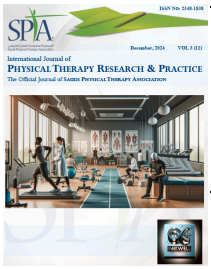

INTERNATIONAL JOURNAL OF
PHYSICAL THERAPY RESEARCH & PRACTICE
AN OFFICIAL JOURNAL OF SAUDI PHYSICAL THERAPY ASSOCIATION

Original Article

Association of Fatigue with Physical Functioning, Postural Balance, and Fall Efficacy in Women with and without Type 2 Diabetes Mellitus

Muneera Mohammed Almurdi1*, Abdulrahman M. Alsubiheen[1], Khattam Mohammed Nasiri[1], Tahani Saad Almutairi[1], Fahad Alrashed[2], Syamala Buragadda[3]

1. Department of Health Rehabilitation Sciences, College of Applied Medical Sciences, King Saud University, P.O. Box 10219, Riyadh 11433, Saudi Arabia.
2. Department of Cardiac Sciences, College of Medicine, King Saud University, P.O. Box 7805, Riyadh 11472, Saudi Arabia.
3. Recovery & Performance Laboratory, Faculty of Medicine, Leonard A Miller Centre, Memorial University of Newfoundland, St. John's, Canada

*Corresponding Author/s: malmurdi@ksu.edu.sa

Article info

Received : **Nov. 18, 2024**
Accepted : **Nov. 29, 2024**
Published : **Dec. 31, 2024**

To Cite: Almurdi, M. M., Alsubiheen, A. M. ., Nasiri, K. M. ., Almutairi, T. S. ., Alrashed , F. A. ., & Buragadda, S. Dr Association of Fatigue with Physical Functioning, Postural Balance, and Fall Efficacy among Individuals with Type 2 Diabetes Mellitus . International Journal of Physical Therapy Research & Practice, 3(11), 416–424. https://doi.org/10.62464/ijoprp.v3i11.66

Abstract

Background: Type 2 diabetes mellitus significantly impacts patients' health-related quality of life (HRQoL), affecting physical, psychological, social, and emotional well-being. This study examined the differences in fatigue, postural balance, fall efficacy, and HRQoL among patients with and without type 2 diabetes across these critical domains. **Methods:** This cross-sectional study involved 37 females with type 2 diabetes (mean age 52.9 ± 7.3 years) who were recruited from a diabetes clinic, along with 16 healthy female participants. Fatigue, postural balance, fall efficacy, and HRQoL were measured using the Fatigue Severity Scale, Berg Balance Scale, the International Fall Efficacy Scale, and the 36-item Short-Form Survey questionnaire, respectively. **Results:** Fatigue scores were significantly higher in people with type 2 diabetes than healthy participants (d= 0.457; p= -0.01). No statistically significant differences in HRQoL were found between the groups, except for role limitations due to emotional problems (d = 0.36, p = 0.013) and social functioning (d = 0.51, p < 0.01). Participants with type 2 diabetes showed no significant differences in postural balance and fall efficacy compared to healthy subjects (p > 0.05). However, fatigue emerged as a significant predictor of physical functioning in individuals with type 2 diabetes but not in healthy participants. **Conclusion:** In conclusion, individuals with type 2 diabetes experience significantly higher fatigue levels, which predict physical functioning, while reporting greater limitations in social functioning and emotional health compared to healthy participants. Identifying these differences guides healthcare professionals in designing more personalized care strategies for individuals with type 2 diabetes.

Keywords: Chronic disease; diabetes; fall efficacy; fatigue; postural control; quality of life.

Introduction

Diabetes is a group of metabolic diseases

associated with hyperglycemia due to complications in insulin secretion, function, or both (Cimbiz & Cakir, 2005). According to the International Diabetes Federation Atlas, 537 million people worldwide have diabetes mellitus (DM), and the number of adults with diabetes is expected to reach 95 million by 2030 and 136 million by 2045, making it the most prominent global epidemic (International Diabetes Federation, 2021). The World Health Organization reports that Saudi Arabia has the highest rate of DM in the Middle East and the seventh highest globally, with 34.1% of males and 27.6% of females affected (Al Dawish & Robert, 2021).

