Open Journal of Epidemiology, 2025, 15(4), 793-801
https://www.scirp.org/journal/ojepi
ISSN Online: 2165-7467
ISSN Print: 2165-7459

Association of Poverty Income Ratio on the Effect of Peripheral Neuropathy on Overall Mortality in a Non-Diabetic Adult Population

Adeoye Adenekan

Department of Public Health and Primary Care, Faculty of Medical Sciences, University of the West Indies, Saint Augustine, Trinidad and Tobago
Email: adeoye.adenekan@uwi.edu, deenekan@yahoo.com

How to cite this paper: Adenekan, A. (2025) Association of Poverty Income Ratio on the Effect of Peripheral Neuropathy on Overall Mortality in a Non-Diabetic Adult Population. *Open Journal of Epidemiology*, **15**, 793-801.
https://doi.org/10.4236/ojepi.2025.154051

Received: August 4, 2025
Accepted: September 21, 2025
Published: September 24, 2025

Copyright © 2025 by author(s) and Scientific Research Publishing Inc.
This work is licensed under the Creative Commons Attribution International License (CC BY 4.0).
http://creativecommons.org/licenses/by/4.0/
Open Access

Abstract

Peripheral neuropathy (PN) is a disorder of the peripheral nervous system associated with significant morbidity and mortality. PN is common among U.S. adults, even in the absence of diabetes, where it presents with sensory symptoms such as tingling, numbness, burning, pain, and sensory ataxia. Motor symptoms include muscle cramps, stiffness, weakness, and wasting. The overall prevalence of PN in the United States is 13.5% in adults with diabetes and 11.6% in adults without diabetes, clearly indicating that PN is a significant public health problem among U.S. adults. Poverty and low income have been associated with poor health outcomes. There are no published studies examining whether poverty income ratio is associated with the effect of PN on overall mortality among U.S. adults without diabetes. Using the socioecological model as the theoretical framework, the purpose of this longitudinal study was to examine whether poverty income ratio moderated the effect of PN on overall mortality. Secondary data from the National Health and Nutrition Examination Survey (NHANES) 1999-2015 dataset were analyzed using complex sample Cox regression analysis with the threshold for statistical significance taken at $p < 0.05$. PN in the left foot was associated with an increased hazard (HR) of overall mortality (HR, 2.32, 95% CI: 1.01, 5.34; $p < 0.05$), while poverty income ratio moderated the effect of PN in either foot ($p < 0.05$). Participants without diabetes but who were poorer (with a reduced poverty income ratio of 0 - 1.99), had an increased hazard for overall mortality when diagnosed with PN in the left foot. This study is significant in its implications for positive social change. The results can enable relevant stakeholders to institute policies to reduce income inequality, promote gainful employment, and institute appropriate targeted screening for PN among U.S. adults without diabetes who are poor and of lower income.

Keywords

Peripheral Neuropathy, Non-Diabetic, Overall Mortality, Poverty Income Ratio, Adults, NHANES, United States

1. Introduction

There is a significant burden of PN with an associated overall mortality among adults without diabetes in the United States [1]. PN is very prevalent, particularly in the older population [2] and presents with significant morbidity that reduces the quality of life (QoL) of affected patients or individuals [3]. Approximately two-thirds of patients suffering from PN experience neuropathic pain which can be so disabling as to have a detrimental effect on their mental health and eventually culminating in a reduced QoL [3]. Moreover, PN is such a prevalent disease, especially among adults and it presents both diagnostic and therapeutic challenge to physicians and other healthcare providers [2]. It is estimated that the prevalence of PN in some studies is as high as 10.4% for middle-aged (40 - 69 years) and 26.8% for older (>70 years) adults in the U.S. population [1]. Clearly, these statistics indicate that PN is a significant public health problem among adults in the United States.

