

**Self-reported physical activity using the International Physical Activity Questionnaire (IPAQ)  
in Australian adults with type 2 diabetes, with and without peripheral neuropathy**

Dr Rebecca C Nolan (PhD)<sup>a1</sup>, Associate Professor Annette J Raynor (PhD)<sup>b</sup>, Dr Narelle M Berry (PhD)<sup>c</sup>, Professor Esther J May (PhD)<sup>a</sup>

<sup>a</sup>University of South Australia  
GPO Box 2471  
Adelaide SA 5001  
Division of Health Sciences

<sup>b</sup>Edith Cowan University  
270 Joondalup Drive  
Joondalup, WA 6027  
School of Medical and Health Sciences

<sup>c</sup>Flinders University  
GPO Box 2100  
Adelaide SA 5001  
School of Nursing and Midwifery

**Corresponding Author:** Dr Rebecca C Nolan<sup>1</sup>. [Rebecca.nolan@mymail.unisa.edu.au](mailto:Rebecca.nolan@mymail.unisa.edu.au)

**Word Count (excluding abstract):** 2267

**Conflicts of Interest:** None

---

<sup>1</sup> Present Address:  
Level 3 Citi Centre  
PO Box 6 Rundle Mall  
Adelaide SA 5000  
Ph: +61 8 8226 6420

## **Abstract**

### ***Objective***

The aim of this study was to survey the level of self-reported physical activity in people with type 2 diabetes, with and without peripheral neuropathy.

### ***Methods***

A sample of South Australian adults (n=481) aged 33-88 years with type 2 diabetes, including 55 people with peripheral neuropathy, completed the International Physical Activity Questionnaire (IPAQ). Levels of self-reported physical activity were compared between those with and without peripheral neuropathy.

### ***Results***

People with type 2 diabetes and peripheral neuropathy (*Mdn* =1433, *IQR* = 495–3390 MET.min/wk) were less physically active than those without peripheral neuropathy (*Mdn* =2106, *IQR* = 876–4380 MET.min/wk) ( $p = 0.04$ ). A total of 49% of people with type 2 diabetes and peripheral neuropathy met physical activity recommendations of 150 minutes of at least moderate activity per week, compared to 57% of people with type 2 diabetes alone.

### ***Conclusions***

These findings demonstrate that people with type 2 diabetes and peripheral neuropathy reported being significantly less active than people with type 2 diabetes alone. People with type 2 diabetes and peripheral neuropathy need to be encouraged to perform higher levels of physical activity for biological, physical and psychological benefits. Further studies using objective measures of physical activity are required to support these results.

### ***Keywords***

Physical Activity, type 2 diabetes, peripheral neuropathy, IPAQ

## **Introduction**

It has been reported that approximately 1 million Australians have diabetes [1]. It is widely regarded that the presence of type 2 diabetes increases the risk of associated microvascular and macrovascular complications which may affect various systems involving the heart, eyes, kidneys and feet [1]. Peripheral neuropathy affects the peripheral sensory nerves, and may include painful symptoms such as burning, deep aching, constricting and throbbing along with non-painful symptoms such as numbness, tingling, extreme sensitivity, or feelings of deadness within the lower limb [2, 3]. The sensory loss associated with peripheral neuropathy increases the risk of foot ulceration and associated amputation [4].

The presence of peripheral neuropathy is associated with a diminished quality of life that is thought to be due to the loss of sensation in the extremities, painful or disruptive symptoms, and difficulties with functional tasks which impact on the ability to perform activities of daily living [5]. The decline in functional capacity and quality of life together with the possible ulceration, amputation and loss of strength are important issues which must be managed in people with type 2 diabetes and peripheral neuropathy.

Physical activity and exercise is a well-established treatment option for people with type 2 diabetes. Physical activity and exercise has not only been shown to provide various biological benefits in people with type 2 diabetes [6, 7], but may also improve their quality of life [8]. It is recommended that people with type 2 diabetes should undertake 150 minutes of at least moderate intensity physical activity per week [9]. However the disruptive symptoms and reduced functional capacity in those who also experience peripheral neuropathy may inhibit their ability to participate in physical activity. Given the various advantages of physical activity, it is important to understand whether or not people with type 2 diabetes and peripheral neuropathy are participating in regular physical activity, and to what extent.

Therefore, the purpose of this study was to survey the level of self-reported physical activity in people with type 2 diabetes, with and without peripheral neuropathy using the International Physical Activity Questionnaire (IPAQ).

