ORIGINAL ARTICLE

The Impact of Diabetes Mellitus on Functional Disability among the Patients with and without Diabetic Polyneuropathy: A Comparative Study

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ABSTRACT

Background and Objective: Diabetes mellitus (DM) is a global epidemic associated with increased health expenditure and low quality of life. The complications of diabetes such as diabetic polyneuropathy (DPN) is associated with an increased risk of physical disability, and later may result in early death. The objective of this study was to evaluate the functional disability in patients with and without DPN. **Methods:** A total of 260 subjects were recruited and divided into three groups, DM with DPN (G1), isolated DM (G2), and controls (G3) with 65, 65 and 130 subjects respectively. They were assessed for functional disability with WHO Disability Assessment Schedule 2.0 (WHODAS 2.0) questionnaire. A simple mean and standard deviation were used to analyse the Demographic variables, whereas one-way ANOVA and Tukey test for multiple comparison were used to analyse the data. **Results:** The overall WHODAS scores of the three groups were 48.97 ± 8.87, 38.38 ± 2.83 and 36.26 ± 0.84 respectively. There was a significant statistical difference in WHODAS in G1, G2 and G3 ($p = 0.000$). **Conclusion:** The functional disability is more in patients with DM with and without DPN when compared to controls.

Keywords: Diabetes mellitus, diabetic polyneuropathy, functional disability, WHODAS

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INTRODUCTION

Diabetes mellitus (DM) is a group of metabolic disorders marked by hyperglycaemia known to interfere with insulin production, insulin action or both. DM caused by a number of different pathophysiological mechanisms; these could range from autoimmune death of pancreatic beta cells, resulting in insulin deficiency, to defects that lead to insulin resistance (Edwards et al. 2008). The increasing incidence of DM poses a serious challenge for the medical profession all over the world. Annual worldwide healthcare costs for diabetes treatment and complications prevention are calculated at 727 billion USD in year 2017 and it is estimated as 776 billion USD in the year 2045 (Muc, Saracen & Grabska-Liberek 2018).

DM and its complications are often associated with increasing risk of physical disability (Officer & Groce 2009). Diabetic polyneuropathy (DPN) is present in up to 50% of all chronic diabetic patients and is a major cause of morbidity and mortality (UK Prospective Diabetes Study 1991). In the United States alone, the total costs associated with DPN are USD 10.9 billion a year. Up to 25% of the diabetic patients develop painful neuropathy, characterized by pain, paraesthesia, and sensory loss. Sensory loss can lead to the development of pressure ulcers, balance impairments, an altered gait with potentially increased risk of falling and impaired levels of physical activity. Reduced mobility can lead to restrictions in daily and social activities, dependency on others, depression and as a result decreased quality of life (QoL) (Edwards et al. 2008).

Functional disability is frequently defined as difficulty in performing tasks which are essential for independent living. (Godino et al. 2017; Boyle et al. 2010; Gregg, Beckles & Williamson 2000) such tasks include dressing, lifting or carrying objects, managing money and walking up several flights of stairs. Persons with diabetes are more likely to develop functional disability in tasks of everyday living compared to those without diabetes which in turn, is related to increased expenditures, hospitalizations, and mortality (Hardy et al. 2011; Kalyani et al. 2010; Kalyani et al. 2017). Consequently, functional disability among persons with diabetes represents a significant public health and economic burden. The reasons for this higher prevalence of disability among persons with DM remain unclear but may relate to the presence of comorbidities such as cardiovascular diseases (CVD) and obesity. Socio demographic factors, health status, and lifestyle behaviours may contribute to heterogeneity in the development and progression of functional disability over time (Chen et al. 2016; Boyd et al. 2008).

