

Review Article

Lower back pain in women across life stages: Insights from adolescence to menopause

Rupali Milind Salvi¹, Shubhada Kale²

¹Department of Community Health Nursing, Bharati Vidyapeeth College of Nursing, ²Department of Mental Health Nursing, Themi Grant Institute of Nursing Education, Pune, Maharashtra, India.



***Corresponding author:**

Rupali Milind Salvi,
Department of Community
Health Nursing, Bharati
Vidyapeeth College of Nursing,
Pune, Maharashtra, India.

rumisa.salvi@gmail.com

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ABSTRACT

Low back pain (LBP) is a leading cause of disability worldwide, affecting individuals across all age groups and imposing a substantial burden on healthcare systems and quality of life. Despite extensive research, effective diagnostic and management strategies remain challenging due to LBP's multifactorial nature. Studies have identified a range of risk factors, including musculoskeletal degeneration, hormonal changes, lifestyle habits, and psychosocial stressors, which contribute to its high prevalence, particularly in older populations. Advances in imaging techniques and biomechanical assessments have significantly improved diagnostic accuracy. Non-pharmacological approaches, such as physical therapy and ergonomic interventions, remain the cornerstone of LBP management, while pharmacological treatments and interventional methods offer symptomatic relief but carry potential side effects. Emerging therapies, including regenerative medicine, artificial intelligence in diagnostics, and telemedicine, show promise in reshaping LBP care by improving accessibility and personalization. This review discusses the prevalence, risk factors, diagnostic tools, and treatment modalities for LBP, emphasizing the importance of integrating traditional and innovative approaches. Future research should focus on the long-term efficacy, accessibility, and gender-specific considerations of these therapies to optimize outcomes for individuals with LBP.

Keywords: Digital health, Low back pain, Prevalence, Regenerative medicine, Risk factors

INTRODUCTION

Low back pain (LBP) is one of the most common musculoskeletal complaints globally, contributing significantly to disability,^[1] healthcare costs,^[2] and reduced quality of life.^[3] Women experience a disproportionate burden due to unique anatomical, hormonal, and biomechanical factors, which influence pain perception and response to treatment.^[4]

The impact of LBP varies across a woman's life stages [Figure 1]. During adolescence, growth spurts and lifestyle choices play a key role, while in menopause, degenerative changes become more dominant. Understanding how these factors interact over time helps in developing effective interventions that address both acute and chronic manifestations of LBP.^[5]

Overview of LBP and its gender-specific prevalence

LBP refers to discomfort or pain in the lumbar spine, sometimes radiating to the lower extremities. It can be classified as acute (<6 weeks), subacute (6–12 weeks), or chronic (>12 weeks),^[6] with chronic cases significantly impacting mobility and well-being.^[7]

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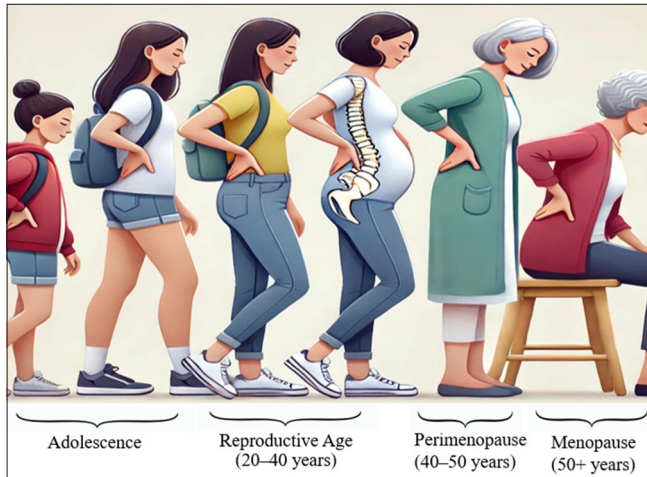


Figure 1: Stages of life in women - progression of lower back pain (LBP) from adolescence to menopause. It illustrates the progression of LBP across key life stages in women, including adolescence, reproductive age, perimenopause, and menopause. It highlights the interplay of age-specific anatomical, hormonal, and lifestyle changes contributing to the development and exacerbation of LBP.