Diabetic neuropathy (DNP) is considered one of the most common chronic microvascular complications in both type 1 and type 2 diabetes that results in damage to the nervous system (Feldman et al., 2019). According to the American Diabetes Association, DNP is defined as "the presence of symptoms and/or signs of peripheral nerve dysfunction in people with diabetes after the exclusion of other causes" (Boulton et al., 2005; Aleidan et al., 2020). DNP significantly affects a patient's lifestyle; almost 5 million people die yearly from its complications (Asif & Batool, 2020). In a hospital-based study in Riyadh, 69.2% of participants had DPN, with age, disease duration, and glycated hemoglobin (HbA1c) level identified as the most significant risk factors (Aljohani et al., 2020). Other factors include neuropathic foot pain and decreased sensations, leading to frequent falls and injuries (Aleidan et al., 2020; Lin et al., 2019).

Motor dysfunction is another prevalent phenomenon in people with type 2 diabetes, characterized by muscle strength and size reduction, particularly in the lower extremities. Loss of muscle function affects overall body movement and can lead to postural instability and changes in walking strategy, increasing the risk of falls (Almurdhi et al., 2017; Almurdhi et al., 2016). Similarly, postural instability is a common complication among patients with diabetes (Mustapa et al., 2016). Individuals with DPN demonstrate impairment in postural control and exhibit greater postural sway in quiet standing compared to healthy subjects (Dixit et al., 2015). A study conducted in the UK found disturbances in postural balance and changes in walking characteristics, such as shorter step length and slower speed, among patients with diabetes and prediabetes compared to healthy controls, with these changes related to small fiber neuropathy (Almurdhi et al., 2017). This confirms that disruptions in sensory integration may lead to postural instability and an increased risk of falls (Espejo-Antúnez et al., 2020; Ghanavati et al., 2013).

Fatigue is another common complication, with a high incidence of 61% among patients with diabetes (Drivsholm et al., 2005) and a generally higher prevalence among females (Schur et al., 2007). Fatigue is associated with poor glycemic control, and controlling blood glucose levels has been shown to improve fatigue (Kaur et al., 2019). Physiological, psychological, and lifestyle factors contribute to fatigue (Fritschi & Quinn, 2010), which manifests as overtiredness, fragility, and emotional or physical exhaustion (Mueller-Schotte et al., 2016). Fatigue can hinder regular exercise, physical functioning, and engagement in daily living activities (Avlund et al., 2008; Singh et al., 2016), negatively impacting psychosocial well-being and overall health (Stewart et al., 2008).

Quality of life (QoL) encompasses physical, psychological, social, and spiritual well-being (Ferrell et al., 1995). Health-related QoL (HRQoL) in patients with DM is influenced by factors such as disease duration, diabetes-related stress, medication adherence, depression, insulin use,

marital status, and neuropathies (Jorgetto & Franco, 2018). A study in Mexico reported lower HRQoL in patients with DM across various domains, including physical function, pain, and mental health, with depression cited as the main factor negatively impacting HRQoL (Zurita-Cruz et al., 2018; Bădescu et al., 2016). Similarly, studies in Saudi Arabia found the prevalence of depression among patients with type 1 and type 2 diabetes to be 37% and 37.9–49.6%, respectively (El Mahalli, 2015; Gemeay et al., 2015).

While there have been limited studies on the individual impacts of diabetes on fatigability, postural balance, and HRQoL, no study has explored the association between fatigue, postural balance, fall efficacy, and HRQoL in detail among these patients in Saudi Arabia. Understanding this association may encourage PwD to maintain good mental and physical health, positively impacting healthcare outcomes. Further, it is important to address the clinical manifestations, complications, and social influence of diabetes. By integrating these key components, our model may help to understand the association between fatigue, postural balance, fall efficacy, and HRQoL in people with type 2 diabetes.

Therefore, this study aimed to investigate fatigue, postural balance, fall efficacy and HRQoL among people with type 2 diabetes compared to healthy subjects. We hypothesized that PwD would have higher fatigue, reduced postural balance, fall efficacy, and HRQoL than healthy subjects.

Methods

Participants

We conducted a cross-sectional comparative study at the Rehabilitation Health Sciences Department at King Saud University, whose Institutional Review Board approved the study, and all the participants gave written informed consent to participate (after explaining their right to refuse or subsequently withdraw and that all data would be reported anonymously and confidentiality).

