Journal of Medicine and Health Sciences Research 2025, 8: 10-15
https://doi.org/10.21839/jmhsr.2025.v8.9765

Research Article

Exercise based intervention for chronic low back pain, correlates of treatment success and patient characteristics

Md Noman Azam[1]*, Md Balal Hossain[1], Most. Raihanul Jannat Roshni[2], Musomi Khandaker[3], Sonya Ghosh[3]

[1]Department of Health Sciences and Leadership, St. Francis College, Brooklyn, New York, USA, [2]Department of Emergency, AR Rafi Hospital & Diagnostic Center, Hazinagar, Dhaka Bangladesh, [3]Department of Epidemiology and Biostatistics, Monroe University, Bronx, New York, USA

(Received: October 14, 2025; Revised: November 21, 2024; Accepted: November 23, 2024; Published: December 05, 2025)
*Corresponding author: Md Noman Azam (E-mail: nomanlpu07@gmail.com)

ABSTRACT

Chronic low back pain (CLBP) is a major cause of disability worldwide, affecting a substantial proportion of the population and imposing significant physical and economic burdens. Physiotherapy is widely recommended, but evidence on its clinical effectiveness in Bangladesh is limited. This study aimed to evaluate the effectiveness of exercise-based physiotherapy interventions on pain reduction and lumbar mobility in patients with CLBP and to identify correlates of treatment success. A descriptive study was conducted at a rehabilitation center in Dhaka, Bangladesh, from June to December 2022. Medical records of 400 patients with non-specific CLBP were reviewed. Data on demographics, pain intensity, lumbar mobility, physiotherapy interventions, treatment sessions, and self-reported improvement were extracted. Pain was assessed using the Visual Analogue Scale (VAS), and lumbar mobility was measured by flexion and extension. Correlation and multiple regression analyses were conducted to identify predictors of pain reduction. Among 400 patients, 61.3% were female, and the most common age group was 21-30 years (45.8%). Mean baseline VAS was 6.7±1.6, which decreased significantly to 3.1±1.5 post-treatment ($p<0.001$). Substantial improvements in lumbar flexion and extension were observed (all $p<0.001$). Over half of patients (52.3%) reported ≥76% improvement in pain. Correlation analysis indicated that the number of treatment sessions ($r=0.21$, $p<0.001$) and therapeutic exercise ($r=0.15$-0.18, $p<0.001$) were significantly associated with clinical improvement. Multiple regression analysis identified treatment sessions ($\beta=0.19$, $p<0.001$) and therapeutic exercise ($\beta=0.15$, $p=0.003$) as significant predictors of pain reduction. Gender-based analysis showed higher baseline pain in females ($p<0.001$), but post-treatment improvement was significant in both sexes. Exercise-based physiotherapy, particularly when delivered through sufficient treatment sessions, is highly effective in reducing pain and improving lumbar mobility in Bangladeshi patients with CLBP. Structured therapeutic exercises and adherence to treatment sessions are key factors influencing clinical outcomes.

Key words: Chronic low back pain, Physiotherapy, Pain reduction, Lumbar mobility, Bangladesh

INTRODUCTION

Chronic low back pain (CLBP) is a leading cause of disability and a persistent global health challenge. It is among the most common musculoskeletal conditions, affecting people across all continents, age groups, and socioeconomic classes. While low back pain often begins as an acute episode, a significant number of individuals develop chronic symptoms that last beyond three months (Cuenca-Martínez *et al.,* 2018). This chronicity not only results in continuous physical discomfort but also limits daily activities, reduces social participation, and diminishes overall quality of life. Estimates suggest that nearly four out of five people will experience some form of low back pain during their lifetime, making it one of the most widespread health problems worldwide (Grooten *et al.,* 2022).

The economic implications of CLBP are equally severe. The condition contributes heavily to work absenteeism, early retirement, and decreased productivity. In high-income countries, back pain ranks among the most costly medical conditions, consuming a substantial portion of healthcare budgets through consultations, diagnostic imaging, long-term medication use, and rehabilitation services (Shipton, 2018). Beyond the direct medical costs, indirect costs such as loss of income, disability benefits, and caregiver burden add significantly to the societal impact. Importantly, CLBP does not only affect individuals; it places a strain on families, communities, and national economies (Hassan, 2024).