In women, LBP is influenced not only by injury or degeneration but also by gynecological factors^[8] such as dysmenorrhea,^[9] endometriosis,^[10] pelvic inflammatory disease,^[11] and pregnancy.^[12] Structural differences in pelvic alignment,^[13] lumbar curvature,^[14] and muscle distribution^[15] further increase susceptibility compared to men.^[16,17] Lifestyle factors such as prolonged sitting, poor posture, and obesity^[18] exacerbate LBP, while menopause-related estrogen decline weakens bone density,^[19] making LBP more severe.^[20]

LBP prevalence varies across life stages,^[21] affecting 50–80% of women.^[22] Adolescents experience LBP due to poor posture^[23] and school-related factors^[24], while pregnancy-related LBP affects up to 50% of pregnant women due to spinal curvature degenerative changes.^[25,26] Psychosocial factors, including stress, anxiety, and caregiving burdens, further contribute to chronic LBP and delayed healthcare access.^[27]

Importance of a life-course perspective in understanding LBP

LBP in women evolves across different life stages, making a life-course perspective essential for identifying risk factors and tailoring interventions. Adolescents benefit from education on posture and physical activity, reproductive-age women need targeted care for pregnancy-related LBP, and postmenopausal women require strategies to manage degenerative changes and osteoporosis.^[28]

This perspective highlights the cumulative impact of risk factors, as untreated LBP in youth can lead to chronic issues

later. It also emphasizes gender-specific influences, such as hormonal fluctuations, often overlooked in generalized treatments.^[29] A multidisciplinary approach, integrating physical therapy, lifestyle modifications, medical treatments, and public health strategies, is crucial for effective management across all life stages.^[30]

LBP ACROSS LIFE STAGES

A life-course perspective is essential in understanding LBP, as symptoms often begin in adolescence and evolve over time. Identifying risk factors early can aid in prevention and reduce long-term impact.^[31]

Adolescence: Risk factors, lifestyle influences, and prevention

Adolescence is a pivotal stage for musculoskeletal development, during which rapid skeletal growth can outpace muscle and ligament adaptation, making the spine more vulnerable to stress.^[32] Postural issues often emerge due to prolonged sitting, excessive screen time, and sedentary habits, leading to muscle imbalances and spinal misalignment.

Environmental factors, including academic pressures, prolonged sitting in classrooms, and carrying heavy backpacks, contribute to spinal strain. While physical activity is crucial for musculoskeletal health, improper training techniques and a lack of conditioning can predispose adolescents to back pain. Without timely intervention, these risk factors may lead to chronic LBP in adulthood.^[33]

Prevention strategies should focus on posture education, ergonomic awareness, and structured physical activity that strengthens core muscles and improves flexibility.^[34] Schools and community programs play a vital role in promoting proper backpack use,^[35] movement breaks, and a balanced mix of stretching, strength training, and aerobic exercises. Addressing these factors early can significantly reduce the long-term burden of LBP.^[36]

Reproductive age: Hormonal influences, pregnancy-associated pain, and occupational contributors

The reproductive years bring hormonal, physical, and lifestyle changes that significantly impact spinal health.^[37] Estrogen and progesterone, key reproductive hormones, influence musculoskeletal function by affecting ligament stability. Progesterone-induced ligamentous laxity can contribute to joint instability, particularly in the lumbar spine, increasing susceptibility to LBP.^[38] Women with pre-existing musculoskeletal conditions may experience worsening symptoms due to hormonal fluctuations, emphasizing the need for targeted interventions.^[39]

