

Rehabilitation Strategies for Patients with Diabetes-Related Musculoskeletal and Neurological Complications

Dr. Nandini Gupta¹, Sahil Mehta², Priya Ramesh³, Karan Joshi⁴

ABSTRACT

Diabetes mellitus is associated with a wide range of musculoskeletal and neurological complications that impair function, mobility and quality of life. Rehabilitation, and physiotherapy in particular, plays an important role in managing these complications, yet the available strategies are often underused. This review synthesises current evidence on rehabilitation strategies for diabetes-related musculoskeletal and neurological complications. It examines musculoskeletal conditions such as adhesive capsulitis, limited joint mobility and diabetic foot problems, and neurological complications including peripheral and autonomic neuropathy and associated balance impairment. The literature indicates that targeted rehabilitation, including joint mobilisation, stretching and strengthening for musculoskeletal complications, and balance, sensorimotor and gait training for neurological complications, improves function, mobility and balance and reduces fall risk, while exercise therapy additionally supports glycaemic control. The review emphasises the importance of an individualised, multidisciplinary approach incorporating foot care and patient education. It concludes that rehabilitation is a valuable, evidence-supported component of diabetes care, and highlights the need for greater integration, standardisation and research to optimise outcomes.

KEYWORDS: *Diabetes Mellitus, Rehabilitation, Physiotherapy, Peripheral Neuropathy, Musculoskeletal Complications, Balance Training, Diabetic Foot, Exercise Therapy*

INTRODUCTION

Diabetes mellitus is a major global health problem whose long-term complications extend well beyond the classical microvascular and macrovascular consequences to include a broad

spectrum of musculoskeletal and neurological disorders [1]. These complications, which include adhesive capsulitis, limited joint mobility, diabetic foot problems, peripheral neuropathy and autonomic dysfunction, significantly impair function, mobility, balance and quality of life, and contribute to disability and falls [1], [2]. Rehabilitation, particularly physiotherapy, has an important role in managing these complications, although it is often underutilised relative to pharmacological and metabolic management.

Musculoskeletal complications of diabetes are common and frequently overlooked. Conditions such as adhesive capsulitis of the shoulder, limited joint mobility or diabetic cheiroarthropathy, and an increased predisposition to certain soft-tissue disorders restrict movement and cause pain [2], [3]. Diabetic foot complications, arising from the interaction of neuropathy, vascular disease and biomechanical changes, are a leading cause of disability and amputation. These conditions are amenable to physiotherapy interventions including joint mobilisation, stretching, strengthening and biomechanical management.

Neurological complications, principally diabetic peripheral neuropathy and autonomic neuropathy, are among the most disabling consequences of diabetes [4]. Peripheral neuropathy impairs sensation and motor control, leading to balance deficits, abnormal gait and an increased risk of falls and foot ulceration, while autonomic neuropathy affects multiple systems. Rehabilitation strategies including balance and sensorimotor training, gait re-education and fall-prevention programmes address these deficits, and exercise therapy additionally contributes to glycaemic control and overall health [4], [5].

The growing global prevalence of diabetes means that the burden of these musculoskeletal and neurological complications is rising correspondingly, yet they remain underrecognised relative to the cardiovascular and renal consequences that dominate clinical attention [1], [2]. Because these complications directly impair movement, balance and the performance of daily activities, they fall squarely within the scope of physiotherapy, which is well placed to preserve function and independence when its role is recognised and resourced.

The problem addressed in this review is the need to synthesise current evidence on rehabilitation strategies for the diverse musculoskeletal and neurological complications of diabetes, which are often considered separately. Accordingly, this review examines

rehabilitation approaches across these complications, evaluates the supporting evidence, and emphasises the importance of an individualised, multidisciplinary approach to optimise function and quality of life in people with diabetes.