The World Health Organization Disability Assessment Schedule 2.0 (WHODAS 2.0) is a practical, generic assessment instrument that can measure health and disability at population level or in clinical practice. WHODAS 2.0 quantifies the patient's functioning through analysis of various domains such as cognition, mobility, self-care, good relationship with people, life activities and participation. It consists of 36 questions covering six domains: cognition (6 items); mobility (5 items); self-care (4 items); good relationship with people (5 items); life activities (8 items); and participation (8 items). Each question has five alternatives as possible answers; the first answer represents "No struggle" and the fifth answer "Extreme struggle or unable to perform". The sum of the answers constitutes a 0-100 score in which the higher the number, the worse the functioning level (Chi et al. 2014).

The aim of this study is to find out the impact of DM on functional disability among the patients with and without DPN using WHODAS 2.0 questionnaire, and their functional disability is also compared with the age matched controls (healthy individuals).

MATERIALS AND METHODS

This study was approved by the Institutional Ethical Committee, Voluntary Health Services Hospital, Chennai, KG Hospital, and Post Graduate Institute, Coimbatore. A Power Analysis was used in this study to estimate the minimum sample size required for an experiment, given a desired significance level, effect size, and statistical power. With Power Analysis, 260 samples were needed. This study was conducted over a period of six months which started on March 2019 till August 2019. A total of 130 subjects were identified who met the inclusion criteria and recruited. 65 subjects who were clinician-diagnosed Type 2 DM with DPN were assigned as Group1 (G1 = DM with DPN) (Figure 1). 65 subjects who were clinician-diagnosed Type 2 DM without DPN were assigned as Group2 (G2 = isolated DM). 130 subjects without any metabolic disorders including DM and without any types of associated neuropathy who consented to take part in the study were assigned as Group3 (G3 = controls). Cluster randomization was used to categorize the subjects into respective groups. Written consent was obtained from the individuals. A simple mean and standard deviation were used to analyse the demographic variables; one-way ANOVA and Tukey test for multiple comparison were used to analyse the data. The one-way ANOVA was used to determine whether there are any statistically significant differences between the means of three groups. Tukey test uses pair wise post-hoc testing to determine whether there is a difference between the mean of all possible pairs using a studentized range distribution. This method tests every possible pair of all groups.

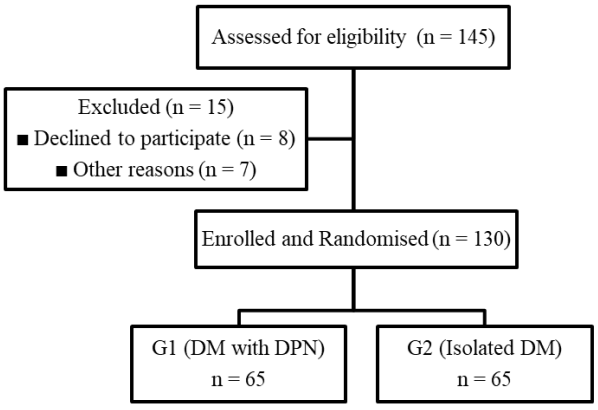

Figure 1: Flow of patients throughout the course of the study

RESULTS

Table I describes the demographic variables which include the age, gender, years of formal education, marital status, and co morbidities. Table II shows the means and standard deviations of WHODAS in G1 was 48.97 ± 8.87, in G2 was 38.38 ± 2.83 and in G3 was 36.26 ± 0.84. The results of one-way ANOVA were statistically significant in WHODAS in G1, G2 and G3 (p = 0.000), along with F-ratio = 164.496. Table III shows the multiple comparisons of WHODAS scores among the groups. The Tukey honestly significant difference (HSD) test was