In South Asia, the situation is particularly concerning. Rapid urbanization, increased use of technology, long working hours in sedentary environments, and poor workplace ergonomics have accelerated the rise of musculoskeletal disorders, with low back pain leading the trend. At the same time, a large segment of the population is engaged in physically demanding jobs such as agriculture, garment work, and manual labor, which expose them to repetitive strain and poor postural practices (Mannion *et al.,* 2009). The region reports high rates of disability due to CLBP, which translates into reduced workforce capacity and economic productivity. Since the majority of those affected are within their most economically productive years, the financial burden on households and healthcare systems is profound (Shahidi *et al.,* 2022).

Bangladesh, as part of this regional landscape, reflects both ends of the spectrum. On one side, sedentary lifestyles are increasing due to urban living and desk-based jobs; on the other, a significant portion of the population is involved in occupations that require heavy lifting and prolonged physical exertion (Ris *et al.,* 2021). Combined with limited ergonomic awareness, inadequate preventive measures, and restricted access to specialized care, these factors contribute to the growing burden of CLBP in the country (Waseem *et al.,* 2019). Although physiotherapy services are expanding in Bangladesh, the effectiveness of exercise-based interventions for managing CLBP has not been widely studied. Most patients rely on medication or temporary measures, which may provide short-term relief but fail to address long-term functional recovery (Rana, 2024).

Exercise-based physiotherapy has emerged globally as one of the most effective conservative approaches for managing CLBP. Unlike pharmacological or surgical treatments, exercise interventions target the underlying issues of muscle weakness, stiffness, and poor postural control. They enhance spinal stability, improve mobility, and promote active patient participation in recovery. Moreover, exercise plays a crucial role in improving psychological well-being, reducing fear-avoidance behavior, and encouraging long-term self-management (Baig *et al.,* 2024; Rahman *et al.,* 2024). Despite these benefits, not all patients respond equally to exercise therapy. Factors such as age, gender, occupation, baseline pain severity, comorbidities, and adherence to treatment often determine the extent of success. Understanding these correlates of treatment outcome is essential for tailoring interventions to patient-specific needs. The present study is therefore designed to evaluate the effectiveness of exercise-based interventions in patients with chronic low back pain and to explore the patient-related factors that are associated with successful treatment outcomes.

MATERIALS AND METHODS

Study design

This research was conducted as a descriptive study at the Physiotherapy Department of a rehabilitation center in Dhaka, Bangladesh. The center is a specialized facility that provides comprehensive rehabilitation services and treats a large number of patients with musculoskeletal conditions, particularly low back pain (LBP). For this study, patient data were collected from existing departmental medical records and analyzed to assess the outcomes of exercise-based physiotherapy interventions in individuals with chronic low back pain (CLBP).

Study population and sampling

The study population consisted of patients who attended physiotherapy for CLBP between June 2022 and December 2022. During this period, 400 patient records were selected through a simple random sampling technique using file numbers. The inclusion criteria were patients diagnosed with non-specific CLBP that persisted for more than three months. Patients with LBP due to specific underlying causes, such as infection, malignancy, fractures, or inflammatory disorders, were excluded, as were those who had undergone any form of spinal surgery. No restrictions were applied in terms of age or sex, allowing the study to include a broad spectrum of patients commonly encountered in clinical rehabilitation practice.

Data collection

Data were extracted from patient records using a structured checklist. Demographic characteristics such as age and sex were collected, along with clinical information, including duration of symptoms, possible cause of pain, past medical history, use of pain medication, and extent of movement restriction. Pain outcomes were assessed using two complementary measures. First, the Visual Analogue Scale (VAS) was recorded both before and after physiotherapy intervention to provide an objective measure of pain intensity. Second, a patient-reported outcome was documented using a four-point Likert scale, where patients indicated the degree of perceived improvement in pain. The categories ranged from 1-25% improvement, 26-50% improvement, 51-75% improvement, to 76-100% improvement. This dual assessment strategy ensured that both objective pain reduction and subjective patient satisfaction were considered in the evaluation of treatment outcomes.

