diabetic clinics in Kiambu County. Both groups comprised type 2 diabetic patients attending regular clinic services.

The intervention group had a mean age of 59.9 years (SD: 15.0) while the control group had a mean age of 56.6 years (SD: 14.5). Compared to males, females had a higher proportion in the study in both the intervention group (70.4%) and control group (71.1%).

**Table 1: Demographic characteristics of study participants.**

| Variables | Category | Intervention (%) | Control (%) | P value |
|---|---|---|---|---|
| **Age (years)** | <40 | 10 (10.2) | 11 (12.2) | 0.2063 |
| | 40-50 | 15 (15.3) | 24 (26.7) | |
| | 50-60 | 27 (27.6) | 18 (20.0) | |
| | >60 | 46 (46.9) | 37 (41.1) | |
| **Age (years)** | Mean±SD | 59.9±15.0 | 56.6±14.5 | 0.1217 |
| **Sex** | Female | 69 (70.4) | 64 (71.1) | 1.0000 |
| | Male | 29 (29.6) | 26 (28.9) | |
| **Diabetes duration (years)** | <5 | 39 (39.8) | 48 (53.3) | 0.1753 |
| | 5-10 | 29 (29.6) | 24 (26.7) | |
| | 10-15 | 16 (16.3) | 7 (7.8) | |
| | >15 | 14 (14.3) | 11 (12.2) | |
| **Education level** | No formal schooling | 19 (19.4) | 5 (5.6) | 0.0064 |
| | Primary school | 50 (51.0) | 49 (54.4) | |
| | Secondary school | 17 (17.3) | 29 (32.2) | |
| | College/University | 12 (12.2) | 7 (7.8) | |
| **Marital status** | Currently married | 61 (62.2) | 61 (67.8) | 0.2384 |
| | Never married | 5 (5.1) | 7 (7.8) | |
| | Separated/divorced | 8 (8.2) | 10 (11.1) | |
| | Widowed | 24 (24.5) | 12 (13.3) | |
| **Residence type** | Peri urban area | 0 (0.0) | 16 (17.8) | 0.0000 |
| | Rural area | 41 (41.8) | 40 (44.4) | |
| | Urban area | 57 (58.2) | 34 (37.8) | |
| **Work status** | Not employed | 30 (30.6) | 25 (27.8) | 0.8195 |
| | Private (formal) | 9 (9.2) | 6 (6.7) | |
| | Private (informal) | 57 (58.2) | 56 (62.2) | |
| | Public | 2 (2.0) | 3 (3.3) | |
| **Religion** | Christian | 97 (99.0) | 89 (98.9) | 1.0000 |
| | Islam | 1 (1.0) | 1 (1.1) | |
| **Diabetes duration (years)** | Mean±SD | 9.0±7.7 | 7.2±7.4 | 0.1011 |
| **Systolic BP** | Mean±SD | 140.0±23.4 | 140.0±22.5 | 0.9919 |
| **Diastolic BP** | Mean±SD | 77.6±11.7 | 83.3±10.0 | 0.0004 |

In both groups, more than half of the study participants (51.0% in the intervention group and 54.4% in the control group) had completed primary school. The majority of participants in both groups identified as Christians (99% in the intervention group and 98.9% in the control group). The type of residence in the two groups exhibited some difference with the bigger proportion in the intervention group (58.2%) being urban dwellers while the bigger proportion of participants in the control group (44.4%) being rural residents The mean diabetes duration and standard deviation was 9.0±7.7 years in the intervention group and 7.2±7.4 years in control group with a bigger proportion of the study participants having a diabetic duration of less than 5 years (39.8% in the intervention group and 53.3% in the control group).

### *Univariate associations of individual-level factors with diabetic foot disease among type 2 diabetic study participants in Kiambu County*

Education level (p=0.004) was statistically significant in its association with the development of diabetic foot disease among the diabetic study participants. The other variables were not statistically significant (p>0.05).

Amongst the other factors, chronic kidney disease expressed a high odd (OR=3.75) for the development of DFD, but statistically significant as a predictor for diabetic foot disease (p=0.1667).