Table I: Demographic Variables

S. N.	Characteristics		G1 (DM with DPN) n = 65	G2 (Isolated DM) n = 65	G3 (Controls) n = 130
1	Age		60.52 ± 12.86	67.85 ± 7.77	65.46 ± 9.45
2	Gender	Female	30 (46.2%)	32 (49.2%)	66 (50.8%)
		Male	35 (53.8%)	33 (50.8%)	64 (49.2%)
3	Years of formal education		8.69±4.39	8.34±4.37	9.11±3.16
4	Marital status	Never married	3 (4.6%)	5 (7.7%)	0 (0%)
		Currently married	27 (41.5%)	34 (52.3%)	102 (78.5%)
		Separated	3 (4.6%)	4 (6.2%)	0 (0%)
		Widowed	32 (49.2%)	22 (33.8%)	28 (21.5%)
5	Comorbidities	Present	64 (98.5%)	56 (86.2%)	116 (89.2%)
		Absent	1 (1.5%)	9 (13.8%)	14 (10.8%)

Table II: ANOVA between the groups G1, G2 and G3

	G1 (DM with DPN) n = 65	G2 (Isolated DM) n = 65	G3 (Controls) n = 130	F-ratio	p-value
WHODAS	48.97 ± 8.87	38.38 ± 2.83	36.26 ± 0.84	164.496	0.000*

*significant at p < 0.05

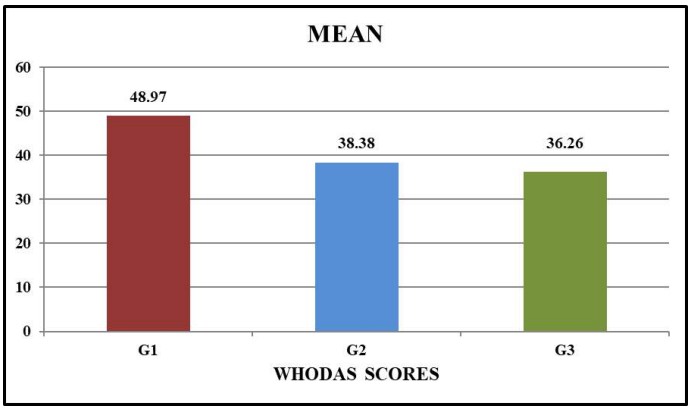

Figure 2: WHODAS scores in each group

Table III: Multiple Comparisons of WHODAS scores between G1, G2 and G3

Dependent variable	(I) Group	(J) Group	Mean Differences (I-J)	Std Error	Sig.	95% confidence	
						Lower bound	Upper bound
WHODAS	G3	G2	-2.123*	0.711	0.009*	-3.80	-0.45
		G1	-12.708*	0.711	0.000*	-14.38	-11.03
	G2	G3	2.123*	0.711	0.009*	0.45	3.80
		G1	-10.585*	0.821	0.000*	-12.52	-8.65
	G1	G3	12.708*	0.711	0.000*	11.03	14.38
		G2	10.585*	0.821	0.000*	8.65	12.52

*significant at $p < 0.05$

performed under the significant result of ANOVA. Multiple comparison results presented statistical differences between groups G1 & G2, G2 & G3 and G1 & G3 ($p = 0.000$).

DISCUSSION

In this study, functional disability among the patients with diabetes mellitus (DM) with and without diabetic polyneuropathy (DPN) when compared to controls assessed with WHODAS 2.0, showed a significant change in all the domains. The WHODAS scores were higher in groups G1 (DM with DPN) 48.97 ± 8.87, G2 (isolated DM) 38.38 ± 2.83 than in group G3 (controls) 36.26 ± 0.84. We also found the presence of functional disability in G3 group, who are controlled subjects without DM and without any types of associated polyneuropathy. This could be due to the process of aging and age-related co-morbidities such as hypertension, cervical spondylitis, osteoarthritis, rheumatoid arthritis, etc.

Individuals with diabetes had at least twofold higher rates of coexisting chronic conditions than those without diabetes (Werfalli et al. 2018). This study showed that diabetes was associated with poor functional disability when considering their age, gender, socio-economic status (low education), being in a low wealth quintile, having a poor employment history, marital status (not being in a partnership) and co-morbid conditions.