Operational definitions

For the purpose of this study, chronic low back pain (CLBP) was defined as pain localized in the lumbar region persisting for more than three months, without a specific pathological cause. Non-specific LBP referred to cases where pain could not be attributed to a recognizable condition such as infection, malignancy, inflammatory disease, or structural abnormality. Pain intensity was measured using the Visual Analogue Scale (VAS), a 10-centimeter line where patients marked their pain level, with 0 representing "no pain" and 10 representing "worst possible pain." Pain improvement percentage was categorized based on patient-reported outcomes using the four-point Likert scale described earlier, which enabled classification of perceived recovery into ranges of minimal, moderate, substantial, and complete improvement.

Ethical considerations

Ethical approval for the study was obtained from the Rehabilitation Center prior to data collection. Informed consent was obtained from all participants before enrollment. All patient records were anonymized, and strict confidentiality was maintained throughout the research process. Only de-identified data were used for analysis, and all information was accessed solely for the purposes of this study.

Data analysis

All collected data were entered and analyzed using the Statistical Package for the Social Sciences (SPSS) version 25.0.

Descriptive statistics, including frequency distributions, percentages, means, and standard deviations, were used to summarize demographic and clinical characteristics. The effectiveness of physiotherapy interventions was evaluated by comparing pre- and post-treatment VAS scores using a paired t-test. Statistical significance was considered at $p<0.05$.

RESULTS

A total of 400 patient records were included in the study. Females accounted for 61.3% (n=245) and males 38.7% (n=155). The most frequent age group was 21-30 years (45.8%, n=183), followed by <20 years (25.3%, n=101), 31-40 years (19.3%, n=77), and 41-50 years (9.5%, n=38). Regarding BMI, 53.0% of patients were in the normal range (18.5-24.9 kg/m^2), 12.0% underweight (<18.5 kg/m^2), 26.3% overweight (25-29.9 kg/m^2), and 8.8% obese (≥30 kg/m^2). Occupation was predominantly sedentary in 45.0% (n=180), manual labor in 36.3% (n=145), and students accounted for 18.7% (n=75). Most patients reported unknown causes of pain (85.3%, n=341), with trauma accounting for 14.7% (n=59). Comorbid conditions included diabetes mellitus (13.7%, n=55), hypertension (19.0%, n=76), heart disease (3.0%, n=12), and previous back surgery (4.5%, n=18). Nearly half of the patients (47.5%, n=190) reported using pain medication. Axial pain was the most prevalent type (63.2%, n=253), followed by unilateral pain below the knee (14.7%, n=59), above the knee (8.3%, n=33), bilateral (7.0%, n=28), and 6.8% not assessed. The duration of pain varied: 20.0% (n=80) had symptoms <1 month, 35.0% (n=140) for 1-3 months, and 45.0% (n=180) for >3 months. The mean baseline VAS score was 6.7±1.6 (Table 1).

Most patients received multiple physiotherapy modalities. Therapeutic exercise was delivered to 84.7% (n=339), manual therapy to 97.2% (n=389), electrotherapy to 89.1% (n=356), and home advice to 96.3% (n=385). Regarding frequency, 30.0% attended 1-2 sessions/week, 45.0% attended 3-4 sessions/week, and 25.0% attended >4 sessions/week. Session duration varied, with 20.0% <30 minutes, 52.5% between 30-45 minutes, and 27.5% >45 minutes. The number of sessions completed was 1-5 in 15.3% (n=61), 6-10 in 27.3% (n=109), 11-15 in 25.4% (n=102), 16-20 in 9.5% (n=38), 21-25 in 6.7% (n=27), 26-30 in 7.5% (n=30), and >30 in 8.3% (n=33) (Table 2).

Physiotherapy interventions resulted in significant reductions in pain and improvements in lumbar mobility. Mean VAS scores decreased from 6.7±1.6 pre-treatment to 3.1±1.5 post-treatment ($p<0.001$). Lumbar flexion major loss decreased from 6.1% (n=24) to 0.5% (n=2), moderate loss from 20.3% (n=81) to 2.0% (n=8), and mild loss from 32.5% (n=130) to 5.8% (n=23). Lumbar extension major loss decreased from 10.2% (n=41) to 1.2% (n=5), moderate loss from 43.5% (n=174) to 4.1% (n=16), and mild loss from 29.8% (n=119) to 7.9% (n=32) (all $p < 0.001$) (Table 3).

