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Effectiveness of a Self-Stretching Exercise Program on Restless Leg Symptoms in Patients with Type 2 Diabetes Mellitus: A Pre-Post Intervention Analysis

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ABSTRACT

Restless legs syndrome (RLS) symptoms, characterized by an urge to move the legs, unpleasant sensations, worsening during rest, and predominance at night, are prevalent sleep-disrupting complaints. **Objectives:** To evaluate the effectiveness of a home-based self-stretching exercise program in reducing RLS symptoms among adults with Type 2 Diabetes Mellitus. **Methods:** This experimental study recruited two hundred (200) adults aged 40–59 years with a confirmed diagnosis of T2DM (HbA1c >6.5%) via convenience sampling at District Headquarter Hospital, Lodhran, and Bahawal Victoria Hospital, Bahawalpur. Following baseline assessment, participants received standardized instruction and hands-on training in a daily lower-limb self-stretching program to perform at home for four weeks. Restless legs symptoms were quantified using the RLS Diagnostic Index (RLS-DI). Pre–and post-changes in RLS-DI Sum Score and Grand Total Score were examined with paired-samples t-tests; item-level frequency shifts were analyzed via chi-square tests (α=0.05). **Results:** The mean RLS-DI Sum Score decreased significantly from 7.39 ± 5.60 to –0.79 ± 6.25 (mean paired difference 8.17, 95% CI 7.06–9.28, t=14.56, p<0.001). The Grand Total Score fell from 3.31 ± 6.83 to –2.27 ± 6.74 (mean difference 5.57, 95% CI 4.38–6.76, t=9.20, p<0.001). Item-level analyses revealed significant reductions in frequency of urge to move (χ^2=17.395, p=0.002), unpleasant sensations (χ^2=13.671, p=0.008), worsening during rest (χ^2=12.009, p=0.017), and sleep disturbance (χ^2=22.665, p=0.001). **Conclusions:** A 4-week self-stretching program was associated with substantial reductions in restless leg syndrome symptoms among adults with T2DM. These findings position self-stretching as a feasible, low-cost, non-pharmacological strategy for managing RLS symptoms in routine outpatient diabetes settings.

INTRODUCTION

Restless legs syndrome (RLS) is a sensorimotor disorder of sleep, which is characterized by an urge to move legs frequently accompanied by unpleasant sensations. The typical symptoms, which generally develop or deteriorate during rest, improve with activity, and exhibit circadian patterns in the evening or at night, cause difficulty in the initiation and maintenance of sleep, as well as in the quality of sleep [1, 2]. Since symptoms often appear when a person is idle and are alleviated temporarily through activity, RLS may have a significant impact on bedtime habits, increase the duration between waking up and going to bed, and disrupt sleep through the night, thereby worsening daytime performance and reducing health-related quality of life [2, 3]. The modern clinical decision-making focuses on the diagnosis based on the symptom and follows the consensus criteria and the exclusion of common mimics, e.g., nocturnal leg cramps, positional pain, pain of peripheral neuropathy, and habitual movement of legs,