PN is an important public health condition with a prevalence of almost 15% in the adult population of age over 40 years in the United States [4]. Peripheral neuropathies encompass all conditions that cause damage to the peripheral nervous system (PNS), which may include mechanical, toxic, and metabolic causes [5]. Furthermore, the clinical symptoms exhibited by sufferers of this chronic debilitating disease depend on its severity, distribution, affected structure of the nerve cell, as well as the type of affected neurons [5]. According to [5], the prevalence of PN is slightly higher in women than men, and the occurrence of PN may be influenced by the type of work performed [5].

Globally, the prevalence of PN also varies considerably from one geographical location to another. African and Middle Eastern countries generally have a low prevalence of PN of 0.8 to 2.5 per 1000 among adults, when compared to a prevalence of 7.3 to 32.5 per 1000 among adults in Europe [6]. It is argued that some of the differences in prevalence rates of PN observed in these different geographical locations could be partly explained by differences in assessment protocol for PN.

Poverty and low income have been associated with poor health outcomes [7]. Lower income will likely reduce an individual's opportunity to purchase essentials for good health, such as enough high-quality food, medications, and other healthcare products [7]. Furthermore, individuals with lower incomes tend to exhibit higher odds of behavioral risk factors such as smoking, physical inactivity, and obesity, which increases their poor health outcomes [7]. It is also argued that individuals with lower incomes tend to have lower educational achievements and less social capital and live in less affluent neighborhoods, where crime and other

life stressors may be prevalent [7]. All these factors are likely to culminate in poor health outcomes. In addition, poor health can also contribute to low income or poverty by limiting an individual's ability to engage in productive employment and reducing economic opportunities. As [7] opined, this two-way causal relationship between income and health highlights the importance of health-related measures to address the issue of income poverty in the wider society.

The theory of the socioecological model [8] proposes that the nature of individuals' interaction with their physical and sociocultural environments can impact health and lead to the development of diseases [8]. It implies that factors or influences operating at every level or construct of this theoretical framework can impact on an individual's health and eventually lead to the development of diseases such as PN.

Hence, there was justification for this research study in which I examined the association of poverty income ratio on the effect of peripheral neuropathy on overall mortality among adults without diabetes in the United States, while controlling for age, gender, and ethnicity.

2. Methods

2.1. Design and Study Participants

The specific quantitative research design for this study was a longitudinal design [9], with the outcome variable, overall mortality, examined in the follow-up mortality dataset of 2015, following the initial diagnosis of PN in the 1999-2000 NHANES dataset. The event of interest was whether the patient died or was alive, at the time of this study. The target population for this study was adults who did not suffer from diabetes in the NHANES 1999 to 2015 dataset. The sample size estimated using G*Power [10] in this study, when the allowable error was 5%, and power set at 80% was 98 participants. This was the minimum sample size required for this study.

2.2. Variables/Sources of Data

The main independent variable in this study was PN, the independent variable or moderating variable was poverty income ratio, the dependent variable was overall mortality, while the covariates were age, gender, and ethnicity. The participants were stratified according to their diabetes status. The main independent variable was PN, a Categorical Nominal variable, and coded as: None = 1, Insensate site group = 2. The other independent variable was poverty income ratio, a Categorical Nominal variable, and coded as 0 to 1.99 = 1, 2 through highest = 2. In addition, Diabetes, a Categorical Nominal variable, coded as Yes = 1 and No = 2. The covariates were age (years), a Continuous variable; Gender, a Categorical Nominal variable, and coded as: Male = 1, Female = 2, and Ethnicity, a Categorical Nominal variable, and coded as: Non-Hispanic White = 1, Non-Hispanic Black = 2, Mexican American = 3, Other Race—Including Multi-Racial = 4, Other Hispanic = 5. The dependent variable was overall mortality, a Categorical Nominal variable, and

coded as 0 = Assumed alive, 1 = Assumed deceased. In the NHANES 1999-2000 dataset, PN was defined as one or more insensate sites of three sites tested per foot based on the Semmes-Weinstein 10 g monofilament.

