

ESTIMATING THE EFFECT OF SYMPTOMS OF DIABETIC PERIPHERAL NEUROPATHY AND DIABETIC RETINOPATHY ON QUALITY-OF-LIFE USING DATA FROM THE 2001-2002 NATIONAL HEALTH AND NUTRITION EXAMINATION SURVEY

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ABSTRACT

OBJECTIVES: To evaluate the effect of symptoms characteristic of diabetic peripheral neuropathy (SDPN), diabetic retinopathy (DR) and co-morbid SDPN & DR (COMORB) on the Healthy Days Core Module (HRQOL-4) measures of the CDC, among US adults =40 years old with diagnosed diabetes, using the 2001-2002 National Health and Nutrition Examination Survey (NHANES).

METHODS: Logistic and ordinary least squares (OLS) regression models were used to assess the impact of SDPN, DR and COMORB on HRQOL-4 measures. Included in the analysis were 429 NHANES respondents aged =40 years old classified as having diagnosed diabetes. Model covariates included age, gender, race, education, current smoking status, currently asthmatic, and history of cardiovascular disease, cancer, arthritis, COPD, hypertension and stroke. The conditions of interest were assessed based upon respondent self-report. All estimates were generated using Stata statistical software, and accounted for the complex survey design of NHANES.

RESULTS: Using the 2001-2002 NHANES, we estimated that, among US adults aged =40 years old with diagnosed diabetes, those with SDPN (OR = 7.66; 95%CI = 2.90, 20.23), DR (3.43; 1.53, 7.69), and COMORB (5.43; 2.32, 12.73) were all more likely to report that they were currently in poor health, compared to those without the condition of interest. Additionally, OLS models suggest that those with SDPN had a significantly greater number of days during the past month in which their physical health was not good, compared to those without SDPN. SDPN was also associated with a significantly greater number of days during the past month in which poor physical or mental health limited their usual activities.

CONCLUSION: Among US adults aged =40 years old with diagnosed diabetes, SDPN, DR, and COMORB all appear to have a significant negative effect on quality-of-life. Future therapies that offer relief of these conditions may have considerable humanistic benefits.

Introduction

Despite the development of comprehensive diabetes management programs over the past 2 decades, many patients with diabetes continue to be at an increased risk for diabetic microvascular complications such as diabetic peripheral neuropathy (DPN) and DR. DPN, SDPN, and DR are significant problems that negatively impact the quality of life of patients with diabetes. Moreover, significant healthcare resources are spent each year to treat these conditions, both for active symptoms and for late-stage complications including ulcers and amputations.

Although often diagnosed and treated separately, DPN and DR are pathologically linked. Previous research (Dyck et al., 1999, for example) has identified three lines of evidence suggesting that DPN and DR have a similar metabolic genesis: 1) DPN and DR are statistically associated; 2) microvascular changes are histologically and functionally similar in vessels taken from areas affected by either condition; and 3) prospective studies evaluating improved glycemic control demonstrates a similar preventive effect on both conditions.

Objective

The objective of this study was to estimate the prevalence and associated quality-of-life loss for patients with symptoms characteristic of diabetic peripheral neuropathy (SDPN), diabetic retinopathy (DR), and those with comorbid SDPN and DR among US adults aged 40 and older with diagnosed diabetes.

Data Sources

NHANES is a nationally representative, periodic survey of the noninstitutionalized US civilian population, and is administered by the National Center for Health Statistics of the Centers for Disease Control and Prevention (CDC). NHANES staff conduct interviews and perform physical examinations on participants. Respondents are interviewed in their homes to obtain information on health history, behaviors, and risk factors. Respondents are also asked to undergo a physical examination in a mobile examination center. The procedures used to select the sample and to conduct the interview and examination have been described in great detail in the literature (CDC, 2002).

For this study, we analyzed the NHANES 2001-2002 release.

Methods

In this study, we analyzed NHANES data to estimate the quality-of-life losses associated with SDPN, DR, and comorbid SDPN and DR. For example, we examined whether or not those with comorbid SDPN and DR are more likely to have difficulty walking up 10 steps than those without both conditions.

Prevalence analyses were conducted using SAS for Windows statistical software (Version 8.2). Final results included both unweighted and weighted (e.g., nationally representative) estimates. Following Gregg et al. (2004), we did not undertake any form of imputation to account for missing data. Regression-based analyses were conducted using Stata statistical software (Version 8.1). Using the sampling weights provided with the NHANES releases, we were able to generate nationally representative prevalence estimates.

Supplemented demographic information with data from the Diabetes questionnaire. Respondents 20+ years of age were asked about history of retinopathy and vision troubles due to diabetes, while respondents 40+ years of age were asked about history of numbness in hands or feet. Thus, our analytic sample was limited to adults 40+ years of age.