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which are not provoked by a sensory desire [1, 4]. There is growing observational data to indicate that RLS is more prevalent in diabetes patients as compared to non-diabetic groups. Recent meta-analysis (observational studies) has indicated that about a quarter of diabetic individuals might experience the symptoms of RLS and that diabetes is related to higher risks of RLS than non-diabetic controls [5]. Research on RLS among patients in various clinical environments indicates a significant prevalence of RLS among patients with type 2 diabetes and its linkages with diabetes complications, especially neuropathy [6-10]. Mechanistically, suggested connections between T2DM and RLS are dysregulated iron management and dopaminergic signaling, microvascular pathophysiology, oxidative damage, and changes in sensory pathways associated with diabetic peripheral neuropathy, which can symptomatically overlap with RLS or serve as an RLS precipitant [6, 8]. This medical overlap highlights the importance of thorough differential diagnosis in clinical settings with diabetes because leg pain can be classified as neuropathy, whereas a contributing pathology of RLS is under-appreciated [1, 8]. The evidence-based management of RLS currently involves treating underlying conditions (e.g., iron deficiency), checking the medications that could worsen the symptoms, and applying pharmacologic treatment in cases when the symptoms are clinically prominent [11]. Nonetheless, pharmacologic treatment can be challenging due to adverse events, polypharmacy implications in the elderly with T2DM, and the potential risk of the development of dopaminergic augmentation when using specific medications with time. In line with this, recent evidence-based practices are placing a more accurate focus on personalized care and regard non-pharmacologic approaches as significant elements of treatment, particularly in groups with a strong risk of drug risks or access limitations [11, 12]. Biologically plausible interventions to RLS include exercise-based and body-based interventions since acute movement removes symptoms and potentially affects peripheral afferent signaling, muscle tone, microcirculation, and arousal related to stress. Symptomatic population clinical trials (such as the patients on hemodialysis with a high rate of secondary RLS) show that exercise and specific stretching exercises could decrease the severity of RLS symptoms and enhance sleep-related outcomes [13, 14]. Meanwhile, lifestyle-based interventions like yoga have demonstrated potential in randomized controlled trials, and decreases in RLS symptoms and their accompanying sleep and mood outcomes, in favor of the larger theory that low-cost movement interventions can be therapeutically useful [15, 16]. While evidence remains heterogeneous across populations, these findings provide a rationale to evaluate feasible self-stretching programs that can be delivered in routine outpatient settings and practiced safely at home. In recent Pakistani rehabilitation studies, structured exercise and stretching protocols have been delivered successfully in supervised and home-based formats, supporting the feasibility of self-directed programs in local outpatient settings [17, 18]. Despite increasing global literature, local data from Pakistan, particularly South Punjab, remain limited regarding the burden of RLS symptoms in adults with T2DM and the responsiveness of RLS symptoms to practical, clinic-to-home interventions. Additionally, given the common coexistence of neuropathic symptoms, sleep fragmentation, and EDS in diabetes, there is a need for interventions that are simple, scalable, and acceptable to patients, while being measurable through validated symptom and sleepiness indices [4, 18]. The study hypothesized that regular self-stretching would reduce RLS symptom burden and potentially improve related daytime functioning, offering a low-risk adjunct to comprehensive diabetes care.

The study lacks a control group, objective outcome measures, long-term follow-up data, and assessment of key confounders like iron status, limiting causal inference and generalizability. The study cannot prove causation, subjective data, the benefits' sustainability is unknown, and real-world feasibility is unclear. Therefore, the present study evaluated the effectiveness of a structured self-stretching exercise program on restless leg symptom severity in adults with T2DM, using standardized symptom scoring and paired pre-post comparisons.

METHODS

This study used an experimental pre-post intervention design to evaluate changes in restless leg symptoms after a home-based self-stretching exercise program among adults with type 2 diabetes mellitus (T2DM). Data collection was conducted for three months from April 2025 to June 2025 at District Headquarter Hospital, Lodhran, and BVH, Bahawalpur. Approval of the study was obtained from the Ethical Review Committee of the Department of Physical Therapy, The Islamia University of Bahawalpur; reference No. 2026-A/DPT. Participation was voluntary, and written informed consent was obtained before enrollment. Participant confidentiality was maintained by anonymizing data and restricting access to study records to the research team. Baseline assessment and 4-week follow-up assessment were performed using the same procedures at the participating sites. Participants (n=200) were recruited using a convenience, non-probability sampling technique from patients attending the participating hospitals during the study period. Adults aged 40-59 years of either sex with