Based on previous studies examining HRQoL, fatigue, and similar outcomes, a medium effect size (Cohen's d = 0.5) was assumed for this study. To achieve a statistical power of 0.8 (80%) with an alpha level of 0.05, a two-tailed t-test for independent means indicated a required sample size of approximately 64 participants per group. However, due to recruitment challenges and practical constraints, the study included 37 participants with type 2 diabetes and 16 healthy controls. We recruited 37 female participants aged 18-60 years with a history of diabetes who were able to walk independently with or without walking aids from the outpatient diabetic clinics at King Abdulaziz University Hospital and King Khalid University Hospital in Riyadh. We excluded individuals with a history of osteoarthritis, foot ulcers, amputation, cardiovascular diseases, and fibromyalgia. We recruited healthy subjects who were not on any medications and were examined to exclude neuromuscular diseases.

We assessed fatigue using the Fatigue Severity Scale (FSS), functional balance using the Berg Balance Scale (BBS), fall efficacy using the Falls Efficacy Scale-International (FES-I), and the HRQoL using the 36-item Short-Form Survey (SF-36). We assessed disability related to DNP in the diabetes group using the Modified Neuropathy Disability Score (MNDS).

Neuropathy Disability

The severity of neuropathy was assessed using the Modified Neuropathy Disability Score (MNDS) scale, which scores sensations as 0 (present) or 1 (reduced or absent) for each leg, and ankle reflexes

as 0 (normal), 1 (present with reinforcement), or 2 (absent) for each leg (Fawzy et al., 2014). The MNDS evaluates vibration (using a 128-Hz tuning fork) and temperature perception (cold tuning fork) in the great toe, as well as the presence or absence of ankle reflexes. Sensory modalities were scored as present (0) or reduced/absent (1), and ankle reflexes were scored as normal (0), present with reinforcement (1), or absent (2). A maximum score of 10 indicates complete loss of sensation and reflexes (Fawzy et al., 2014).

Fatigue

Fatigue was assessed using the Fatigue Severity Scale (FSS), a validated and reliable self-reported questionnaire consisting of nine items that measure fatigue levels over the past week and its impact on motivation, exercise, physical function, and daily activities (Lerdal, 2021; Al-Sobayel et al., 2016). Scores range from 1 (strong disagreement) to 7 (strong agreement), with higher scores indicating greater fatigue (Al-Sobayel et al., 2016). The total mean score was calculated by dividing the total score by the number of items. Based on literature, fatigue levels were categorized as normal (<4), moderate (4–4.9), and severe (≥5) (Jain et al., 2015).

Balance

The Berg Balance Scale (BBS) was used to evaluate functional balance. This valid and reliable tool assesses postural balance using 14 functional tests (Berg et al., 1992; Miyamoto et al., 2004). Each test is scored on a five-point Likert scale ranging from 0 (unable to complete the task) to 4 (independent task completion), with total scores ranging from 0 to 56. Lower scores indicate greater balance impairment, with a cut-off of <45 suggesting significant impairment (Berg et al., 1992). The BBS is a simple, safe, and effective measure for clinical use (Miyamoto et al., 2004).

Fall Efficacy

The International Fall Efficacy Scale (FES-I) was used to measure fear of falling, demonstrating good reliability (Halaweh et al., 2016). Participants rated their concern about falling during 16 activities on a four-point scale (1 = not at all concerned to 4 = very concerned). Total scores ranged from 16 (no concern) to 64 (severe concern) (Kempen et al., 2007; Yardley et al., 2005).

Health-Related Quality of Life (HRQoL)

The 36-item Short-Form Survey (SF-36) was used to assess HRQoL across eight domains: physical functioning, bodily pain, role limitations due to physical or emotional health, mental health, social functioning, vitality, and general health perception (Brazier et al., 1992). The SF-36 has demonstrated reliability and validity for Arabic-speaking populations (Guermazi et al., 2012) and for assessing QoL in patients with chronic conditions, including diabetes (Laucis et al., 2015; Lins & Carvalho, 2016). Scores for each domain range from 0 to 100, with higher scores indicating better health.