From the original NHANES sample of adults 40 years of age and older, we will exclude respondents for the following reasons:
•Did not complete the exam and therefore would not have certain key information (e.g., monofilament testing results, plasma glucose), and
•Were not part of the Peripheral Neuropathy Section of the Lower Extremity Disease examination. Persons are excluded from this exam if they are younger than 40 years of age, have bilateral amputations, or weigh over 400 pounds.

Diabetes-related Variables

We classified a respondent as having been diagnosed with diabetes if:
• He or she answered yes to the question "Doctor told you have diabetes?", or
• He or she reports currently taking insulin or diabetic pills for diabetes.

We classified a respondent as having SDPN if:
• He or she reports numbness, loss of feeling, or painful sensations or feeling in their feet.

We classified a respondent as having DR if:
• He or she answered yes to the question "Has diabetes affected your eyes/do you have retinopathy?"

Quality-of-Life Variables

We assessed a respondent's current health status using the following question:

- What is your current general health status? Responses to this question included:
 - Excellent
 - Very good
 - Good
 - Fair, or
 - Poor

We created a categorical variable for "poor current health status", equal to 1 if the respondent reported poor current health, and 0 otherwise.

We assessed a respondent's physical limitations using the following questions:

- Walking up ten steps difficulty?
- House chore difficulty?
- Walking between rooms on same floor difficulty?
- Standing for long periods difficulty?
- Attending social event difficulty?
- Leisure activity at home difficulty?

- Possible responses to these questions were:
 - No difficulty;
 - Some difficulty;
 - Much difficulty; and
 - Unable to do.

Using these data, we created yes/no indicator (dummy) variables for each response, and modeled each separately (i.e. no difficulty performing particular task, yes/no, some difficulty performing particular task, yes/no, much difficulty performing particular task, yes/no, and unable to perform particular task, yes/no).

- Additionally, we assessed continuous measures of quality-of-life using the following questions:
- Number of days in the last month that physical health was not good?
 - Number of days in the last month that poor physical or mental health rendered you less active than normal?

Models Estimated

Using Stata's SVYREG command, which adjusts for NHANES' complex survey design, we estimated ordinary least squares regression models of the general form:

$$BOI_i = \beta_0 + \beta_1COND_i + \beta_2X_i + e_i$$

where BOI_i is a continuous quality-of-life outcome (e.g., number of days in the past month that physical health was not good), COND is a condition indicator (SDPN, DR, or comorbid SDPN and DR), X is a vector of explanatory variables, and e is the error term.

Explanatory variables included: elderly status (non-elderly is the reference category), gender, race (non-white is the reference category), current smoker status (not a current smoker is the reference category), education (high school graduate and above is the reference category), self-reported cardiovascular disease, cancer, arthritis, chronic obstructive pulmonary disease, hypertension, stroke, and currently asthmatic.

Using Stata's SVYLOGIT command, which adjusts for NHANES' complex survey design, we estimated logistic regression models of the general form:

$$BOI_{1i} = \beta_0 + \beta_1COND_i + \beta_2X_i + e_i$$

where BOI_{1i} is a dichotomous outcome of interest (e.g., some difficulty walking ten steps or inability to perform normal household chores), COND is a condition indicator (SDPN, DR, or comorbid SDPN and DR), X is a vector of explanatory variables, and e is the error term.

Explanatory variables included: elderly status (non-elderly is the reference category), gender, race (non-white is the reference category), current smoker status (not a current smoker is the reference category), education (high school graduate and above is the reference category), self-reported cardiovascular disease, cancer, arthritis, chronic obstructive pulmonary disease, hypertension, stroke, and currently asthmatic.

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Explanatory variables included: elderly status (non-elderly is the reference category), gender, race (non-white is the reference category), current smoker status (not a current smoker is the reference category), education (high school graduate and above is the reference category), self-reported cardiovascular disease, cancer, arthritis, chronic obstructive pulmonary disease, hypertension, stroke, and currently asthmatic.

Results

Modeling Estimates

Outcome Modeled	Parameter of Interest ^{1, 2}	Odds Ratio ³	95% Conf. Interval
Self-reported "poor" general health status	SDPN**	7.66	2.90 20.23
	Retinopathy**	3.43	1.53 7.69
	Comorbid SDPN and DR**	5.44	2.32 12.73
Some difficulty walking 10 steps	SDPN**	2.49	1.41 4.42
	Retinopathy	1.49	0.75 2.98
	Comorbid SDPN and DR*	3.23	1.22 8.55
Inability to perform household chores	SDPN	2.00	0.67 5.98
	Retinopathy**	5.83	1.98 17.17
	Comorbid SDPN and DR*	5.33	1.34 21.19
Some difficulty performing household chores	SDPN**	2.93	1.36 6.31
	Retinopathy	1.46	0.59 3.62
	Comorbid SDPN and DR	1.90	0.85 4.28
Much difficulty walking between rooms on same floor	SDPN	5.27	0.73 37.85
	Retinopathy**	82.20	5.49 1230.28
	Comorbid SDPN and DR*	13.87	1.53 125.50
Some difficulty standing for long periods of time	SDPN**	3.91	1.92 7.97
	Retinopathy	1.44	0.60 3.41
	Comorbid SDPN and DR	1.57	0.60 4.10
Much difficulty with attending social events	SDPN*	3.52	1.26 9.85
	Retinopathy	1.74	0.41 7.31
	Comorbid SDPN and DR*	4.80	1.10 20.93
Unable to perform normal leisure activities	SDPN	0.90	0.04 18.62
	Retinopathy*	78.92	2.72 2290.93
	Comorbid SDPN and DR ⁴	NA	
Some difficulty performing normal leisure activities	SDPN	1.82	0.78 4.24
	Retinopathy	1.56	0.76 3.21
	Comorbid SDPN and DR*	2.39	1.02 5.62