Pregnancy is a major contributor to LBP, as weight gain, a shifting center of gravity, and postural changes place strain on the spine. The hormone relaxin further increases ligament laxity, heightening the risk of instability and discomfort.^[40] Many women experience pregnancy-associated low back pain (PABL) or sciatica due to pressure on spinal nerves. Without proper management, PABL may persist postpartum, leading to chronic back pain. Education, physical therapy, and ergonomic adaptations are essential for mitigating these effects.^[41]

Occupational and lifestyle factors also play a crucial role in LBP during the reproductive years. Many women balance demanding work, childcare, and household responsibilities, leading to prolonged standing, lifting, or poor posture. Sedentary jobs and high-stress levels contribute to muscle tension and chronic pain.^[42] In addition, limited physical activity and poor sleep hygiene further exacerbate LBP risk. Addressing these challenges through ergonomic modifications, stress management, and regular exercise is essential for long-term spinal health.^[43]

Menopause: Hormonal decline, osteoporosis, and management strategies

Menopause marks a critical phase in musculoskeletal health, where hormonal decline accelerates degenerative changes that contribute to LBP.^[44] The sharp reduction in estrogen impacts bone density, muscle mass, and spinal integrity, increasing vulnerability to osteoporosis and degenerative disc disease.^[45] Estrogen plays a key role in maintaining bone strength, and its decline heightens the risk of vertebral fractures and spinal deformities,^[46] making LBP more prevalent and persistent during this stage.

Osteoporosis is a major concern, as weakened vertebrae increase susceptibility to fractures and spinal degeneration. Degenerative disc disease, spinal stenosis, and facet joint arthritis become more common, leading to chronic pain and reduced mobility. These conditions, combined with age-related declines in muscle strength, create additional strain on the lower back.^[47]

Managing LBP in menopausal women requires a proactive approach focused on maintaining bone health, muscle strength, and overall spinal function. Preventive measures, such as weight-bearing exercises, adequate calcium and vitamin D intake, and pharmacological interventions, are crucial in reducing osteoporosis risk. Strengthening core muscles, improving flexibility, and incorporating postural awareness through physical therapy can help mitigate spinal degeneration. In addition, ergonomic adjustments, stress management, and maintaining an active lifestyle play essential roles in reducing LBP and preserving mobility during this stage of life.^[48]

CONTRIBUTING FACTORS OF LBP

LBP in women arises from a complex interplay of biomechanical and psychosocial influences that evolve across different life stages. Factors such as postural habits, hormonal fluctuations, degenerative changes, and lifestyle choices contribute to pain severity and persistence [Table 1]. These factors not only contribute to the onset and severity of pain but also shape its perception and persistence.^[49]

Biomechanical: Physical activity, body mechanics, and obesity

Physical activity plays a crucial role in spinal health, with its benefits extending from adolescence to menopause. Regular exercise supports muscle strength and flexibility, essential for maintaining proper spinal alignment and preventing injury.^[50] However, sedentary behavior, poor posture, slouching and prolonged sitting,^[51] and improper body mechanics contribute to LBP.

Obesity further exacerbates LBP by placing excess strain on the lumbar spine. This is particularly concerning during menopause when hormonal shifts and metabolic changes lead to weight gain, worsening spinal stress, and pain.^[52] Addressing obesity through weight management, strengthening exercises, and ergonomic awareness is key to reducing LBP severity in women.^[53]

Psychosocial: Stress, anxiety, and depression on pain perception

Psychological and emotional factors significantly influence pain perception in LBP.^[54] Chronic stress, anxiety, and depression heighten pain sensitivity, aggravate muscle tension, and reduce pain tolerance. Hormonal fluctuations during menopause can further intensify these effects, contributing to distress and disability. Integrating stress management, counseling, and social support into LBP care enhances both physical and emotional resilience, improving overall outcomes.^[55]

DIAGNOSIS AND MANAGEMENT

The clinical approach to diagnosing and managing LBP in women must consider the unique factors influencing spinal health across different life stages. While the fundamental principles of diagnosis remain consistent, a life-course perspective is essential to tailor treatment strategies effectively.^[56]