The relationship between diabetes and functional disability was seen in all four functional domains, with activities of daily living having the most diabetes-related burden, followed by instrumental activities of daily living, lower extremity mobility, and general physical activities. Chronic hyperglycaemia can trigger inflammatory pathways in the body, leading to a loss of muscle mass, strength, and quality, especially in the lower limbs. This might lead to a decrease in physical activity and involvement in daily activities, worsening the onset of functional impairment. Further, comorbidities commonly associated with longer duration of diabetes, such as coronary heart disease, peripheral arterial disease, and stroke, can all lead to functional disability (Schwartz et al. 2008).

Declining cognitive functioning in patients with diabetes might affect adherence to treatment and drug regimens (McGuire, Ford & Ajani 2006; Sinclair, Grilling & Bayer 2000; Coker & Shumaker 2003). Patients with diabetes with low cognitive functioning were less likely to engage in diabetes monitoring and treatment, resulting in more hospitalizations, restrictions of activity daily living, and the need for more personal assistance, leading to increased functional disability and mortality. Abnormalities in cognitive functioning tests can promptly and effectively reveal changes in neuropsychological functioning and act as a warning indicator for hypoglycaemia (Park et al. 2007; Wong et al. 2013; Bardenheier et al. 2014). This can possibly be a predictor of future functional disability.

CONCLUSION

The functional disability scores are severely higher in patients with DM and DPN, moderately higher in patients with isolated DM and mildly higher in age matched controls (healthy individuals without DM and without any types of associated polyneuropathy). The results directly reflect the level of disability are getting worse when the patients have DPN with involvement of sensory and motor decline as well as autonomic dysfunction. It is recommended to monitor the level of diabetics' functional activities and independence in daily life, so that their health status can be improved and early detection can help in plan of care in order to avoid complications.

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CONFLICT OF INTEREST

The authors declare no conflict of interest.

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REFERENCES

1. Bardenheier, B.H., Gregg, E.W., Zhuo, X., Cheng, Y.J., Geiss, L.S. (2014). Association of functional decline with subsequent diabetes incidence in U.S. adults aged 51 years and older: the health and retirement study 1998–2010. *Diabetes Care, 37,* 1032-1038.