Data Analysis

Data were analyzed using SPSS (V27.0, IBM Corporation, Armonk, New York, USA). We set the two-tailed statistical significance at $p<0.05$. We inspected the data for normality by histograms and Q-Q plots. We used independent t-tests to compare the groups and Pearson's correlation to analyze the relationship between fatigue, BBS, fall efficacy, and HRQoL scores. We calculated effect sizes (Cohen's d or q) and confidence intervals (95% CI) (Chuan & Penyelidikan, 2006) and interpreted the effect sizes (d) as small (0.2), medium (0.5), and large (0.8 or greater). For

correlation, we considered associations as weak (≤0.3), moderate (0.3-0.5), and strong (≥0.5). We used regression analysis (R2) to determine whether fatigue could predict HRQoL.

Results

We screened 55 PwD for eligibility criteria and excluded 18 participants as they had co-morbidities (n=12), falls (n=4), and chronic kidney failure (n=2). As shown in Table 1, the diabetic and healthy groups were similar in age and body mass. Almost half of the participants (n=16; 43.2%) had DNP, and the mean (SD) severity of DNP was 1.05 (1.96). PwD had significantly higher fatigue scores than healthy participants (d=.457; p-0.01). The HRQoL in the diabetes group was not significantly different from the healthy group except for RE (d-.36; p-0.013) and limitation of SF (d-.51; p<0.01). There was no significant difference in postural balance and fall efficacy scores between diabetic and healthy groups (p>0.05).

Associations among fatigue, postural balance, fall efficacy, and HRQoL

As shown in Table 2, higher fatigue levels were significantly associated with lower PF (r=-0.44; p-0.06) and higher pain (r--0.44; p-0.04) in PwD, while these relationships were not statistically significant among healthy participants. The postural balance scores were not significantly associated with either PF or pain in both groups (p>0.05). Fall efficacy was not significantly associated with PF, pain, or GHP in both groups (p>0.05). The GHP scores were significantly associated with fatigue and postural balance scores in healthy participants, while the relationship was insignificant in the diabetes group. Group-wise correlational analysis showed that the association between GHP and pain with fatigue significantly differs between diabetes and healthy groups (r=0.02; q=0.74). Similarly, the relationship between BBS and GHP significantly differed between the two groups (r=0.01; q=0.8). The relationship between fall efficacy and PF, pain and GHP was insignificant between the groups (p>0.05).

Fatigue as a predictor of PF

To determine whether fatigue predicted PF, we performed a linear regression using fatigue as a predictor in diabetes and healthy groups. The regression model significantly predicted 18.5% of the variance in the diabetic group (p =.008), and it was not significant in the healthy group (R2 =.011; p=.705) (Table 3).

Discussion

This study aimed to investigate fatigue, balance, risk of falls, and health-related quality of life (HRQoL) among individuals with and without diabetes mellitus (DM). The findings revealed that fatigue levels were higher in individuals with DM compared to healthy participants. HRQoL components, such as role limitations due to emotional health (RE) and social functioning (SF), also differed significantly between the groups. Moreover, fatigue significantly predicted physical functioning (PF) in the diabetes group but not in individuals without DM.

Fatigue is a common symptom in individuals with DM, often resulting from the body's inability to effectively utilize glucose as an energy source and the constant need for blood sugar management (Fritschi & Quinn, 2010). Additionally, complications such as neuropathy and nephropathy contribute to fatigue, underscoring the importance of comprehensive management strategies (Kaur et al., 2019). Consistent with these findings, prior research has indicated that individuals with type 2 diabetes experience higher fatigue and depression levels than healthy adults

(Kim & Son, 2019). Fatigue is influenced by physiological factors (e.g., blood glucose levels), psychological factors (e.g., depression and emotional distress), and lifestyle factors (e.g., reduced physical activity) (Fritschi & Quinn, 2010; Singh et al., 2016). A sedentary lifestyle exacerbates fatigue by reducing aerobic capacity, creating a cyclical decline in physical function (Mueller-Schotte et al., 2016).

Blood glucose variations play a critical role in fatigue severity among people with diabetes (PwD). Although managing blood glucose levels may help reduce fatigue (Kaur et al., 2019), studies have shown mixed results, with some failing to demonstrate significant improvements (Fritschi & Quinn, 2010). Addressing these contributing factors remains essential for improving HRQoL, as fatigue extends beyond metabolic dysfunction and significantly impacts daily life (Fritschi et al., 2017).