2.3. Instrumentation or Measures

Secondary data from the NHANES 1999 to 2015 dataset were used in this study. This data was collected by the Centers for Disease Control and Prevention, and hence, the data was assumed to be valid and reliable. The dataset was freely available; hence, no special instruments or data-collection tools were employed. The data for the research study was assembled in SPSS version 27 before performing the statistical analyses.

Ethical considerations and Execution: This study was approved by the Walden University's Institutional Review Board (IRB) on 03/08/2023, with the approval number 03-08-23-0753053. In this study, I employed the use of the NHANES dataset from 1999 to 2000, and the follow-up mortality dataset of 2015. The variables of interest from the 1999 to 2000 dataset were merged with the variables of interest in the 2015 follow-up mortality dataset in SPSS version 27, using the participant's respondent sequence number (SEQN). After the merger, the data was cleaned. Because this was a complex sample of data from a nationally representative dataset from the NHANES 1999 to 2015 dataset, it was essential to perform weighting before the statistical analysis. In a nationally representative dataset such as the NHANES 1999 to 2015, there is usually an underrepresentation and overrepresentation of certain groups. Weighting of the data was necessary to ensure that the data used for the statistical analysis was representative of the population from which it was collected.

2.4. Data Analysis

Descriptive statistics for PN, poverty income ratio, overall mortality, diabetes, age, gender, and ethnicity were displayed in frequency tables. Inferential statistics for PN, poverty income ratio, overall mortality, age, gender, and ethnicity was performed using complex sample Cox regression analysis.

3. Results

Descriptive statistics of the study participants and the complex sample Cox regression analysis are shown below.

Table 1. Frequencies and percentages of participants with variables in the study.

Variable	n	%
PN. RT. Ft.:		
Yes	66	27
No	183	73
Valid	249	100

Continued

Missing	120,533	
Total	120,782	
PN. LT. Ft.:		
Yes	73	24
No	227	76
Valid	300	100
Missing	120,482	
Total	120,782	
PIR:		
0 - 1.99	4773	56
≥2	3709	44
Valid	8482	100
Missing	112,300	
Total	120,782	
Mortality status:		
Assumed alive	48,936	82
Assumed dead	10,404	18
Valid	59,340	100
Missing	61,442	
Total	120,782	
Diabetes:		
Yes	489	5
No	8936	95
Valid	9425	100
Missing	111,357	
Total	120,782	
Age:		
18 - 49 years	3028	56
≥50 years	2420	44
Valid	5448	100
Missing	115,334	
Total	120,782	
Gender:		
Male	4883	49
Female	5082	51
Valid	9965	100
Missing	110,817	
Total	120,782	
Ethnicity:		
Non-Hispanic White	3423	34

Continued

Non-Hispanic Black	2273	23
Mexican American	3393	34
Other Race-Including Multiracial	287	3
Other Hispanic	589	6
Valid	9965	100
Missing	110,817	
Total	120,782	

Table 2. Complex sample Cox regression analysis right foot and overall mortality. PN in the right foot was not associated with overall mortality ($p > 0.05$).

Parameter	B	*p*	Hazard Ratio (HR)	95% CI	
				Lower	Upper
PN. RT. Ft.	−0.21	0.32	0.81	0.28	2.34
PIR	−1.36	0.03			
Diabetes	−1.47	0.01			
Age	−0.11	0.01			
Gender	−0.12	0.68			
Ethnicity	0.40	0.11			

Table 3. Complex sample Cox regression analysis left foot and overall mortality. PN in the left foot was associated with an increased hazard of overall mortality ($p < 0.05$).

Parameter	B	*p*	Hazard Ratio (HR)	95% CI	
				Lower	Upper
PN. LT. Ft.	0.84	0.02	2.32	1.01	5.34
PIR	−0.85	0.01			
Diabetes	−1.32	0.01			
Age	−0.10	0.01			
Gender	−0.18	0.48			
Ethnicity	0 .31	0.09			

Table 4. Complex sample Cox regression interaction between PN, PIR and Overall mortality. PIR moderated the effect of PN on Overall mortality.