Outcome	Parameter of Interest ^{1, 2}	Parameter Estimate ³	95% Conf. Interval
Number of days in the last month that physical health was not good	SDPN**	5.08	2.86 7.30
Number of days in the last month that poor physical or mental health rendered you less active than normal	SDPN*	1.60	0.06 3.14
	Retinopathy	0.12	-1.51 1.75
	Comorbid SDPN and DR	-0.47	-3.61 2.67
* Significant at the 95% level. ** Significant at the 99% level.			

SOURCE: 2001-2002 National Health and Nutrition Examination Survey (NHANES).

¹ NOTE: Each row in this table represents a distinct model. Separate models for SDPN, DR, and comorbid SDPN and DR were estimated for each outcome.

² NOTE: Explanatory variables included: Elderly status, gender, race (non-white is the reference category), current smoker status, education (high school graduate and above is the reference category), self-reported cardiovascular disease, cancer, arthritis, chronic obstructive pulmonary disease, hypertension, stroke, and currently asthmatic.

³ Estimated using Stata's SVYLOGIT command, which accounts for NHANES's complex survey design.

⁴ Comorbid SDPN and DR predicted failure perfectly and was not used in the model estimation.

⁵ Estimated using Stata's SVYREG command, which accounts for NHANES's complex survey design.

Discussion

Using the 2001-2002 NHANES, it is estimated that 11.8 million adults over the age of 40 have been diagnosed with diabetes.

Of these, nearly 4.0 million have SDPN and 3.1 million have DR. 1.5 million have comorbid SDPN and DR (COMORB).

Using the NHANES 2001-2002 we estimated that, among US adults aged 40 years and older with diagnosed diabetes, those with SDPN (OR = 7.66; 95%CI = 2.90, 20.23), DR (3.43; 1.53, 7.69), and COMORB (5.43; 2.32, 12.73) were all more likely to report that they were currently in poor health, compared to those without the condition of interest. Additionally, those with SDPN report significantly more days (5.08 days) in the last month that physical health was not good, and significantly more days (1.60 days) in the last month that poor physical or mental health rendered them less active than normal, than those without the condition.

Those with SDPN (2.49; 1.41, 4.42), and COMORB (3.23; 1.22, 8.55) were all more likely to report that they had some difficulty walking ten steps, compared to those without the condition of interest.

Those with DR (5.83; 1.98, 17.17), and COMORB (5.33; 1.34, 21.19) were all more likely to report that they were unable to perform normal household chores, compared to those without the condition of interest. Those with SDPN (2.93, 1.36, 6.31) were more likely to report that they had some difficulty performing normal household chores, compared to those without the condition of interest.

Those with SDPN (3.91; 1.92, 7.97) were more likely to report that they had some difficulty standing for long periods of time, compared to those without the condition of interest.

Those with DR (82.20; 5.49, 1230.28), and COMORB (13.87; 1.53, 125.50) were all more likely to report that they had much difficulty walking between rooms on same floor, compared to those without the condition of interest.

Those with SDPN (3.52; 1.26, 9.85), and COMORB (4.80; 1.10, 20.93) were all more likely to report that they had much difficulty with attending social events, compared to those without the condition of interest.

Those with DR (78.92; 2.72; 2290.93) were more likely to report that they were unable to perform normal leisure activities, compared to those without the condition of interest.

Those with COMORB (2.39; 1.02, 5.62) were more likely to report that they had some difficulty performing normal leisure activities, compared to those without the condition of interest.

Limitations

Unfortunately, NHANES 2001-2002 does not contain much information on DR. For this study, we were limited to one question in the diabetes questionnaire which asks whether or not the respondent was ever told by a doctor that diabetes has affected her/his eyes or that s/he had retinopathy. As is evident, this measure is not clinical in nature, and thus we were not able to stage this definition of retinopathy.

All definitions were based upon respondent self-report, and as such, may be subject to response bias.

Conclusions

Prevalence estimates presented here suggest that novel therapies that can be used to provide relief of SDPN and DR may address a substantial unmet medical need among patients with these conditions.

Further, QoL results suggest that a therapy of this sort may have considerable humanistic benefits by reducing the estimated impact of SDPN and DR on quality-of-life.

Acknowledgements

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