REVIEW METHODOLOGY

This narrative review was based on a structured search of peer-reviewed literature concerning rehabilitation and physiotherapy for diabetes-related musculoskeletal and neurological complications. Databases were searched using terms relating to diabetes mellitus, peripheral neuropathy, adhesive capsulitis, limited joint mobility, diabetic foot, balance training, exercise therapy and rehabilitation. Systematic reviews, randomised controlled trials and relevant guidelines were prioritised, and findings were organised by complication category, encompassing musculoskeletal and neurological complications. The principal complications and corresponding rehabilitation strategies are illustrated in Figure 1 & summarised in Table 1.

In synthesising the evidence, the review considered both the functional benefits of rehabilitation for each complication and the broader metabolic effects of exercise, recognising that in diabetes these dimensions are closely linked. Particular attention was given to interventions supported by controlled trials and to outcomes of clear clinical importance, such as balance, fall risk, joint mobility and glycaemic control.

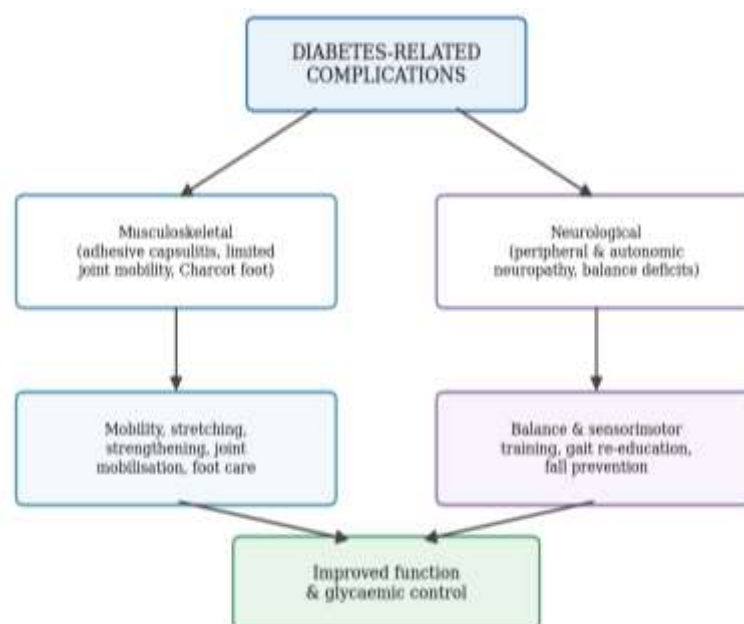


Figure 1: Diabetes-related musculoskeletal and neurological complications and corresponding rehabilitation strategies

Table 1: Diabetes-related complications and rehabilitation approaches.

Complication	Rehabilitation approach
Adhesive capsulitis	Joint mobilisation, stretching, graded exercise
Limited joint mobility	Stretching, range-of-motion and hand exercises
Diabetic foot	Offloading, foot care, gait and footwear advice
Peripheral neuropathy	Balance, sensorimotor and gait training
Autonomic / balance deficits	Fall prevention, functional training

REHABILITATION STRATEGIES

Musculoskeletal Complications

The strategies considered below are grouped into musculoskeletal and neurological categories for clarity, but in practice these complications frequently coexist in the same patient and interact, so that comprehensive assessment across both domains is usually required.

These conditions are frequently more refractory in people with diabetes than in the general population, often requiring longer and more persistent rehabilitation [2], [3]. Setting realistic expectations and maintaining engagement over an extended course are therefore important aspects of management.

Musculoskeletal complications of diabetes respond to targeted physiotherapy. Adhesive capsulitis, which is more common and often more severe in people with diabetes, is managed with joint mobilisation, stretching and graded exercise to restore shoulder range of motion and reduce pain [2], [3]. Limited joint mobility, affecting the hands and other joints, is addressed with stretching and range-of-motion exercises. These interventions aim to preserve and restore movement, prevent contracture and maintain functional independence, and are most effective when initiated early.

The mechanisms linking diabetes to musculoskeletal complications are thought to involve the accumulation of advanced glycation end-products in periarticular connective tissue, leading to stiffening, thickening and reduced extensibility [1], [2]. This understanding explains why early, sustained mobility work is important, since established contracture and capsular thickening are more difficult to reverse than early stiffness. It also underscores the value of integrating musculoskeletal screening into routine diabetes review, so that these often-overlooked

complications are identified and treated before they become disabling.