Parameter	B	*p*	Hazard Ratio (HR)	95% CI	
				Lower	Upper
PN. RT. Ft.	−1.13	0.01	0.32	0.19	0.56
PN. LT. Ft.	0.03	0.01	1.35	1.13	1.62
PIR	−0.45	0.01	0.64	0.53	0.76

4. Discussion

In this study, 27% of the participants suffered from PN in the right foot, compared to 24% in the left foot, see **Table 1**. 56% or most of the participants had a PIR of 0 to 1.99, compared to 44% of the participants with a PIR of ≥2. Most participants were assumed alive (82%) when compared to assumed dead (18%). The majority of the participants did not suffer from diabetes (95%), while only 5% suffered from diabetes. 56% of the study participants were of the ages 18 to 49 years, 44% of the participants were 50 years and older. Most of the participants were females (51%), while males accounted for 49% of the study participants. Non-Hispanic Whites accounted for most of the participants (34%), while Other Race-Including Multi-racial accounted for the least proportion (3%).

In this study, PN in the right foot was not associated with overall mortality (HR, 0.81; 95% CI: 0.28, 2.34; $p > 0.05$), see **Table 2**. PN in the left foot was associated with an increased hazard of overall mortality (HR, 2.32; 95% CI: 1.01, 5.34; $p < 0.05$), see **Table 3**. This finding is consistent with a study in the U.S., where PN was associated with overall mortality [1]. PIR moderated the effect of PN in both the right and left foot on overall mortality, see **Table 4**.

Since PIR has a negative B coefficient (−0.85; HR, 0.43) and diabetes also has a negative B coefficient (−1.32; HR, 0.27), it implies that participants who did not suffer from diabetes but had a reduced poverty income ratio (0 - 1.99) or were poorer, had an increased hazard for overall mortality, when diagnosed with PN in the left foot. Age has a negative B coefficient (−0.10; HR, 0.90); it implies that when adjusted for age, younger participants had a reduced hazard for overall mortality, when diagnosed with PN in the left foot. In other words, increasing age increases the hazard for overall mortality in participants not suffering from diabetes when diagnosed with PN in the left foot. Gender ($p > 0.05$) and Ethnicity ($p > 0.05$) were not associated with the effect of PN on the left foot on overall mortality in this study.

There are no previous studies that have examined whether PIR was associated with the effect of PN on overall mortality among adults who did not suffer from diabetes in the United States. In this study, PIR moderated the effect of PN in both the right and left foot on overall mortality. This finding is consistent with other studies, where poverty and income inequality were associated with poor health outcomes [11].

4.1. Limitations

This study has some limitations. One of the limitations is that there are other important causes of PN in the United States, such as AIDS/HIV and chemotherapy which were not controlled for in this study because of the sample size and availability of data constraints. In addition, trans or non-binary gender respondents were not controlled for in this study because there was not a large enough sample size for this category of respondents. Another limitation is the missing data across all variables from the NHANES 1999-2015 dataset. These missing data could have

introduced bias in the results.

4.2. Implications

The results of this study demonstrated that poverty income ratio was associated with the effect of PN in the left foot on overall mortality. Participants who did not suffer from diabetes, but with reduced poverty income ratio or poorer, had an increased hazard for overall mortality, when diagnosed with PN in the left foot. These results build on existing evidence that low income and poverty are associated with poor health outcomes [11]. For the discipline of public health and public health practitioners, it serves as a reminder that there should be a renewed interest in policies and laws that address and seek to reduce income inequality within society.

4.3. Recommendations for Further Research

The findings of this study, within its limitations, highlight that adults who do not suffer from diabetes but with a reduced poverty income ratio or poorer, when diagnosed with PN in the left foot, had an increased hazard for overall mortality. Further research should aim to examine PN in its entirety (both feet), since this study only examined PN in either the right or left foot.