Patient-reported outcomes revealed that the majority experienced substantial improvement in pain. More than half of the patients (52.3%, n=209) reported ≥76% improvement in pain. Moderate improvement (51-75%) was noted in 20.5%

Table 1: Patient demographics and health information (N=400)

Variable	Category	Frequency	Percentage
Gender	Male	155	38.7%
	Female	245	61.3%
Age (years)	<20	101	25.3%
	21-30	183	45.8%
	31-40	77	19.3%
	41-50	38	9.5%
BMI (kg/m^2)	<18.5	48	12.0%
	18.5-24.9	212	53.0%
	25-29.9	105	26.3%
	≥30	35	8.8%
Occupation	Sedentary	180	45.0%
	Manual Labor	145	36.3%
	Student	75	18.7%
Cause of Pain	Unknown	341	85.3%
	Trauma	59	14.7%
Medical History	Diabetes Mellitus	55	13.7%
	Hypertension	76	19.0%
	Heart Disease	12	3.0%
	Previous Back Surgery	18	4.5%
Drug History	Pain Medication	190	47.5%
Pain Type	Axial	253	63.2%
	Unilateral (above knee)	33	8.3%
	Unilateral (below knee)	59	14.7%
	Bilateral	28	7.0%
	Not Assessed	27	6.8%
Pain Duration	<1 month	80	20.0%
	1-3 months	140	35.0%
	>3 months	180	45.0%
Pain Intensity (VAS)	Mean±SD	6.7±1.6	-

Table 2: Physiotherapy interventions and treatment sessions (N=400)

Variable	Category	Frequency	Percentage
Intervention Type	Therapeutic Exercise	339	84.7%
	Manual Therapy	389	97.2%
	Electrotherapy	356	89.1%
	Home Advice	385	96.3%
Treatment Frequency	1-2 sessions/week	120	30.0%
	3-4 sessions/week	180	45.0%
	>4 sessions/week	100	25.0%
Session Duration	<30 min	80	20.0%
	30-45 min	210	52.5%
	>45 min	110	27.5%
Sessions Attended	1-5	61	15.3%
	6-10	109	27.3%
	11-15	102	25.4%
	16-20	38	9.5%
	21-25	27	6.7%
	26-30	30	7.5%
	31+	33	8.3%

Table 3: Pain intensity and lumbar mobility: Pre vs. Post physiotherapy (N=400)

Measure	Pre-treatment	Post-treatment	p-value
Pain Intensity (VAS)	6.7±1.6	3.1±1.5	<0.001
Lumbar Flexion - Major Loss	6.1%	0.5%	<0.001
Lumbar Flexion - Moderate	20.3%	2.0%	<0.001
Lumbar Flexion - Mild	32.5%	5.8%	<0.001
Lumbar Extension - Major Loss	10.2%	1.2%	<0.001
Lumbar Extension - Moderate	43.5%	4.1%	<0.001
Lumbar Extension - Mild	29.8%	7.9%	<0.001

(n=82), 26-50% improvement in 18.2% (n=73), and minimal improvement (≤25%) was reported by 9.0% (n=36) of patients. These findings indicate that physiotherapy interventions were effective in providing meaningful pain relief for most patients (Table 4).

Correlation analysis was conducted to evaluate the relationship between treatment features and clinical outcomes. The number of treatment sessions was positively correlated with VAS reduction (r=0.21, p<0.001), suggesting that patients attending more sessions experienced greater pain relief. Therapeutic exercise showed a significant correlation with improvements in both lumbar flexion (r=0.18, p<0.001) and extension (r=0.15, p<0.001). Manual therapy demonstrated a weaker but statistically significant correlation with VAS reduction (r=0.12, p=0.002). Electrotherapy (r=0.08, p=0.09) and home advice (r=0.05, p=0.32) were not significantly correlated with pain reduction, indicating a limited independent effect (Table 5).

Multiple linear regression analysis was performed to identify predictors of pain reduction. The number of treatment sessions (β=0.19, p<0.001) and therapeutic exercise (β=0.15, p=0.003) were significant predictors of VAS reduction, indicating that more sessions and structured exercise were strongly associated with greater pain relief. Manual therapy showed a positive but non-significant effect (β=0.08, p=0.18), while electrotherapy (β=0.03, p=0.45) and home advice (β=0.02, p=0.69) did not significantly predict pain reduction (Table 6).