## **Methods**

### ***Participants***

Participants were recruited from a diabetes member organisation in South Australia through several mail-outs using random sampling. The inclusion criterion was having type 2 diabetes and there were no exclusion criteria. Participation was voluntary and anonymous and the return of the questionnaire was deemed as consent. Ethical clearance was obtained from the University of South Australia (UniSA) Human Research Ethics Committee (P374/08).

### ***Description of questionnaire***

The short self-administered IPAQ [10] was used to assess physical activity. The IPAQ focuses on the amount of physical activity performed over the past seven day period. The IPAQ includes questions about the time spent engaging in vigorous physical activity, moderate physical activity and walking. Within these domains participants are asked to consider all types of physical activity including activities performed during leisure time, domestic and gardening activities, work related activities and transport related activities.

The IPAQ is shown to be reliable ( $\rho = 0.76$ ) and at least as valid as other physical activity measures (concurrent= 0.58; criterion= 0.30 against Computer Science Accelerometer) [10]. Although it was originally intended that the IPAQ be used for adults aged between 18-65 years, it has since been tested on older adults to assess its' suitability. Several articles have supported its use on older adults over 65 years of age with suitable reliability (ICC = 0.47-0.94) and validity ( $\rho = 0.28-0.53$ ) being demonstrated across all domains of the IPAQ [11-13].

The data obtained from the IPAQ was used to estimate the total amount of physical activity completed in a seven day period by weighting the reported minutes per week in each domain by a MET (metabolic equivalent) energy expenditure estimate. The weighted MET-minutes per week were then calculated by multiplying the duration (minutes), frequency (days) and MET intensity, and then summing across the three domains, namely vigorous, moderate and walking to produce a weighted estimate of total physical activity per week ( $\text{MET}\cdot\text{min}\cdot\text{wk}^{-1}$ ) (Table 1) [10].

## ***Procedures***

The questionnaire was mailed to 4000 individuals who were also asked to provide their age, sex, the number of years since diagnosis of type 2 diabetes, and whether or not they had been diagnosed by their medical officer as having peripheral neuropathy as a complication of their type 2 diabetes.

## ***Data Analysis***

Data from the IPAQ were processed according to the IPAQ author's instructions which included the following recommendations [14]. If 'don't know/not sure' was selected or if data were missing, that case was removed from the analysis. Physical activity data which was unreasonably high were considered outliers and excluded from analysis. This included any case by which the total activity time was greater than 960 minutes (16 hours) per day, assuming an average person sleeps for eight hours per day. Those who reported less than ten minutes of activity per day in any domain were re-coded to zero minutes based on evidence that suggests that physical activity in minimum bouts of ten minutes is required to achieve health benefits. Finally, data was truncated in an attempt to normalise the distribution of the three domains of physical activity. It was recommended that any domain exceeding three hours or 180 minutes per day, be re-coded to 180 minutes, permitting a maximum of 21 hours of activity in a week to be reported for each domain [14].

Assessment of the data revealed that it was not normally distributed, and thus a logarithmic transformation was performed in order to use parametric statistics. Independent two-sample t-tests were used to detect differences between those who had been diagnosed with peripheral neuropathy compared to those who had not. Data is presented using medians (*Mdn*) and inter-quartile ranges (*IQR*). Descriptive statistics (means and standard deviations) were used to describe the age and years since diagnosis of type 2 diabetes of the participants.

The reported minutes per week of moderate and vigorous activities were used to determine if participants were meeting the recommended physical activity levels of 150 minutes of at least moderate physical activity per week [9].

## **Results**

A response rate of 15.1% or 605 responses were received from the 4000 questionnaires of which 481 valid responses were used for analysis. There were 124 responses (20.5%) excluded from the analysis for various reasons such as blank responses, not returning the entire questionnaire, and invalid and outlier responses. Of those valid responses, a total of 465 respondents (96.7%) provided their sex, while 463 respondents (96.3%) indicated whether or not they had been diagnosed with peripheral neuropathy. Of the valid responses the majority were male (58.8% male, 37.8% female, 3.3% unknown), and 11.4% identified as being diagnosed with peripheral neuropathy.

### ***Demographics***

The characteristics of the participants by sex and presence of peripheral neuropathy are shown in Table 2. The age of the participants ranged between 33-83 years with the male respondents being significantly older than the females respondents ( $M = 64.1 \pm 7.9$ , 95% CI = 63.2 – 65.1 years). Respondents who had indicated they had been diagnosed with peripheral neuropathy were significantly older than those with type 2 diabetes alone, with the time since diagnosis of type 2 diabetes also being significantly longer ( $M = 12.0 \pm 9.5$ , 95% CI = 9.3 – 14.6 years).