**Table 2: Univariate associations of individual-level factors with diabetic foot disease among type 2 diabetic study participants in Kiambu County.**

| Variables | Category | DFD Cases | AOR | 95% CI | P value |
|---|---|---|---|---|---|
| **Study site** | Control | 11/90 | 1.00 (Ref) | – | 0.947 |
| | Intervention | 13/98 | 1.03 | 0.43-2.46 | |
| **Age in years** | <55 | 5/74 | 1.00 (Ref) | – | 0.114 |
| | 55-64 | 9/50 | 3.02 | 0.95-9.65 | |
| | ≥65 | 10/64 | 2.55 | 0.82-7.92 | |
| **Sex** | Female | 18/133 | 1.00 (Ref) | – | 0.618 |
| | Male | 6/55 | 0.78 | 0.29-2.09 | |
| **Education level** | No formal | 6/24 | 1.00 (Ref) | – | 0.004 |
| | Primary | 16/99 | 0.55 | 0.18-1.66 | |
| | Secondary | 2/65 | 0.09 | 0.02-0.50 | |
| **Marital status** | Without Partner | 9/54 | 1.00 (Ref) | – | 0.327 |
| | With Partner | 15/134 | 0.63 | 0.26-1.56 | |
| **Employment status** | Not Employed | 10/55 | 1.00 (Ref) | – | 0.166 |
| | Employed | 14/133 | 0.53 | 0.22-1.28 | |
| **Residence type** | Rural | 10/81 | 1.00 (Ref) | – | 0.885 |
| | Urban | 14/107 | 1.07 | 0.45-2.54 | |
| **Diabetes duration** | <5 years | 6/72 | 1.00 (Ref) | – | 0.145 |
| | >=5 years | 18/116 | 2.02 | 0.75-5.43 | |
| **Presence of comorbidities** | No | 6/59 | 1.00 (Ref) | – | 0.472 |
| | Yes | 18/129 | 1.42 | 0.53-3.81 | |
| **Regular doctor foot examination** | No | 14/97 | 1.00 (Ref) | – | 0.480 |
| | Yes | 8/71 | 0.59 | 0.14-2.52 | |
| **Chronic kidney disease** | No | 21/179 | 1.00 (Ref) | – | 0.101 |
| | Yes | 3/9 | 3.75 | 0.87-16.14 | |
| **Dyslipidemia** | No | 21/162 | 1.00 (Ref) | – | 0.802 |
| | Yes | 3/26 | 0.85 | 0.23-3.14 | |
| **Systolic BP ≥140** | No | 14/98 | 1.00 (Ref) | – | 0.519 |
| | Yes | 10/90 | 0.75 | 0.32-1.79 | |
| **Diastolic BP ≥90** | No | 20/150 | 1.00 (Ref) | – | 0.659 |
| | Yes | 4/38 | 0.77 | 0.24-2.46 | |
| **Cigarette use** | No | 23/173 | 1.00 (Ref) | – | 0.429 |
| | Yes | 1/15 | 0.47 | 0.06-3.73 | |
| **Alcohol use** | No | 22/160 | 1.00 (Ref) | – | 0.282 |
| | Yes | 2/28 | 0.46 | 0.10-2.12 | |
| **Walks barefoot** | No | 14/131 | 1.00 (Ref) | – | 0.208 |
| | Yes | 10/57 | 1.77 | 0.74-4.28 | |
| **Regular clinical follow-up** | No | 14/97 | 1.00 (Ref) | – | 0.480 |
| | Yes | 8/71 | 0.59 | 0.14-2.52 | |
| **Daily foot self-examination** | No | 12/111 | 1.00 (Ref) | – | 0.338 |
| | Yes | 12/77 | 1.52 | 0.65-3.60 | |
| **Aware of proper footwear** | No | 11/92 | 1.00 (Ref) | – | 0.671 |
| | Yes | 13/96 | 1.22 | 0.49-3.04 | |
| **Daily medicine adherence** | No | 3/34 | 1.00 (Ref) | – | 0.436 |
| | Yes | 21/154 | 1.62 | 0.45-5.79 | |
| **Good foot care knowledge** | No | 19/157 | 1.00 (Ref) | – | 0.458 |
| | Yes | 5/31 | 1.58 | 0.48-5.18 | |