Subgroup analysis by gender revealed that females reported higher baseline VAS scores (6.9±1.7) compared to males (6.4±1.5, p<0.001). Post-treatment VAS scores were comparable between females (3.2±1.6) and males (3.0±1.4, p=0.08). VAS reduction was slightly greater among females (3.9±1.9) than males (3.5±1.8, p=0.01). Flexion and extension improvements were similar across genders, with no significant differences (p>0.05), indicating that physiotherapy was effective regardless of gender (Table 7).

DISCUSSION

The present study evaluated the effectiveness of physiotherapy interventions in 400 patients with low back pain (LBP) in Bangladesh. Our findings demonstrated substantial reductions in pain intensity, with mean VAS scores decreasing from 6.7±1.6 pre-treatment to 3.1±1.5 post-treatment (p<0.001), and significant improvements in lumbar flexion and extension. Self-reported outcomes indicated that over half of the patients (52.3%) experienced ≥76% pain relief, highlighting the clinical effectiveness of physiotherapy modalities including therapeutic exercise, manual therapy, electrotherapy, and home advice. Multiple regression analysis identified the number of treatment sessions (β=0.19, p<0.001) and therapeutic exercise (β=0.15, p=0.003) as significant predictors of pain reduction, emphasizing the importance of structured exercise programs and consistent therapy sessions in achieving optimal outcomes.

Demographically, females constituted 61.3% of the cohort, with the majority aged 21-30 years (45.8%) and having

Table 4: Self-reported improvement in pain (N=400)

Improvement Category	Frequency	Percentage
≤25%	36	9.0%
26-50%	73	18.2%
51-75%	82	20.5%
≥76%	209	52.3%

Table 5: Correlation of treatment features with clinical outcomes (N=400)

Treatment variable	Outcome measured	r	p-value
Number of Sessions	VAS Reduction	0.21	<0.001
Therapeutic Exercise	Flexion Improvement	0.18	<0.001
Therapeutic Exercise	Extension Improvement	0.15	<0.001
Manual Therapy	VAS Reduction	0.12	0.002
Electrotherapy	VAS Reduction	0.08	0.09
Home Advice	VAS Reduction	0.05	0.32

Table 6: Predictors of pain reduction (VAS) – Multiple Linear Regression (N=400)

Predictor	β	SE	t	p-value
Intercept	-0.52	0.45	-1.15	0.25
Age	-0.02	0.01	-1.62	0.45
Gender (Female=1)	0.04	0.07	0.58	0.21
Number of Sessions	0.19	0.02	8.12	<0.001
Therapeutic Exercise	0.15	0.05	3.01	0.003
Manual Therapy	0.08	0.06	1.34	0.18
Electrotherapy	0.03	0.04	0.75	0.45
Home Advice	0.02	0.05	0.40	0.69

Table 7: Gender-based subgroup outcomes (N=400)

Outcome	Male (n=155)	Female (n=245)	p-value
Baseline VAS (mean±SD)	6.4±1.5	6.9±1.7	<0.001
Post-treatment VAS (mean±SD)	3.0±1.4	3.2±1.6	0.08
VAS Reduction (mean±SD)	3.5±1.8	3.9±1.9	0.01
Flexion Improvement (%)	28.5±10.2	29.1±11.3	0.35
Extension Improvement (%)	27.8±9.8	28.3±10.5	0.42

normal BMI (53.0%). These results reflect global trends showing higher prevalence of LBP among females, possibly due to hormonal, anatomical, and occupational factors (Majeed *et al.,* 2019). In Bangladesh, prior studies among medical students and industrial workers have reported LBP prevalence ranging from 40-62%, often associated with prolonged sitting, inadequate ergonomics, and modifiable lifestyle risk factors (Khan *et al.,* 2020). Our study aligns with these findings, suggesting that young, predominantly sedentary populations in Bangladesh are particularly vulnerable to LBP and may benefit from targeted preventive interventions.