### ***Physical activity***

There were 450 participants (93.5%) from the total sample ( $n = 481$ ) who reported they had completed at least 10 minutes of physical activity during the previous 7-days. People with type 2 diabetes and peripheral neuropathy participated in significantly less physical activity compared to those with type 2 diabetes alone ( $p = 0.04$ ) (Table 3). There were 31 participants or 6.4% of the total sample ( $n = 481$ ) who reported that they had not participated in any physical activity at a walking, moderate or vigorous intensity during the previous 7-days.

Of the total sample, 47% ( $n = 228$ ) indicated they had engaged in at least 10 minutes of vigorous physical activity during the past 7-days, 57% ( $n = 274$ ) had engaged in at least 10 minutes of moderate activity, and 90% ( $n = 433$ ) had engaged in at least 10 minutes of walking. There were no

significant differences in the amount of vigorous, moderate or walking activity completed by those with and without peripheral neuropathy (Table 3).

Walking was the preferred activity for all participants and contributed the highest proportion of activity for all participants (Table 4). A total of 29% (n = 131) of participants indicated walking was the only form of physical activity they had engaged in during the previous 7-days.

Using the minutes per week data for each of the intensities within the IPAQ, each participant could be classified as either adhering or not adhering to physical activity recommendations of 150 minutes per week of at least moderate intensity [8]. The results indicated 57% of all respondents met these recommendations. Less than half (49%) of people with type 2 diabetes and peripheral neuropathy met physical activity recommendations, compared to 57% of people with type 2 diabetes alone.

## **Discussion**

In this study we surveyed self-reported physical activity in people with type 2 diabetes and type 2 diabetes and peripheral neuropathy and found that the latter were significantly less active. A total of 51% of respondents with type 2 diabetes and peripheral neuropathy did not meet physical activity recommendations of 150 minutes of at least moderate intensity activity per week.

There appears to be limited published information on self-reported physical activity in people with type 2 diabetes and peripheral neuropathy. Van Schie et al. [15] used accelerometry to assess the level of physical activity in people with peripheral neuropathy, whilst comparing these results with self-reported physical activity assessed using the IPAQ. The authors found that participants reported almost twice as much physical activity compared to the current study, with a median of 2517 (*IQR* = 686, 10,016) MET-min/wk. A possible reason for the difference in results between the two studies may be that the inclusion criteria used by Van Schie et al. [15] stipulated that participants had to be able to walk for at least four minutes. The present study did not have any inclusion criteria of this nature and therefore the sample may have included more sedentary or functionally impaired



individuals with any activity of less than ten minutes duration being recoded to zero minutes that would further decrease the median value.

Though no studies have compared the self-reported physical activity levels of people with type 2 diabetes compared to type 2 diabetes and peripheral neuropathy using the IPAQ, the two groups have been compared using objective measures [16]. Van Sloten et al. [16] found that when assessing physical activity using a pedometer, those with peripheral neuropathy took significantly less steps per day compared to those without peripheral neuropathy. This is in agreement with the current study which found people with peripheral neuropathy were significantly less active than those with type 2 diabetes alone.

A total of 49% of respondents with type 2 diabetes and peripheral neuropathy met physical activity recommendations. Walking was the most preferred type of activity of all participants, however walking was not included as a contributor to physical activity recommendations. Therefore despite many respondents being physically active it appears it was not at a high enough intensity. Though no other studies appear to have reported the proportion of people with type 2 diabetes and peripheral neuropathy who meet physical activity recommendations, several have reported adherence levels to physical activity recommendations in people with type 2 diabetes alone to be between 25% and 41.7% [17-20]. However these studies have substantially larger sample sizes (between  $n = 648$  to  $n = 20,000$ ) compared to the current study and furthermore, comparison of such studies should be done with caution as researchers have found that varying the frequency and duration requirements of the scoring algorithms can yield different results [21, 22].

### ***Study limitations and future recommendations***

It is recommended that further research be conducted using a larger sample by targeting people with type 2 diabetes and peripheral neuropathy. The use of a sub-set of participants with type 2 diabetes meant only a small proportion (11.4%,  $n = 55$ ) identified as having peripheral neuropathy thus limiting the sample. The overall response rate of 15.1% was lower than expected despite numerous attempts to remind participants to respond, and as such this limitation must be considered when

making generalisations. Another limitation of this study is the use of self-reported physical activity questionnaires which may lead to recall bias. Although self-report measures are deemed appropriate for large scale surveys, further research may also indicate the use of objective measures of physical activity, such as accelerometry to support these results.