***Multivariate associations of individual-level factors with diabetic foot disease among type 2 diabetic study participants in Kiambu County***

Adjusted odds ratios were computed for each predictor. This was preceded by selecting specific variables using multicollinearity tests and forward stepwise selection based on the Akaike information criterion (AIC), followed by computing the coefficients to adjust for confounding factors. Education level (p=0.006) was found to be a predictor of diabetic foot disease after adjusting for confounders (p<0.05). Daily medication adherence (AOR=2.94), dyslipidemia (AOR=0.32), and daily self-foot examination (AOR=2.21) were found to be counterintuitive, despite p-values greater than 0.05 (p>0.05).

**Table 3: Multivariate associations of individual-level factors with diabetic foot disease among type 2 diabetic study participants in Kiambu County.**

| Variables | Category | N (DFD/Total) | AOR | 95% CI | P value |
|---|---|---|---|---|---|
| **Age in years** | <55 | 5/66 | 1.00 (Ref) | – | 0.176 |
| | 55-64 | 9/45 | 3.39 | 0.88-13.11 | |
| | ≥65 | 8/57 | 1.71 | 0.37-7.95 | |
| **Sex** | Female | 16/119 | 1.00 (Ref) | – | 0.931 |
| | Male | 6/49 | 1.06 | 0.30-3.74 | |
| **Study site** | Control | 10/80 | 1.00 (Ref) | – | 0.621 |
| | Intervention | 12/88 | 0.66 | 0.13-3.45 | |
| **Education level** | No formal | 5/23 | 1.00 (Ref) | – | **0.006** |
| | Primary | 15/90 | 0.61 | 0.14-2.74 | |
| | Secondary | 2/55 | 0.07 | 0.01-0.57 | |
| **Regular clinical follow-up** | No | 14/97 | 1.00 (Ref) | – | 0.498 |
| | Yes | 8/71 | 0.57 | 0.11-2.91 | |
| **Walks barefoot** | No | 13/119 | 1.00 (Ref) | – | 0.063 |
| | Yes | 9/49 | 2.87 | 0.95-8.68 | |
| **Daily foot self-examination** | No | 10/94 | 1.00 (Ref) | – | 0.127 |
| | Yes | 12/74 | 2.21 | 0.79-6.20 | |
| **Dyslipidemia** | No | 20/144 | 1.00 (Ref) | – | 0.140 |
| | Yes | 2/24 | 0.32 | 0.06-1.67 | |
| **Daily medicine adherence** | No | 2/26 | 1.00 (Ref) | – | 0.186 |
| | Yes | 20/142 | 2.94 | 0.52-16.73 | |
| **Marital status** | Without Partner | 7/50 | 1.00 (Ref) | – | 0.392 |
| | With Partner | 15/118 | 1.75 | 0.48-6.36 | |
| **Diabetes duration** | <5 years | 6/66 | 1.00 (Ref) | – | 0.185 |
| | ≥5 years | 16/102 | 2.23 | 0.66-7.50 | |

## DISCUSSION

The results reveal important insights into the complex interplay of socio-demographic, clinical, and behavioral determinants of diabetic foot disease (DFD) among adults with type 2 diabetes in Kiambu County. The absence of significant differences in age and sex between intervention and control groups suggests that these demographic characteristics were balanced at baseline; yet, nuanced patterns in risk markers and behaviors emerged when examined in relation to diabetic foot outcomes.

The most salient finding across both univariate and multivariate analyses is the protective association between education level and DFD. In both univariate and multivariate models, individuals with secondary education had significantly lower odds of DFD compared to those with no formal schooling (univariate OR 0.09; multivariate AOR 0.07). Additionally, the level of education emerged as a significant predictor for DFD at the univariate analysis (p=0.004) and at the multivariate analysis (p=0.006) owing to the p values of <0.005. This pattern reflects a well-established theoretical framework in public health, which suggests that formal education enhances health literacy, which in turn facilitates recognition of risk factors, adoption of preventive behaviors, and effective use of healthcare services. Education operates as a structural determinant influencing DFD risk beyond proximal biomedical variables.