5. Conclusion

PN is associated with a substantial burden among adults not suffering from diabetes in the United States. Poverty and low income, as demonstrated by the results of this study, increased the risk of overall mortality among these adults not suffering from diabetes, especially when diagnosed with PN in the left foot. Thus, to improve the health outcomes of these adults suffering from PN, there should be concerted effort on the part of relevant stakeholders to advocate for and ensure policies that reduce income inequality, promote gainful employment, and improve social welfare programs, which will improve the health outcomes for these individuals.

Acknowledgements

I wish to acknowledge the guidance received from Dr. Srikanta Banerjee and Dr. Peter Anderson, both of Walden University, Minnesota, United States.

Conflicts of Interest

The author declares no conflicts of interest regarding the publication of this paper.

References

[1] Hicks, C.W., Wang, D., Matsushita, K., Windham, B.G. and Selvin, E. (2021) Peripheral Neuropathy and All-Cause and Cardiovascular Mortality in U.S. Adults. *Annals of Internal Medicine*, **174**, 167-174. https://doi.org/10.7326/M20-1340

[2] Callaghan, B.C., Gao, L., Li, Y., Zhou, X., Reynolds, E., Banerjee, M., Pop-Busui, R., Feldman, E.L. and Ji, L. (2018) Diabetes and Obesity Are the Main Metabolic Drivers

of Peripheral Neuropathy. *Annals of Clinical and Translational Neurology*, **5**, 397-405. https://doi.org/10.1002/acn3.531

[3] Girach, A., Julian, T. H., Varrassi, G., Paladini, A., Vadalouka, A. and Zis, P. (2019) Quality of Life in Painful Peripheral Neuropathies: A Systematic Review. *Pain Research and Management*, **2019**, Article 2091960. https://doi.org/10.1155/2019/2091960

[4] Valentine, W.M. (2020) Toxic Peripheral Neuropathies: Agents and Mechanisms. *Toxicologic Pathology*, **48**, 152-173. https://doi.org/10.1177/0192623319854326

[5] Szewczyk, A.K., Jamroz-Wisniewska, A. and Rejdak, K. (2021) A Retrospective Analysis of Pain Etiology in Middle-Aged Patients with Peripheral Neuropathy. *Medicina*, **57**, 1-13. https://doi.org/10.3390/medicina57080787

[6] Hanewinckel, R., Judith Drenthen, J., Oijen, M.V., Hofman, A., Doorn, P.A. and Ikram, M.A. (2016) Prevalence of Polyneuropathy in the General Middle-Aged and Elderly Population. *Neurology*, **87**, 1892-1898. https://doi.org/10.1212/WNL.0000000000003293

[7] Oshio, T. (2019) Exploring the Health-Relevant Poverty Line: A Study Using the Data of 663,000 Individuals in Japan. *Oshio International Journal for Equity in Health*, **18**, 1-9. https://doi.org/10.1186/s12939-019-1118-8

[8] Kilanowski, J.F. (2017) Breadth of the Socio-Ecological Model. *Journal of Aeromedicine*, **22**, 295-297. https://doi.org/10.1080/1059924X.2017.1358971

[9] Frankfort-Nachimas, C. and Leon-Guerrero, A. (2018) Social Statistics for a Diverse Society. 8th Edition, Sage Publications.

[10] Faul, F., Erdfelder, E., Buchner, A. and Lang, A.G. (2009) Statistical Power Analyses Using G*Power 3.1: Tests for Correlation and Regression Analyses. *Behavior Research Methods*, **41**, 1149-1160. https://doi.org/10.3758/BRM.41.4.1149

[11] Li, Z., Zhou, L., Wu, Y., Ding, T., Gan, Y. and Fan, X. (2024) Associations of Healthy Lifestyle and Family Income to Poverty Ratio with All-Cause Mortality among People with Prediabetes and Diabetes: A Prospective Cohort Study. *BMC Public Health*, **25**, 1-11. https://doi.org/10.1186/s12889-024-21206-0