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a diagnosis of type 2 diabetes mellitus (T2DM) and HbA1c > 6.5% who were willing to participate were eligible for inclusion. Exclusion criteria were type 1 diabetes mellitus, nephropathy, heart disease, history of trauma, musculoskeletal conditions that could limit safe stretching performance or confound lower-limb symptoms, and diabetic neuropathy. Restless leg symptoms were assessed using the Restless Legs Syndrome Diagnostic Index (RLS-DI) [19]. The RLS-DI captured core symptom domains, and summary scores were derived according to the scoring approach used in the study dataset. Participants received instructions and demonstrations in a standardized, home-based self-stretching exercise program. The program was delivered by qualified physiotherapy staff and prescribed for four weeks. Instruction was provided in a gender-appropriate manner (female participants by female staff and male participants by male staff). Participants were advised to perform the prescribed stretches at least five times a week and at least two times a day at home throughout the intervention period as per the schedule and guidance provided. After ethical approval and permission from the Ethical Committee of the Department, eligible patients were approached in the outpatient setting. Baseline data were collected using the RLS-DI. Participants were then trained in the self-stretching program and followed for four weeks. At the end of week 4, the RLS-DI was re-administered using the same data collection procedures.

Data were analyzed using SPSS (version 23.0). Continuous variable, i.e., RLS-DI total score, was summarized using mean and standard deviation. Pre-post changes in continuous RLS-DI total scores were evaluated using paired-samples tests (paired t-test where applicable). Categorical symptom responses and categorized ESS outcomes were examined using cross-tabulations, and associations were evaluated using chi-square tests. Statistical significance was set at $p<0.05$.

RESULTS

A total of 200 participants consisted of 97 (48.5%) males and 103 (51.5%) females with a mean age of 50.76 (SD 5.537). All participants completed both baseline (pre-intervention) and follow-up (post-intervention) assessments. Both RLS-DI summary measures improved significantly at follow-up. For the Sum Score, the mean decreased from 7.39 ± 5.60 to −0.79 ± 6.25, corresponding to a mean pre-post difference of 8.17 points (95% CI: 7.06 to 9.28), t=14.56, p<0.001. For the Grand Total score, the mean decreased from 3.31 ± 6.83 to −2.27 ± 6.74, corresponding to a mean difference of 5.57 points (95% CI: 4.38 to 6.76), t=9.20, p<0.001 (Table 1).

Table 1: Pre-Post Changes in RLS-DI Summary Scores (Paired-Samples t-Tests)

Outcomes	Pre	Post	MD (Post)	t-test	p-value
	Mean ± SD	Mean ± SD			
Sum Score (RLS-DI)	7.390 ± 5.602	-0.790 ± 6.249	8.170	14.556	<0.001
Grand Total (RLS-DI)	3.310 ± 6.825	-2.270 ± 6.737	5.570	9.201	<0.001

Item-level analyses demonstrated marked shifts from higher-frequency symptoms ('occurs regularly') toward lower-frequency categories ('occurs occasionally' and 'not present') for multiple core domains. Statistically significant distribution changes were observed for urge to move the legs (p=0.002), unpleasant sensations (p=0.008), worsening at rest (p=0.017), and sleep disturbances (p=0.001). Relief with movement (p=0.180) and evening/night predominance (p=0.092) did not reach significance at the 0.05 level (Table 2).

Table 2: Pre and Post-Distribution of RLS-DI Symptom-Frequency Items and Chi-Square Tests

Item	Pre-Not Present, n (%)	Pre-Occasionally, n (%)	Pre-Regularly, n (%)	Post Not Present, n (%)	Post Occasionally, n (%)	Post Regularly, n (%)	χ^2	p-value
Urge to Move Legs	13 (6.5%)	45 (22.5%)	142 (71.0%)	70 (35.0%)	106 (53.0%)	24 (12.0%)	17.395	0.002
Unpleasant Sensations	9 (4.5%)	69 (34.5%)	122 (61.0%)	75 (37.5%)	101 (50.5%)	24 (12.0%)	13.671	0.008
Worsen at Rest	18 (9.0%)	71 (35.5%)	111 (55.5%)	72 (36.0%)	99 (49.5%)	29 (14.5%)	12.009	0.017
Relief with Movement	55 (27.5%)	83 (41.5%)	62 (31.0%)	59 (29.5%)	86 (43.0%)	55 (27.5%)	6.272	0.180
Evening/Night Increase	30 (15.0%)	50 (25.0%)	120 (60.0%)	92 (46.0%)	82 (41.0%)	26 (13.0%)	7.986	0.092
Sleep Disturbances	25 (12.5%)	50 (25.0%)	125 (62.5%)	73 (36.5%)	102 (51.0%)	24 (12.0%)	22.665	0.001