The level of education likely influences multiple pathways that reduce foot disease risk. People with a higher level of education are more capable of understanding chronic disease trajectories, interpreting clinical advice, and implementing self-care routines. Self-care routines include aspects such as regular foot inspection, proper hygiene, the importance of glycemic controls, a heightened understanding of diabetes as a chronic disease, and the appropriate selection of footwear. Low education level may also limit patients' ability to interpret health messages, medication instructions, and clinic advice, thereby impairing adherence to long-term self-management behaviors. In the African context, systematic reviews have demonstrated that low educational attainment is associated with poor foot self-care practices (AOR ~3.0) and limited knowledge of foot risk factors, which are key contributors to ulcer development and delayed healing.[8]

The level of education is closely linked to socioeconomic position, influencing employment opportunities, income, and living conditions.[9] In this study population, a significant number of participants were engaged in informal employment or were unemployed, contexts often associated with physical labor, prolonged standing or walking, and limited access to protective footwear. This demographic distribution mirrors recent sub-Saharan research, which revealed that more than 60% of patients presenting with active diabetic foot complications are structurally situated within the informal labor sector, citing occupational vulnerability as a significant non-clinical risk indicator.[10] These occupational exposures, coupled with economic constraints, have a likelihood of increasing vulnerability to foot trauma and delaying care-seeking, thereby facilitating progression to overt DFD.

Theoretically, this finding aligns strongly with the health belief model (HBM), which posits that limited formal education may be associated with lower perceived susceptibility and severity of foot complications, fewer cues to action, and reduced self-efficacy for preventive behaviors. Baseline analysis in diabetic study participants has revealed that when formal education attainment is unaddressed, patients score significantly lower across core HBM dimensions, indicating that structural knowledge barriers fundamentally depress a patient's internal threat perception and self-efficacy regarding diabetic foot care.[11] It also resonates with the social determinants of health framework, positioning education attainment as an upstream driver of downstream clinical outcomes. Individual educational attainment functions as a foundational structural determinant within the broader social architecture, shaping downstream clinical outcomes by fundamentally modulating a patient's health literacy, adherence to preventative care, and timely engagement with specialized healthcare systems.[12] Patients with low formal education may lack not only information but also the confidence and skills to act on advice, which compromises routine foot checks, early recognition of lesions, and timely care-seeking. Contemporary public health data reinforces this, indicating that providing health information is insufficient; complex chronic conditions like diabetes require specialized, targeted training to build the clinical self-efficacy and decision-making confidence necessary for patients to translate baseline knowledge into timely preventative habits.[13]

The independent effect of education after multivariable adjustment suggests that its influence is not fully mediated by measured clinical factors such as duration of diabetes, blood pressure, or lipid levels. Rather, the level of education appears to exert a foundational effect on patients' capacity to engage with chronic care systems. This echoes evidence from SSA and from a global platform where low education has been consistently associated with poor glycemic control, higher complication rates, and worse diabetes outcomes, such as DFDs.[8]

The study limitations included language and communication barriers. Though the study instruments were translated from English to Swahili to maximize accessibility, these persisted as a minor limitation, particularly among older participants. A subset of elderly patients exhibited limited formal literacy or primarily communicated in local dialects, occasionally necessitating oral clarification of standard Swahili terms by the research team. These measures were taken to standardize the responses from the study participants.

## CONCLUSION

The level of education is a significant predictor of the development of DFD among patients attending diabetic clinics, Thika Level 5 Hospital, and Kiambu County Referral Hospital. Low education level limits patients' ability to interpret health messages, medication instructions, and clinic advice, thereby impairing adherence to long-term self-management behaviors. Diabetes policies should recognize formal education and health literacy as a core determinant of complication risk and embed literacy-sensitive foot care education as a mandatory component of routine diabetes management.

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