Diagnostic tools and stage-specific risk assessment

Accurate diagnosis of LBP relies on a combination of clinical evaluation and imaging techniques. X-rays, magnetic resonance images, and computed tomography scans play a key role in identifying musculoskeletal conditions such as

scoliosis and disc herniations in adolescent and reproductive-age women^[57] [Table 2]. In postmenopausal women, these tools are crucial for detecting degenerative changes, osteoporotic fractures, and spinal stenosis, which contribute to chronic LBP.^[58]

Since LBP manifests differently throughout life, clinicians must consider stage-specific risk factors. Adolescents may require assessments focusing on posture, growth patterns, and activity-related strain. In reproductive-age women, hormonal influences and pregnancy-related spinal stress should be factored in.^[59] For postmenopausal women, osteoporosis, osteoarthritis, and degenerative disc disease become primary concerns. A tailored diagnostic approach ensures that interventions are appropriately targeted to each life stage.^[60]

Treatment options: Non-pharmacological, pharmacological, and surgical interventions

Managing LBP effectively requires a multimodal approach that integrates non-pharmacological, pharmacological,

and surgical options based on the severity of pain and life-stage-specific factors.^[61]

Non-pharmacological interventions

Physical therapy is a cornerstone of LBP management across all life stages. In adolescents, it addresses postural alignment and muscle imbalances. For reproductive-age women, physical therapy strengthens core muscles and improves spinal mobility,^[62] especially in those experiencing pregnancy-related LBP. In postmenopausal women, exercises focus on maintaining muscle strength, balance, and flexibility to mitigate osteoporosis-related complications.

Yoga is another effective intervention that improves flexibility, strength, and mental well-being. Adolescents benefit from posture correction and stress reduction, while reproductive-age women use yoga for pregnancy-related spinal health and postpartum recovery. In postmenopausal women, yoga enhances balance and mobility, reducing the risk of falls and fractures.^[63]

Table 1: Comparison of LBP risk factors across life stages.

Life stage	Hormonal factors	Postural issues	Degenerative changes	Lifestyle factors	Psychosocial factors	Common conditions
Adolescence	Growth spurts	Poor posture	Rare	Sedentary lifestyle, sports injuries	Academic stress	Scoliosis, muscle strain
Reproductive Age	Pregnancy, hormonal changes	Weight distribution changes	Rare	Obesity, physical strain	Work-life balance stress	Pregnancy-associated back pain
Menopause	Estrogen decline	Postural changes due to aging	Osteoporosis, osteoarthritis	Sedentary lifestyle, weight gain	Emotional instability	Chronic LBP, spinal stenosis

LBP: Low back pain

Table 2: Comparison of diagnostic tools for LBP across life stages.

Diagnostic tool	Adolescence	Reproductive age	Menopause	Advantages	Limitations	Clinical utility
X-ray	Identifies scoliosis	Limited use	Detects osteoporotic fractures	Affordable, widely available	Limited soft tissue visualization	Screening for structural abnormalities
MRI	Detects disc herniation	Soft tissue evaluation	Shows degenerative changes	Excellent detail of soft tissues	Expensive, time-consuming	Comprehensive soft tissue analysis
CT-Scan	Rarely needed	Limited use	Detects spinal stenosis	High resolution of bone structures	High radiation exposure	Detailed bone evaluation
DEXA (Bone Scan)	Not applicable	Not commonly used	Assesses bone density	Accurate osteoporosis assessment	Limited to bone health	Evaluating osteoporosis risk
Ultrasound	Not commonly used	Evaluates soft tissues	Limited relevance	Non-invasive, portable	Limited depth of imaging	Focused tissue evaluation
Clinical examination	Posture, growth patterns	Pregnancy-related pain	Chronic pain evaluation	Low-cost, initial assessment tool	Subjective, limited precision	Baseline and preliminary diagnosis

LBP: Low back pain, MRI: Magnetic resonance imaging, CT: Computed tomography, DEXA: Dual-energy X-ray absorptiometry

Ergonomics also plays a crucial role in LBP management. Teaching women proper body mechanics while sitting, standing, and lifting can prevent or alleviate pain. Adolescents should develop good posture habits early, while ergonomic modifications in the workplace and home benefit reproductive-age and menopausal women by reducing spinal strain and enhancing daily functioning [Table 3].