### ***Conclusions***

This study estimates the self-reported physical activity in people with type 2 diabetes and those who have peripheral neuropathy as a complication of their type 2 diabetes. It was identified that people with type 2 diabetes and peripheral neuropathy had lower levels of physical activity compared to those with type 2 diabetes alone. The most prevalent form of physical activity was walking, which lead to many participants not meeting physical activity recommendations as they were not doing enough activity at a moderate intensity. It is therefore important to promote the use of moderate intensity physical activity in this population, given its positive effects on the biological, sociological and psychological outcomes of peripheral neuropathy.

**Acknowledgements:** Nil

**Authors Disclosures:** The authors have nothing to disclose

**Authors Contributions:**

R.N. contributed to the conception, design and analysis of data, wrote the manuscript

A.R & E.M contributed to the conception, design and analysis of data, reviewed and edited the manuscript.

N.B. Contributed to the analysis of the data, reviewed and edited the manuscript.

## References

1. Shaw J, Tanamas S. Diabetes: the silent pandemic and its impact on Australia. Baker IDI Heart and Diabetes, Melbourne, 2012
2. Australian Institute of Health and Welfare. Diabetes: Australian facts 2008. Department of Health, Canberra, 2008
3. Boulton A, Vinik a, Arezzo J, Bril V, Feldman E, Freeman R et al. Diabetic neuropathies. *Diabetes Care*, 2005;28:956-962
4. Bansal V, Kalita J, Mirsa U. Diabetic neuropathy. *Postgrad Med.*, 2006;82:95-100
5. Mold J, Vesely S, Keyl B, Schenk J, Roberts M. The prevalence, predictors, and consequences of peripheral sensory neuropathy in older patients. *J Am Board Fam Pract.*, 2004;17:309-318
6. World Health Organisation. Guidelines for the prevention, management and care of diabetes mellitus. World Health Organisation, Egypt, 2006
7. Warren M. Physical activity: exercise prescription for the older adult with type 2 diabetes. *Top Geriatr Rehabil.*, 2010; 26:221-232
8. American College of Sports Medicine. ACSM's guidelines for exercise testing and prescription. 8<sup>th</sup> Edn, Wolters Kluwer, Philadelphia, 2010
9. American College of Sports Medicine/American Diabetes Association. Exercise and type 2 diabetes: joint position statement. *Med Sci Sports Exerc.*, 2010; 42:2282-2303
10. Craig C, Marshall A, Sjostrom M, Bauman A, Booth M, Ainsworth B, et al. International physical activity questionnaire: 12 country reliability and validity. *Med Sci Sports Exerc.*, 2003;35:1381-1395

11. Jancey J, Lee A, Howat P, Clarke A, Wang K, Shilton T. Reducing attrition in physical activity programs for older adults. *J Aging Phys Act.*, 2007;15:152-165
12. Tomioka K, Iwamoto J, Seaki K, Okamoto N. Reliability and validity of the International Physical Activity Questionnaire (IPAQ) in elderly adults: the Fujiwara-kyo study. *J Epidemiol.*, 2011;21:459-465
13. Hurtig-Wennlof A, Hagstromer M, Olsson L. The international physical activity questionnaire modified for the elderly: aspects of validity and feasibility. *Public Health Nutr.*, 2010;13:1847-1854
14. IPAQ 2005; [www.ipaq.ki.se](http://www.ipaq.ki.se)
15. Van Schie C, Noordhof E, Busch-Westbroek T, Beelen A, Nollet F. Assessment of physical activity in people with type 2 diabetes and peripheral neuropathy. *Diabetes Res Clin Pract.*, 2011;92:9-11
16. Van Sloten T, Savelberg H, Duimel-Peeters I, Meijer K, Henry R, Stehouwer C, et al. Peripheral neuropathy, decreased muscle strength and obesity are strongly associated with walking in persons with type 2 diabetes without manifest mobility limitations. *Diabetes Res Clin Pract.*, 2011;91:32-39
17. Morrato E, Hill J, Wyatt H, Ghushchyan V, Sullivan P. Physical activity in US adults with diabetes and at risk for developing diabetes. *Diabetes Care*, 2007;30:203-209
18. Resnick H, Foster G, Bardsley J, Ratner R. Achievement of American diabetes association clinical practice recommendations among US adults with diabetes, 1999-2000. *Diabetes Care*, 2006;29:531-537
19. Zhao G, Ford E, Li C, Balluz. Physical activity in US older adults with diabetes mellitus: prevalence and correlated of meeting physical activity recommendations. *J Am Geriatr Soc.*, 2011;59:132-137