Diabetic Foot and Biomechanical Management

Diabetic foot complications require a biomechanical and preventive approach within rehabilitation. Physiotherapy contributes through gait assessment and re-education, offloading strategies, footwear advice and foot-care education aimed at reducing abnormal pressures and preventing ulceration [3], [5]. Because diabetic foot problems arise from the interaction of neuropathy, deformity and abnormal loading, their management is inherently multidisciplinary, and physiotherapy plays a key role alongside podiatry and medical care in preserving foot health and mobility.

A particular strength of physiotherapy in diabetic foot care is its focus on the biomechanical drivers of ulceration, which medical management alone does not address [3], [5]. By identifying abnormal pressure distribution, gait deviations and structural deformity, the physiotherapist can target the mechanical causes of tissue breakdown through offloading and gait modification. Combined with rigorous foot-care education, this biomechanical approach contributes to the prevention of a complication whose consequences, including ulceration and amputation, are among the most serious in diabetes.

Peripheral Neuropathy and Balance Training

Lower-limb strengthening and gait re-education complement balance work by improving the motor capacity needed for stable walking and safe negotiation of the environment [4]. Together these elements form a comprehensive sensorimotor programme targeting the multiple deficits that neuropathy produces.

Diabetic peripheral neuropathy impairs sensation and proprioception, producing balance deficits, abnormal gait and increased fall risk [4]. Balance and sensorimotor training, gait re-education and lower-limb strengthening are central rehabilitation strategies, and evidence indicates that such training improves postural control, balance and gait and reduces fall risk in people with diabetic neuropathy [4], [5]. These interventions address the functional consequences of sensory loss by enhancing the use of remaining sensory information and improving neuromuscular control.

The rationale for balance training in diabetic neuropathy rests on the principle that, although sensory loss cannot be reversed, the nervous system can be trained to make better use of

residual sensory and visual information and to improve anticipatory and reactive postural control [4]. Progressive balance and gait training challenges these systems under controlled conditions, promoting adaptation. Given the high cost of falls in this population, in terms of injury, fear and loss of independence, the reported reductions in fall risk represent a clinically meaningful benefit that justifies wider implementation of such programmes.

Exercise Therapy and Glycaemic Benefits

This metabolic dimension distinguishes rehabilitation in diabetes from rehabilitation in many other conditions, where exercise addresses function alone. In diabetes, the same exercise that restores strength and balance also acts on the underlying disease by improving insulin sensitivity and glucose uptake, creating a virtuous link between functional and metabolic benefit [5], [6].

Beyond the management of specific complications, exercise therapy confers broad benefits in diabetes, including improved glycaemic control, cardiovascular health, strength and function [5], [6]. Structured exercise, encompassing aerobic and resistance components, is a cornerstone of diabetes management and supports the prevention and management of complications. Rehabilitation programmes therefore integrate condition-specific interventions with general exercise to address both the local complication and the underlying metabolic disorder. The reported benefits of rehabilitation across key outcomes are summarised in Figure 2 & Table 2.

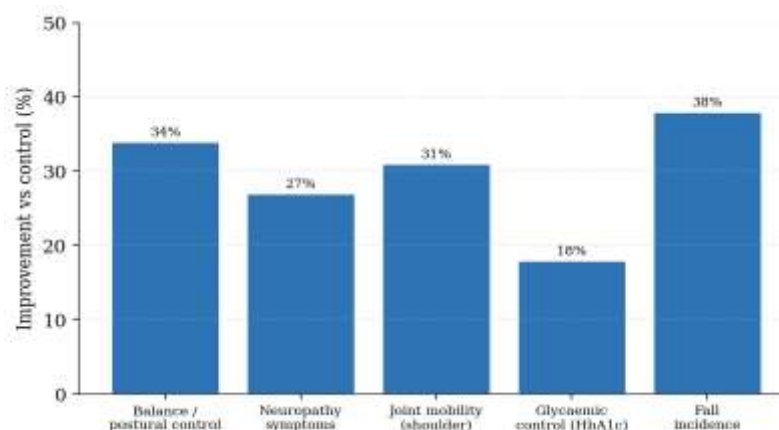


Figure 2: Reported improvement associated with rehabilitation across key outcomes in diabetes