Pharmacological management

Medications are often necessary when conservative treatments do not provide sufficient relief. Non-steroidal anti-inflammatory drugs are commonly used to manage

inflammation and pain across all age groups [Table 4], but their prolonged use in postmenopausal women must be monitored due to potential gastrointestinal and renal risks.^[64]

In menopausal women, hormone therapy (HT) may offer relief by addressing estrogen-related musculoskeletal pain.^[65] However, HT should be used selectively, considering associated risks such as cardiovascular events and breast cancer.^[66]

Surgical interventions

Surgery is typically reserved for severe cases where conservative treatments have failed. Adolescents rarely require surgical intervention, except in cases of severe

Table 3: Non-pharmacological interventions for LBP.

Intervention	Adolescence benefits	Reproductive Age benefits	Menopause benefits	Key techniques	Evidence base	Recommendations
Physical Therapy	Corrects posture	Core strengthening	Muscle strengthening	Stretching, strengthening exercises	Strong	Tailored to stage-specific needs
Yoga	Improves flexibility	Spine health during pregnancy	Balance, flexibility	Asanas like Cat-Cow, Downward Dog	Moderate	Integrate with physical therapy
Ergonomics	Prevents early onset of LBP	Prevents chronic LBP	Reduces workplace strain	Proper posture, workstation setup	Limited evidence	Incorporate into daily activities
Weight Management	Reduces strain on spine	Supports pregnancy-related weight gain	Prevents degenerative changes	Diet plans, exercise routines	Strong	Personalized plans
Stress Management	Reduces muscle tension	Improves work-life balance	Mitigates emotional strain	Mindfulness, CBT	Moderate	Complement with other therapies
Lifestyle Modification	Encourages active lifestyle	Reduces sedentary behavior	Prevents age-related decline	Regular physical activity, a healthy diet	Moderate	Long-term adherence required

LBP: Low back pain, CBT: Cognitive behavioral therapy

Table 4: Pharmacological management of LBP.

Medication type	Adolescence use	Reproductive age use	Menopause use	Mechanism of action	Side effects	Clinical guidelines
NSAIDs	Occasional	Commonly used	Limited use due to GI risks	Reduces inflammation, relieves pain	GI upset, kidney damage	Short-term, lowest effective dose
Acetaminophen	Rarely used	Alternative to NSAIDs	Safer for GI issues	Analgesic effect	Hepatotoxicity	Monitor liver function
Muscle Relaxants	For acute pain	Limited use	Rarely prescribed	Relieves muscle spasms	Drowsiness, dependency risk	Short-term use
Hormone Therapy	Not applicable	Rarely needed	Alleviates musculoskeletal pain	Balances estrogen levels	Breast cancer risk, cardiovascular events	Case-by-case basis
Topical Analgesics	Effective for mild cases	Effective for mild cases	Limited utility	Localized pain relief	Skin irritation	As-needed use
Opioids	Rarely prescribed	Last resort	Last resort	Central nervous system pain relief	Dependency, sedation risk	Only for severe, chronic cases

LBP: Low back pain, NSAID: Non-steroidal anti-inflammatory drugs, GI: Gastrointestinal

scoliosis.^[67] Reproductive-age women with conditions such as herniated discs or spinal instability may benefit from minimally invasive procedures like microdiscectomy. In postmenopausal women, surgical options such as spinal fusion or decompression may be considered for advanced degenerative conditions. However, surgical intervention should be a last resort, following a thorough risk-benefit assessment.^[68]

By adopting a life-stage-specific approach to diagnosis and management, healthcare providers can optimize LBP outcomes in women, improving their quality of life and long-term spinal health.