Individuals with diabetes often have reduced physical functioning, higher anxiety, and lower HRQoL compared to those without diabetes (Özdemir & Şahin, 2020). These findings are consistent with studies reporting lower HRQoL across domains in Mexican populations and other groups with type 2 diabetes, primarily due to emotional distress and diabetes-related complications (Gómez-Pimienta et al., 2019; Zurita-Cruz et al., 2018). Chronic complications such as peripheral neuropathy, retinopathy, and nephropathy further limit PF and negatively impact HRQoL (Martín-Timón & del Cañizo-Gómez, 2015). Additionally, individuals with diabetes face increased cardiovascular risks, exacerbating their health challenges (Martín-Timón & del Cañizo-Gómez, 2015).

Conclusion

This study demonstrates that diabetes significantly impacts social functioning, a crucial aspect of overall health-related quality of life (HRQoL). People with diabetes may face challenges in relationships, work, and social activities due to various physical and psychological factors, including the disease's direct effects on energy levels and health and associated economic and social consequences. While differences exist between individuals with diabetes and their non-diabetic counterparts, the study also highlights that fatigue, emotional issues, and social functioning can vary widely among people with diabetes. This indicates that an individual’s physical and psychological health, along with their available support and resources, significantly influences their HRQoL. The differences in fatigue scores and emotional problems between the diabetic and healthy groups emphasize the profound effect diabetes can have on overall well-being. Therefore, healthcare providers must recognize these negative impacts and ensure that individuals with diabetes receive the necessary resources and support to manage their condition effectively.

Author Contributions

All authors significantly contributed to the work reported, including conception, study design, execution, data acquisition, analysis, and interpretation. They actively participated in drafting, revising, or critically reviewing the manuscript, provided final approval of the version to be published, agreed on the journal submission, and accepted accountabilities for all aspects of the work.

Data Availability Statement

The authors will transparently provide the primary data underpinning the findings or conclusions of this article, without any unjustified reluctance. If need from editorial team.

Funding

This research is funded by Researchers Supporting Project number (RSPD2023R798), King Saud University, Riyadh, Saudi Arabia.

Conflicts of Interest

The authors declare no conflict of interest.

Acknowledgments

The authors acknowledge funding from Researchers Supporting Project number (RSPD2023R798), King Saud University, Riyadh, Saudi Arabia.

Reference

Al Dawish MA, Robert AA. Diabetes Mellitus in Saudi Arabia: challenges and possible solutions. Handbook of healthcare in the Arab world: Springer; 2021. p. 1083-100.

Al-Sobayel HI, Al-Hugail HA, AlSaif RM, Albawardi NM, Alnahdi AH, Daif AM, et al. Validation of an Arabic version of fatigue severity scale. Saudi medical journal. 2016;37(1):73.

Aleidan FA, Ahmad BA, Alotaibi FA, Aleesa DH, Alhefdhi NA, Badri M, et al. Prevalence and risk factors for diabetic peripheral neuropathy among Saudi hospitalized diabetic patients: a nested case-control study. International Journal of General Medicine. 2020:881-9.

Aljohani M, Karam A, Alamri A, Manfaloti M, Alnakhli H, Shaqroon H. Diabetic neuropathy in Saudi Arabia: a comprehensive review for further actions. Endocrinology and Metabolic Research. 2020;5.

Almurdhi MM, Brown S, Bowling F, Boulton A, Jeziorska M, Malik R, et al. Altered walking strategy and increased unsteadiness in participants with impaired glucose tolerance and Type 2 diabetes relates to small-fibre neuropathy but not vitamin D deficiency. Diabetic medicine. 2017;34(6):839-45.

Almurdhi MM, Reeves ND, Bowling FL, Boulton AJ, Jeziorska M, Malik RA. Reduced lower-limb muscle strength and volume in patients with type 2 diabetes in relation to neuropathy, intramuscular fat, and vitamin D levels. Diabetes care. 2016;39(3):441-7.

Asif M, Batool S. Association between diabetic neuropathy, fall risks and balance in diabetes type 2 patients. Rawal Medical Journal. 2020;45(1):27-30.

Avlund K, Mehlsen MY, Thomsen DK, Viidik A, Zachariae R. Physical functioning and use of health services in a young and old sample. Dan Med Bull. 2008;55:147-51.

Bădescu SV, Tătaru C, Kobylinska L, Georgescu EL, Zahiu DM, Zăgrean AM, et al. The association between Diabetes mellitus and Depression. J Med Life. 2016;9(2):120-5.