The pattern of reported benefits, with the largest effects on balance and fall reduction, reflects the central role of sensorimotor and balance training in addressing the functional consequences of neuropathy [4], [5]. The more modest effect on glycaemic control is consistent with exercise

being one of several determinants of metabolic regulation, valuable but not sufficient alone.

Table 2: Summary of evidence for rehabilitation strategies in diabetes

Strategy	Evidence level	Main reported benefit
Balance / sensorimotor training	Moderate-strong	Improved balance, fewer falls
Joint mobilisation / stretching	Moderate	Restored joint mobility
Foot care / biomechanics	Moderate	Reduced ulceration risk
Exercise therapy	Strong	Improved glycaemic control, function

DISCUSSION

The evidence reviewed indicates that rehabilitation is a valuable and evidence-supported component of care for the musculoskeletal and neurological complications of diabetes. Targeted physiotherapy improves joint mobility in musculoskeletal complications, enhances balance and gait and reduces fall risk in peripheral neuropathy, supports diabetic foot health, and, through exercise therapy, contributes to glycaemic control and overall health [3], [4], [5]. The breadth of these benefits reflects the wide-ranging impact of diabetes on the musculoskeletal and neurological systems.

A central theme is the importance of an individualised, multidisciplinary approach. Diabetes-related complications are diverse and frequently coexist, and their management requires coordination between physiotherapy, podiatry, medical and educational input [3], [5]. Rehabilitation must be tailored to the specific complications and functional limitations of each patient, integrating condition-specific interventions with general exercise and incorporating foot care and patient education. The interaction between complications, such as the contribution of neuropathy to both foot ulceration and falls, underscores the need for comprehensive assessment and coordinated management.

Effective delivery, however, depends on coordination across disciplines and on patient engagement. Because diabetes self-management is demanding and complications accumulate gradually, sustained adherence to rehabilitation and exercise is a recognised challenge, and education and behavioural support are integral to success [5]. Embedding rehabilitation within structured, patient-centred diabetes care is therefore as important as the specific exercises

prescribed.

The dual role of exercise, addressing both specific complications and the underlying metabolic disorder, is a distinctive and valuable feature of rehabilitation in diabetes. By improving glycaemic control alongside function and balance, exercise therapy offers benefits that extend beyond symptom management to the modification of disease processes [5], [6]. This integration of metabolic and functional benefit makes rehabilitation a particularly efficient component of diabetes care, and supports its prioritisation alongside pharmacological management. The clinical significance lies in the potential to preserve function, prevent disability and reduce serious complications such as falls and amputation.

The preventive potential of rehabilitation deserves particular emphasis. Many of the most serious consequences of diabetes-related complications, including falls, foot ulceration and loss of independence, are to a degree preventable through timely, targeted intervention [3], [4]. Balance training can reduce falls before injury occurs, foot-care and biomechanical management can prevent ulceration before tissue breaks down, and early mobility work can preserve joint function before contracture sets in. This preventive orientation aligns rehabilitation with the broader public-health goal of reducing the disabling sequelae of diabetes.

Several challenges and limitations apply. Rehabilitation for diabetes-related complications is often underutilised, reflecting limited awareness, access and integration into diabetes care pathways. The evidence base varies across complications, being stronger for exercise therapy and balance training and more limited for some musculoskeletal interventions, and heterogeneity in interventions and outcomes complicates comparison. These considerations indicate the need for greater integration of rehabilitation into diabetes care and for further high-quality research.

CONCLUSION

Crucially, rehabilitation complements rather than competes with medical and metabolic management, addressing the functional dimension of diabetes that pharmacological treatment does not reach [5], [6].