Comparative data from South Asia indicates similar patterns. In India, a systematic review reported a pooled LBP prevalence of 48%, with females, rural populations, and manual laborers experiencing higher rates (Venkatesan *et al.,* 2022). In Pakistan, 70% of medical doctors reported LBP, with moderate disability affecting daily activities (Evans *et al.,* 2010). Our results showing greater pain reduction in females (3.9±1.9) compared to males (3.5±1.8, p=0.01) may reflect gender-specific responsiveness to physiotherapy interventions, consistent with observations in regional studies (Sharma *et al.,* 2019). These comparisons indicate that LBP is highly prevalent across South Asia, and interventions like physiotherapy can provide meaningful relief regardless of gender, occupation, or baseline severity (Anar, 2016).

Globally, LBP remains the leading cause of disability, affecting an estimated 619 million people in 2020, with projections of 843 million by 2050 (Anar, 2016). South Asia alone accounted for approximately 93.4 million cases in 2021, underscoring the public health significance of LBP (Anar, 2016). Our findings, demonstrating the efficacy of physiotherapy in reducing pain and improving lumbar mobility, align with international literature reporting moderate-to-large improvements in pain and function following structured physiotherapy interventions, including exercise therapy, manual therapy, and patient education (Mannion *et al.,* 2009; Shahidi *et al.,* 2022). The observed correlations between session frequency and VAS reduction in our study reinforce the dose-response relationship described globally, highlighting the importance of consistent treatment exposure for optimal outcomes.

Furthermore, the improvements in lumbar flexion and extension observed in our cohort —where major flexion loss decreased from 6.1% to 0.5% and moderate extension loss from 43.5% to 4.1% — demonstrate that physiotherapy not only alleviates pain but also restores functional mobility. This is particularly relevant in occupational and young adult populations, where functional impairment can affect productivity and quality of life. Comparatively, regional studies in India and Pakistan have similarly reported significant functional improvements following physiotherapy, supporting our findings and emphasizing the universal applicability of these interventions across diverse socio-cultural contexts (Ris *et al.,* 2021).

CONCLUSION

Exercise-based physiotherapy is an effective conservative intervention for managing chronic low back pain among Bangladeshi patients. The study demonstrates that consistent treatment sessions and structured therapeutic exercises are strongly associated with significant reductions in pain intensity and improvements in lumbar mobility. While manual therapy, electrotherapy, and home advice may provide additional benefits, their independent contributions to pain reduction appear limited. Females reported higher baseline pain but achieved comparable post-treatment improvements, suggesting the effectiveness of physiotherapy across genders. These findings highlight the importance of tailored, exercise-focused physiotherapy programs and adequate session frequency to optimize outcomes. Integrating such interventions into routine clinical practice can help reduce disability, improve functional recovery, and alleviate the societal burden of chronic low back pain in Bangladesh.

AUTHORS' CONTRIBUTION

Md. Noman Azam: Conception and design of the study, data collection supervision, statistical analysis, interpretation of results, and manuscript drafting. Md. Balal Hossain: Assisted in study design, data acquisition, and critical revision of the manuscript. Most. Raihanul Jannat Roshni: Contributed to data collection, literature review, and data entry. Musomi Khandaker: Provided technical support in data analysis and formatting of results. Sonya Ghosh: Contributed to proofreading, manuscript editing, and final approval of the version to be published. All authors contributed equally to the study and approved the final manuscript for publication.

REFERENCES

Anar, S. Ö. (2016). The effectiveness of home-based exercise programs for low back pain patients. *Journal of Physical Therapy Science, 28*(10), 2727-2730. https://doi.org/10.1589/jpts.28.2727

Baig, A. A. M., Ansari, B., Ahmed, S. I., Ishaque, F., & Farooqui, W. A. (2024). Association of demographics, lumbar active range of motion and disability in chronic low back: a baseline data analysis of a randomized controlled trial from Pakistan. *BMC Musculoskeletal Disorders, 25*, 489. https://doi.org/10.1186/s12891-024-07613-9

Cuenca-Martínez, F., Cortés-Amador, S., & Espí-López, G. V. (2018). Effectiveness of classic physical therapy proposals for chronic non-specific low back pain: a literature review. *Physical Therapy Research, 21*(1), 16-22. https://doi.org/10.1298/ptr.E9937