Using Total Score categorization, RLS prevalence decreased from 19.0% (38/200) at baseline to 1.0% (2/200) at follow-up. Using Grand Total categorization, prevalence decreased from 18.0% (36/200) to 1.5% (3/200). Despite these large descriptive reductions, chi-square tests were not statistically significant for either 2×2 table, likely due to very low post-intervention RLS counts and small expected cell frequencies (Table 3).

Table 3: Pre and post Categorical RLS Status and Chi-Square Tests

Categorization	Pre RLS, n (%)	Post RLS, n (%)	No→No	No→RLS	RLS→No	RLS→RLS	χ^2	p-value
Total Score	38 (19.0)	2 (1.0)	160	0	36	2	0.474	0.491
Grand Total	36 (18.0)	1 (1.5)	162	0	35	1	0.485	0.486

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DISCUSSION

In this hospital-based sample of adults with type-2 diabetes mellitus (T2DM), a structured self-stretching program was followed by a marked reduction in Restless Legs Syndrome Diagnostic Index (RLS-DI) symptom burden. Paired-sample analyses showed highly significant pre-to-post improvements in the RLS-DI sum score and the total score, with large-to-moderate within-subject effect sizes. Symptom-pattern crosstabs further suggested clinically meaningful shifts: the proportion reporting "occurs regularly" for key sensory-motor features (urge to move the legs and unpleasant sensations) fell substantially, while the proportion reporting no symptoms increased. Sleep-related impact improved as well, with a notable rise in the proportion reporting no sleep disturbance after the program. Non-pharmacological management is frequently recommended as a first step for many patients with mild-to-moderate RLS symptoms, especially when comorbidities, medication burden, or access barriers make pharmacotherapy less attractive. Contemporary reviews of conservative and rehabilitative approaches describe exercise, stretching, massage-type modalities, and movement-based strategies as plausible symptom-relieving options, although study designs and intervention doses vary considerably [20]. In the broader RLS literature, exercise-based programs have repeatedly been associated with symptom reduction, sleep improvement, and better daytime functioning in selected populations. For example, a meta-analysis of exercise training trials in hemodialysis populations reported consistent improvements in RLS symptom severity and related outcomes [14]. Although our population differed (T2DM rather than end-stage kidney disease), both groups share risk pathways that may amplify sensory symptoms (e.g., metabolic-vascular dysfunction, neuropathic features, and sleep disruption), potentially making movement-based strategies relevant. Evidence specific to diabetes is also converging on the idea that RLS is not rare in T2DM and that addressing RLS may have measurable patient-centered benefits. Observational work has documented the presence of RLS in T2DM cohorts and linked it with reduced sleep quality and quality of life [21]. Notably, even pharmacologic treatment studies in T2DM have shown that symptom improvement is accompanied by better sleep indices, and in some reports, modest improvements in glycemic control, suggesting that reducing nocturnal symptoms may help relieve sleep-related metabolic stress [22]. Within this context, our findings support the plausibility that a low-cost, home-based stretching program can meaningfully reduce symptom burden in a T2DM sample, at least in the short term. The pathophysiology of RLS is multifactorial. Contemporary synthesis work highlights contributions from iron handling and central dopaminergic signaling, as well as interactions with sleep-wake regulation and peripheral sensory inputs [23]. In people with T2DM, additional contributors, such as microvascular changes and diabetic neuropathy, may add sensory symptoms that overlap with RLS complaints or increase their salience. Because neuropathic pain, cramps, positional discomfort, and peripheral neuropathy can mimic RLS, careful clinical characterization is essential, and diabetes-focused guidance has emphasized structured assessment to differentiate true RLS from diabetic neuropathy and related mimics [24]. Supportive evidence for stretching-centered programs comes from interventional studies in clinical populations where RLS is common. For instance, a stretching exercise program in hemodialysis patients reduced RLS severity compared with usual care [25], and intradialytic stretching training has also been associated with improved RLS symptoms and sleep quality [26]. While mechanisms may differ across populations, these studies strengthen the biological and behavioral plausibility of stretching as a symptom-modulating strategy. The largest practical improvements in our crosstab analyses were observed in domains most closely tied to discomfort during rest, urge to move the legs, unpleasant sensations, and worsening at rest. These domains are also the ones most likely to be influenced by changes in muscle tension, peripheral sensory input, and immobility-related discomfort. Sleep disturbance showed a clear improvement, consistent with the idea that reducing evening symptoms decreases sleep fragmentation and improves perceived restrictiveness. In contrast, domains reflecting the defining pattern of RLS (relief with movement and evening/night predominance) showed comparatively smaller shifts and non-significant χ^2 results. This is not necessarily inconsistent with clinical improvement: for participants who continued to have residual symptoms, those symptoms may still have retained the classic RLS pattern (movement-responsive and worse in the evening), even if their overall intensity or frequency was reduced. From a pragmatic standpoint, the observed improvement suggests that structured self-stretching can be considered a low-risk adjunct within T2DM clinics, particularly where access to specialist sleep services or long-term medication monitoring is limited. Finally, while iron therapy and pharmacologic options remain important for selected patients, conservative approaches can be positioned as first-line or complementary strategies alongside medical evaluation, particularly for individuals with mild symptoms or those reluctant to use long-term dopaminergic agents.