Berg KO, Wood-Dauphinee SL, Williams JI, Maki B. Measuring balance in the elderly: validation of an instrument. Can J Public Health. 1992;83 Suppl 2:S7-11.

Boulton AJ, Vinik AI, Arezzo JC, Bril V, Feldman EL, Freeman R, et al. Diabetic neuropathies: a statement by the American Diabetes Association. Diabetes Care. 2005;28(4):956-62.

Brazier JE, Harper R, Jones N, O'cathain A, Thomas K, Usherwood T, et al. Validating the SF-36 health survey questionnaire: new outcome measure for primary care. British medical journal. 1992;305(6846):160-4.

Chuan CL, Penyelidikan J. Sample size estimation using Krejcie and Morgan and Cohen statistical power analysis: A comparison. Jurnal Penyelidikan IPBL. 2006;7(1):78-86.

Cimbiz A, Cakir O. Evaluation of balance and physical fitness in diabetic neuropathic patients. Journal of Diabetes and its Complications. 2005;19(3):160-4.

Dixit S, Maiya A, Shasthry B, Kumaran DS, Guddattu V. Postural sway in diabetic peripheral neuropathy among Indian elderly. The Indian Journal of Medical Research. 2015;142(6):713.

Drivsholm T, de Fine Olivarius N, Nielsen A, Siersma V. Symptoms, signs and complications in newly diagnosed type 2 diabetic patients, and their relationship to glycaemia, blood pressure and weight. Diabetologia. 2005;48:210-4.

El Mahalli AA. Prevalence and Predictors of Depression among Type 2 Diabetes Mellitus Outpatients in Eastern Province, Saudi Arabia. Int J Health Sci (Qassim). 2015;9(2):119-26.

Espejo-Antúnez L, Pérez-Mármol JM, de los Ángeles Cardero-Durán M, Toledo-Marhuenda JV, Albornoz-Cabello M. The effect of proprioceptive exercises on balance and physical function in institutionalized older adults: a randomized controlled trial. Archives of physical medicine and rehabilitation. 2020;101(10):1780-8.

Fawzy OA, Arafa AI, Wakeel MAE, Kareem SHA. Plantar pressure as a risk assessment tool for diabetic foot ulceration in Egyptian patients with diabetes. Clinical Medicine Insights: Endocrinology and