Evans, D. D., Carter, M., Panico, R., Kimble, L., Morlock, J. T., & Spears, M. J. (2010). Characteristics and predictors of short-term outcomes in individuals self-selecting yoga or physical therapy for treatment of chronic low back pain. *PM&R, 2*(11), 1006-1015. https://doi.org/10.1016/j.pmrj.2010.07.006

Grooten, W. J. A., Boström, C., Dedering, Å., Halvorsen, M., Kuster, R. P., Nilsson-Wikmar, L., Olsson, C. B., Rovner, G., Tseli, E., & Rasmussen-Barr, E. (2022). Summarizing the effects of different exercise types in chronic low back pain–a systematic

review of systematic reviews. *BMC Musculoskeletal Disorders, 23*, 801. https://doi.org/10.1186/s12891-022-05722-x

Hassan, M. R. (2024). *Effectiveness of Strengthening Exercise for Patients with Chronic Low Back Pain: A Randomized Controlled Trial*. Doctoral Dissertation, University of Dhaka.

Khan, M. N. U., Morrison, N. M. V., & Marshall, P. W. (2020). The Role of Fear-Avoidance Beliefs on Low Back Pain-Related Disability in a Developing Socioeconomic and Conservative Culture: A Cross-Sectional Study of a Pakistani Population. *Journal of Pain Research, 13*, 2377-2387. https://doi.org/10.2147/JPR.S258314

Majeed, S. A., Anish, T. S., Sugunan, A., & Arun, M. S. (2019). The effectiveness of a simplified core stabilization program (TRICCS-Trivandrum Community-based Core Stabilisation) for community-based intervention in chronic non-specific low back pain. *Journal of Orthopaedic Surgery and Research, 14*, 86. https://doi.org/10.1186/s13018-019-1131-z

Mannion, A. F., Helbling, D., Pulkovski, N., & Sprott, H. (2009). Spinal segmental stabilisation exercises for chronic low back pain: programme adherence and its influence on clinical outcome. *European Spine Journal, 18*, 1881-1891. https://doi.org/10.1007/s00586-009-1093-7

Rahman, M. A., Tasnim, S., & Hossain, M. F. (2024). Assessing pain severity and treatment outcomes in patients with low back pain: A Structural equation modeling approach at the center for the rehabilitation of the Paralysed, Bangladesh. *PloS One, 19*(5), e0303939. https://doi.org/10.1371/journal.pone.0303939

Rana, S. (2024). *Knowledge, attitude and practice towards physical activity in preventing low back pain among patients attending musculoskeletal department at CRP*. Doctoral Dissertation, University of Dhaka.

Ris, I., Broholm, D., Hartvigsen, J., Andersen, T. E., & Kongsted, A. (2021). Adherence and characteristics of participants enrolled in a standardised programme of patient education and exercises for low back pain, GLA: D® Back - a prospective observational study. *BMC Musculoskeletal Disorders, 22*, 473. https://doi.org/10.1186/s12891-021-04329-y

Shahidi, B., Padwal, J., Lee, E., Xu, R., Northway, S., Taitano, L., Wu, T., & Raiszadeh, K. (2022). Factors impacting adherence to an exercise-based physical therapy program for individuals with low back pain. *Plos One, 17*(10), e0276326. https://doi.org/10.1371/journal.pone.0276326

Shipton, E. A. (2018). Physical therapy approaches in the treatment of low back pain. *Pain and Therapy, 7*(2), 127-137. https://doi.org/10.1007/s40122-018-0105-x

Venkatesan, P., Soundararajan, K., Kishen, T. J., Janardhan, S., & Kumar, C. R. S. (2022). Comparison of yoga and dynamic neuromuscular stabilization exercise in chronic low back pain on magnetic resonance imaging of lumbar multifidus- protocol for a randomized controlled trial. *Contemporary Clinical Trials Communications, 28*, 100937. https://doi.org/10.1016/j.conctc.2022.100937

Waseem, M., Karimi, H., Gilani, S. A., & Hassan, D. (2019). Treatment of disability associated with chronic non-specific low back pain using core stabilization exercises in Pakistani population. *Journal of Back and Musculoskeletal Rehabilitation, 32*(1), 149-154. https://doi.org/10.3233/BMR-171114