2. Boyd, C. M., Landefeld, C. S., Counsell, S. R., Palmer, R. M., Fortinsky, R. H., Kresevic, D., ... & Covinsky, K. E. (2008). Recovery of activities of daily living in older adults after hospitalization for acute medical illness. *Journal of the American Geriatrics Society*, *56*(12), 2171-2179.
3. Boyle, J.P., Thompson, T.J., Gregg, E.W., Barker, L.E., Williamson D.F. (2010). Projection of the year 2050 burden of diabetes in the US adult population: Dynamic modeling of incidence, mortality, and prediabetes prevalence. *Popul Health Metr, 8,* 29.
4. Chen, Y. M., Chen, D. R., Chiang, T. L., Tu, Y. K., & Yu, H. W. (2016). Determinants of rate of change in functional disability: An application of latent growth curve modeling. *Archives of Gerontology and Geriatrics*, *64*, 21-28.
5. Chi, W.C., Chang, K.H., Escorpizo, R. (2014). Measuring disability and its predicting factors in a large database in Taiwan using the World Health Organization Disability Assessment Schedule 2.0. *Int J Environ Res Public Health*, *11*(12), 12148-12161.
6. Coker, L.H., Shumaker, S.A. (2003). Type 2 diabetes mellitus and cognition: An understudied issue in women's health. *J Psychosom Res*, *54*, 129-139.
7. Edwards, J.L., Vincent, A.M., Cheng, H.T., Feldman, E.L. (2008). Diabetic neuropathy: Mechanisms to management. *Pharmacol Ther*, *120*(1), 1-34.
8. Godino, J. G., Appel, L. J., Gross, A. L., Schrack, J. A., Parrinello, C. M., Kalyani, R. R., Windham, B. G., Pankow, J. S., Kritchevsky, S. B., Bandeen-Roche, K., & Selvin, E. (2017). Diabetes, hyperglycemia, and the burden of functional disability among older adults in a community-based study. *Journal of Diabetes*, *9*(1), 76-84.
9. Gregg, E.W., Beckles, G.L., Williamson, D.F. (2000) Diabetes and physical disability among older U.S. adults. *Diabetes Care, 23*, 1272-1277.
10. Hardy, S.E., Kang, Y., Studenski, S.A., Degenholtz, H.B. (2011). Ability to walk 1/4 mile predicts subsequent disability, mortality, and health care costs. *J Gen Intern Med, 26*(2), 130-135.
11. Kalyani, R.R., Ji, N., Carnethon, M., Bertoni, A.G., Selvin, E., Gregg, E.W., Sims, M., & Golden, S.H. (2017). Diabetes, depressive symptoms, and functional disability in African Americans: The Jackson Heart Study. *Journal of Diabetes and its Complications, 31*(8), 1259-1265.
12. Kalyani, R.R., Saudek, C.D., Brancati, F.L., Selvin, E. (2010). Association of diabetes, comorbidities, and A1C with functional disability in older adults: Results from the national health and nutrition examination survey (NHANES), 1999 – 2006. *Diabetes Care, 33*(5), 1055-1060.
13. Werfalli, M., Kassanjee, R., Kalula, S., Kowal, P., Phaswana-Mafuya, N., Levitt, N.S. (2018). Diabetes in South African older adults: Prevalence and impact on quality of life and functional disability – as assessed using SAGE Wave 1 data. *Global Health Action, 11*:1, 1449924.
14. McGuire, L.C., Ford, E.S. & Ajani, U.A. (2006). The impact of cognitive functioning on mortality and the development of functional disability in older adults with diabetes: The second longitudinal study on aging. *BMC Geriatr, 6,* 8.
15. Muc, R., Saracen, A., Grabska-Liberek, I. (2018). Associations of diabetic retinopathy with retinal neurodegeneration on the background of diabetes mellitus. Overview of recent medical studies with an assessment of the impact on healthcare systems. *Open Med (Wars)*,*13,*130-136.
16. Officer, A., Groce, N.E. (2009). Key concepts in disability. *Lancet, 374*, 1795-1796.
17. Park, S.W., Goodpaster, B.H., Strotmeyer, E.S., Kuller, L.H., Broudeau, R., Kammerer, C., de Rekeneire, N., Harris, T.B., Schwartz, A.V., Tylavsky, F.A., Cho, Y.W., Newman, A.B. (2007). Accelerated loss of skeletal muscle strength in older adults with type 2 diabetes: The health, aging, and body composition study. *Diabetes Care. 30*(6)*,* 1507-1512.
18. Schwartz, A.V., Vittinghoff, E., Sellmeyer, D.E., Feingold, K.R., de Rekeneire, N., Strotmeyer, E.S., Shorr, R.I., Vinik, A.I., Odden, M.C., Park, S.W., Faulkner, K.A., Harris, T.B. (2008). Diabetes-related complications, glycemic control, and falls in older adults. *Diabetes Care*, *31,* 391-396.
19. Sinclair, A.J., Girling, A.J., Bayer, A.J. (2000). Cognitive dysfunction in older subjects with diabetes mellitus: Impact on diabetes self-management and use of care services. All Wales Research into Elderly (AWARE) Study. *Diabetes Res Clin Pract. 50,* 203-212.
20. UK Prospective Diabetes Study (UKPDS) VIII. (2001) Study design, progress and performance. *Diabetologia, 34,* 877890.
21. Wong, E., Backholer, K., Gearon, E., Harding, J., Freak-Poli, R., Stevenson, C., & Peeters, A. (2013). Diabetes and risk of physical disability in adults: A systematic review and meta-analysis. *Lancet Diabetes Endocrinol, 1,* 106-114.