Rehabilitation is a valuable, evidence-supported component of care for the diverse musculo-

-skeletal and neurological complications of diabetes. Targeted physiotherapy improves joint mobility, enhances balance and gait and reduces fall risk, supports diabetic foot health, and, through exercise therapy, additionally improves glycaemic control and overall health. An individualised, multidisciplinary approach incorporating condition-specific interventions, general exercise, foot care and patient education is essential to optimise outcomes. Despite strong rationale and supportive evidence, rehabilitation for diabetes-related complications remains underutilised, and greater integration into diabetes care, together with standardisation and further high-quality research, is needed to realise its full potential in preserving function and quality of life.

LIMITATIONS

This review has several limitations. As a narrative review rather than a systematic review with meta-analysis, it is subject to selection bias and does not provide pooled quantitative estimates. The breadth of complications covered necessarily limits the depth of analysis for each, and the evidence base varies considerably in quality across complications, being stronger for exercise and balance training and more limited for some musculoskeletal interventions. Heterogeneity in patient populations, interventions and outcome measures limits direct comparison, and the review focuses on the most studied complications, potentially underrepresenting less common or emerging conditions and interventions.

FUTURE SCOPE

Future research should include high-quality randomised controlled trials evaluating specific rehabilitation interventions for the various musculoskeletal and neurological complications of diabetes, with standardised protocols and outcome measures. Studies examining the integration of rehabilitation into routine diabetes care pathways, and strategies to improve access and uptake, would address the current underutilisation. Research into combined interventions that simultaneously target complications and glycaemic control, and into the long-term effects of rehabilitation on disability, falls and amputation, would strengthen the evidence base. The development of accessible, technology-supported and community-based rehabilitation programmes offers promising directions for extending the reach of effective care.

REFERENCES

1. Abate M, Schiavone C, Salini V, Andia I. Management of limited joint mobility in diabetic patients. *Diabetes, Metabolic Syndrome and Obesity*. 2013;6:197-207.

2. Ramchurn N, Mashamba C, Leitch E, et al. Upper limb musculoskeletal abnormalities and poor metabolic control in diabetes. *European Journal of Internal Medicine*. 2009;20(7):718-721.
3. Bus SA, van Netten JJ, Lavery LA, et al. IWGDF guidance on the prevention of foot ulcers in at-risk patients with diabetes. *Diabetes/Metabolism Research and Reviews*. 2016;32(Suppl 1):16-24.
4. Ites KI, Anderson EJ, Cahill ML, et al. Balance interventions for diabetic peripheral neuropathy: a systematic review. *Journal of Geriatric Physical Therapy*. 2011;34(3):109-116.
5. Colberg SR, Sigal RJ, Yardley JE, et al. Physical activity/exercise and diabetes: a position statement of the American Diabetes Association. *Diabetes Care*. 2016;39(11):2065-2079.
6. Pai LW, Li TC, Hwu YJ, et al. The effectiveness of regular leisure-time physical activities on long-term glycemic control in people with type 2 diabetes: a systematic review and meta-analysis. *Diabetes Research and Clinical Practice*. 2016;113:77-85.

Author for Correspondence

Dr. Nandini Gupta

E-mail: nandinigupta2034@yahoo.co.in

¹Associate Professor, Department of Musculoskeletal Physiotherapy, Oasis College of Physiotherapy, Pune

²Assistant Professor, Department of Musculoskeletal Physiotherapy, KIMSUDU College of Physiotherapy

³PG Scholar, Department of Musculoskeletal Physiotherapy, KIMSUDU College of Physiotherapy

⁴PG Scholar, Department of Musculoskeletal Physiotherapy, Oasis College of Physiotherapy, Pune

Received Date: March 10, 2026

Accepted Date: March 31, 2026

Published Date: April 14, 2026

Citation: Dr. Nandini Gupta, Sahil Mehta, Priya Ramesh, Karan Joshi. Rehabilitation Strategies for Patients with Diabetes-Related Musculoskeletal and Neurological Complications. *Journal of Physiotherapy in Medical and Surgical Conditions*. 2026; 2(1): 34-43p.