Diabetes. 2014;7:CMED. S17088.
Federation I. IDF Diabetes Atlas, tenth. International Diabetes. 2021.
Feldman EL, Callaghan BC, Pop-Busui R, Zochodne DW, Wright DE, Bennett DL, et al. Diabetic neuropathy. Nat Rev Dis Primers. 2019;5(1):41.
Ferrell B, Hassey Dow K, Grant M. Measurement of the quality of life in cancer survivors. Quality of life Research. 1995;4:523-31.
Fritschi C, Bronas UG, Park CG, Collins EG, Quinn L. Early declines in physical function among aging adults with type 2 diabetes. Journal of Diabetes and its Complications. 2017;31(2):347-52.
Fritschi C, Quinn L. Fatigue in patients with diabetes: a review. Journal of psychosomatic research. 2010;69(1):33-41.
Gemeay EM, Moawed SA, Mansour EA, Ebrahiem NE, Moussa IM, Nadrah WO. The association between diabetes and depression. Saudi Med J. 2015;36(10):1210-5.
Ghanavati E, Zarbakhsh M, Haghgoo H. Effects of vestibular and tactile stimulation on behavioral disorders due to sensory processing deficiency in 3-13 years old Iranian autistic children. Iranian Rehabilitation Journal. 2013;11(1):52-7.
Gómez-Pimienta E, González-Castro TB, Fresan A, Juárez-Rojop IE, Martínez-López MC, Barjau-Madrigal HA, et al. Decreased quality of life in individuals with type 2 diabetes mellitus is associated with emotional distress. International journal of environmental research and public health. 2019;16(15):2652.
Guermazi M, Allouch C, Yahia M, Huissa T, Ghorbel S, Damak J, et al. Translation in Arabic, adaptation and validation of the SF-36 Health Survey for use in Tunisia. Annals of physical and rehabilitation medicine. 2012;55(6):388-403.
Halaweh H, Svantesson U, Rosberg S, Willen C. Cross-cultural adaptation, validity and reliability of the Arabic version of the Falls Efficacy Scale-International (FES-I). Medical principles and practice. 2016;25(1):1-7.
Jain A, Sharma R, Choudhary PK, Yadav N, Jain G, Maanju M. Study of fatigue, depression, and associated factors in type 2 diabetes mellitus in industrial workers. Ind Psychiatry J. 2015;24(2):179-84.
Jorgetto JV, Franco LJ. The impact of diabetes mellitus on quality of life–differences between genders. Journal of Diabetes & Metabolic Disorders. 2018;17:11-7.
Kaur P, Chugh S, Singh H, Tanwar VS, Sukhija G, Mathur R. Fatigue and diabetes mellitus: a prospective study. International Journal of Advances in Medicine. 2019;6(3):800.
Kempen GI, Todd CJ, Van Haastregt JC, Rixt Zijlstra GA, Beyer N, Freiberger E, et al. Cross-cultural validation of the Falls Efficacy Scale International (FES-I) in older people: results from Germany, the Netherlands and the UK were satisfactory. Disability and rehabilitation. 2007;29(2):155-62.
Kim H, Son H. Fatigue-related factors for community-dwelling older adults with diabetes: A theory-guided multi-dimensional approach using the dynamic biopsychosocial model. International Journal of Environmental Research and Public Health. 2019;16(22):4502.
Laucis NC, Hays RD, Bhattacharyya T. Scoring the SF-36 in orthopaedics: a brief guide. The Journal of bone and joint surgery American volume. 2015;97(19):1628.
Lerdal A. Fatigue severity scale. Encyclopedia of quality of life and well-being research: Springer; 2021. p. 1-5.
Lin YK, Hung M, Sharma A, Chan O, Varner MW, Staskus G, et al. Impaired awareness of hypoglycemia continues to be a risk factor for severe hypoglycemia despite the use of continuous glucose monitoring system in type 1 diabetes. Endocrine Practice. 2019;25(6):517-25.
Lins L, Carvalho FM. SF-36 total score as a single measure of health-related quality of life: Scoping review. SAGE open medicine. 2016;4:2050312116671725.
Martín-Timón I, del Cañizo-Gómez FJ. Mechanisms of hypoglycemia unawareness and implications in diabetic patients. World journal of diabetes. 2015;6(7):912.
Miyamoto ST, Lombardi Júnior I, Berg KO, Ramos LR, Natour J. Brazilian version of the Berg balance scale. Brazilian journal of medical and biological research. 2004;37:1411-21.
Mueller-Schotte S, Bleijenberg N, van der Schouw YT, Schuurmans MJ. Fatigue as a long-term risk factor for limitations in instrumental activities of daily living and/or mobility performance in older adults after 10 years. Clinical Interventions in Aging. 2016:1579-87.
Mustapa A, Justine M, Mohd Mustafah N, Jamil N, Manaf H. Postural control and gait performance in the diabetic peripheral neuropathy: a systematic review. BioMed research international. 2016;2016.
Özdemir N, Şahin AZ. Anxiety Levels, Quality of Life and Related Socio-Demographic Factors in Patients with

Type 2 Diabetes. Nigerian Journal of Clinical Practice. 2020;23(6):775-82.
Schur E, Afari N, Goldberg J, Buchwald D, Sullivan PF. Twin analyses of fatigue. Twin Research and Human Genetics. 2007;10(5):729-33.
Singh R, Teel C, Sabus C, McGinnis P, Kluding P. Fatigue in type 2 diabetes: impact on quality of life and predictors. PloS one. 2016;11(11):e0165652.
Stewart ST, Woodward RM, Rosen AB, Cutler DM. The impact of symptoms and impairments on overall health in US national health data. Medical Care. 2008;46(9):954.
Yardley L, Beyer N, Hauer K, Kempen G, Piot-Ziegler C, Todd C. Development and initial validation of the Falls Efficacy Scale-International (FES-I). Age and ageing. 2005;34(6):614-9.
Zurita-Cruz JN, Manuel-Apolinar L, Arellano-Flores ML, Gutierrez-Gonzalez A, Najera-Ahumada AG, Cisneros-Gonzalez N. Health and quality of life outcomes impairment of quality of life in type 2 diabetes mellitus: a cross-sectional study. Health and quality of life outcomes. 2018;16(1):1-7.