20. Zhao G, Ford E, Li C, Mokdad A. Compliance with physical activity recommendations in US adults with diabetes. *Diabet Med.*, 2008;25:221-227
21. Mealing N, Bowles H, Merom D, Bauman A. Impact of scoring algorithm on physical activity prevalence estimates in Australian adults. *J Sci Med Sport*, 2011;14:27-32
22. Sarkin J, Nichols J, Sallis J, Calfas K. Self-report measures and scoring protocols affect prevalence estimates of meeting physical activity guidelines. *Med Sci Sports Exerc.*, 2000;32:149-156

**Table 1**

Calculation of MET-min/wk variables for the IPAQ

<b>MET-min/wk</b>	<b>Formula</b>
Walking	$3.3 * \text{walking minutes} * \text{walking days}$
Moderate	$4.0 * \text{moderate minutes} * \text{moderate days}$
Vigorous	$8.0 * \text{vigorous minutes} * \text{vigorous days}$
Total	$\text{Walking MET-min/wk} + \text{moderate MET-min/wk} + \text{vigorous MET-min/wk}$

IPAQ: International Physical Activity Questionnaire MET: Metabolic Equivalent

**Table 2**

Age and years since diagnosis of type 2 diabetes of all respondents

	<b>n<sup>†</sup></b>	<b>Age (years) <i>M ± SD</i></b>	<b>95% CI</b>	<b>Years since diagnosis <i>(M ± SD)</i></b>	<b>95% CI</b>
All	481	63.2 ± 8.6	62.4 - 63.9	8.4 ± 6.8	7.8 - 9.1
Male	283	64.1 ± 7.9	63.2 - 65.1*	8.7 ± 6.5	8.0 - 9.5
Female	182	61.8 ± 9.4	60.4 - 63.1	8.0 ± 7.3	6.9 - 9.1
With PN	55	66.6 ± 8.2	64.4 - 69.0*	12.0 ± 9.5	9.3 - 14.6*
Without PN	408	62.7 ± 8.6	61.8 - 63.5	8.0 ± 6.3	7.4 - 8.6

M = mean, SD = Standard Deviation, CI = Confidence Interval, PN = peripheral neuropathy, <sup>†</sup> n = 16 did not provide their sex, n = 18 did not provide their PN status, \* statistically significant within group (95%CI)

**Table 3**

Median and interquartile ranges for those who reported engaging in any physical activity (MET.min/wk)

	n <sup>†</sup>	Median (IQR)	p
<b>Total MET.min/wk</b>			
All	450	2076 (798 – 4285)	
With PN	51	1433 (495 – 3390)	0.04*
Without PN	383	2106 (876 – 4380)	
<b>Vigorous MET.min/wk</b>			
All	228	1140 (720 – 3240)	
With PN	18	1440 (780 – 2520)	0.64
Without PN	204	1440 (720 – 3540)	
<b>Moderate MET.min/wk</b>			
All	274	960 (480 – 1920)	
With PN	26	1320 (540 – 2340)	0.70
Without PN	237	960 (480 – 1860)	
<b>Walking MET.min/wk</b>			
All	433	693 (297 – 1386)	
With PN	47	594 (198 – 1386)	0.20
Without PN	371	693 (330 – 1386)	

PN = peripheral neuropathy, <sup>†</sup> some participants did not indicate their PN status, IQR = interquartile range \* statistically significant within group (p<0.05)



**Table 4**

Percentage contribution (Mean  $\pm$ SD) of vigorous, moderate and walking activities to the total amount of self-reported physical activity during the previous 7-days.

	<b>n<sup>†</sup></b>	<b>Vigorous</b>	<b>Moderate</b>	<b>Walking</b>
All	450	18.59 $\pm$ 24.22	24.66 $\pm$ 26.62	56.75 $\pm$ 34.46
With PN	51	13.20 $\pm$ 23.33	24.38 $\pm$ 30.98	62.41 $\pm$ 38.10
Without PN	383	19.57 $\pm$ 24.28	24.72 $\pm$ 26.07	55.71 $\pm$ 33.98

<sup>†</sup> n = 16 did not provide their PN status