This study used a pre–post design without a parallel control group; therefore, causal inference is limited, and

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improvements could partly reflect regression to the mean, expectancy effects, or concurrent changes in lifestyle and medication. Outcomes were based on self-reported diagnostic index scoring rather than clinician-confirmed diagnosis or objective sleep measures (e.g., polysomnography or actigraphy). The study did not include biochemical characterization (e.g., ferritin or transferrin saturation), standardized assessment of neuropathy severity, or systematic screening for sleep apnea, each of which could confound symptom reporting. Adherence to the home program was not objectively monitored, and longer-term durability of improvement was not assessed. Future work should evaluate self-stretching using randomized controlled designs with appropriate comparators (e.g., education-only, sham stretching, or standard care) and longer follow-up to test durability. Stratification by neuropathy status, iron indices, obesity, and sleep apnea risk could clarify which subgroups benefit most. Incorporating validated severity scales (e.g., IRLS), objective sleep endpoints, and glycemic outcomes (HbA1c) would help clarify whether symptom improvement translates into measurable metabolic benefit. Finally, implementation-focused studies in resource-limited settings should test pragmatic delivery methods (printed protocols, mobile reminders, brief physiotherapist coaching) and quantify adherence, feasibility, and cost-effectiveness.

CONCLUSIONS

A self-administered stretching exercise program was associated with substantial reductions in restless leg syndrome symptoms among adults with type 2 diabetes mellitus. The pattern of improvement was most pronounced for rest-related sensory-motor symptoms and for perceived sleep disruption. These findings support the feasibility and potential clinical value of incorporating structured self-stretching as a conservative management option for restless leg syndrome symptoms in diabetes type 2 diabetes care settings.

Authors' Contribution

Conceptualization: NM
Methodology: MI, MZ
Formal analysis: NM
Writing and Drafting: NM, MI, MZ, MA, WA
Review and Editing: NM, MI, MZ, MA, WA

All authors approved the final manuscript and take responsibility for the integrity of the work.

Conflicts of Interest

The authors declare no conflict of interest.

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