PREVENTION AND EMERGING APPROACHES

Preventing LBP is crucial for improving quality of life, particularly in women who experience hormonal, biomechanical, and psychosocial changes at different life stages. A proactive approach incorporating education, lifestyle modifications, and early interventions can significantly reduce LBP risk and prevent chronicity.^[69]

Education, exercise, and lifestyle modifications

Raising awareness about LBP is essential at all life stages. Adolescents should be educated on posture, physical activity, and ergonomic habits to prevent early musculoskeletal issues. Reproductive-age women need strategies for managing pregnancy-related back pain, while postmenopausal women should focus on osteoporosis prevention and bone health.^[70]

Regular exercise, including strengthening and stretching, is key to LBP prevention. Adolescents benefit from sports and physical activity,^[71] while reproductive-age women

should incorporate core and pelvic floor exercises to manage pregnancy-related changes. Postmenopausal women should engage in weight-bearing exercises to maintain bone density and prevent degenerative conditions.^[72]

Proper posture and ergonomic adjustments further reduce LBP risk.^[73] Women across all life stages should adopt correct sitting, standing, and lifting techniques. Workplace modifications, including ergonomic workstations and movement breaks, are particularly beneficial for reproductive-age and menopausal women.^[74] Maintaining a healthy weight, balanced diet, and stress management also play a role in LBP prevention.^[75]

Innovations in pain management and future research directions

Emerging therapies offer promising advancements in LBP treatment.^[76] Regenerative medicine, including stem cell therapy and biologics, is being explored for tissue repair and degenerative disease management. Safer pharmacological options, such as non-addictive pain medications, aim to reduce opioid dependence.^[77]

Digital health tools and telemedicine are revolutionizing LBP care, providing remote access to healthcare and personalized management through mobile apps that track pain and activity levels. These innovations enhance treatment adherence and outcomes, especially for women in underserved areas.^[78]

Future research should focus on individualized LBP management strategies, incorporating genetic, environmental, and psychosocial factors. Long-term studies on emerging therapies [Table 5], as well as the impact of

Table 5: Emerging therapies for LBP.

Therapy type	Mechanism	Application	Current evidence	Limitations	Potential outcomes	Research needs
Biologic Therapies	Tissue repair	Degenerative disc diseases	Promising experimental studies	High cost, limited availability	Regeneration of damaged tissues	Long-term safety data
Stem cell therapy	Tissue regeneration	Disc and joint repair	Pilot studies	Ethical concerns, cost	Reduced pain, improved mobility	Standardized protocols
Digital health tools	Symptom tracking	Chronic pain management	Growing interest	Access, adherence challenges	Better patient engagement	More clinical trials
Non-addictive analgesics	Pain relief	Chronic and acute pain	Early phase studies	Limited availability	Safe, effective pain management	Extensive pharmacological research
AI-based diagnostics	Improved accuracy	Risk prediction and treatment	Moderate	Data privacy concerns	Precision medicine approach	Broader implementation studies
Telemedicine	Remote consultations	Accessible care	Widely accepted	Internet access issues	Enhanced healthcare access	Policy integration

LBP: Low back pain

diet, sleep, and mental health on LBP, will contribute to a more holistic, evidence-based approach tailored to women's needs.^[79]

CONCLUSION

LBP in women is a complex, multifactorial condition influenced by hormonal, biomechanical, and psychosocial factors across different life stages. Effective management requires a life-course approach, integrating non-pharmacological strategies such as physical therapy, yoga, and ergonomics alongside pharmacological and surgical options when necessary. Prevention through education, lifestyle modifications, and physical activity is key to reducing long-term risks. Clinicians should prioritize individualized, patient-centered care, incorporating both traditional and emerging treatments such as biologics and digital health tools. Future research must further explore gender-specific factors and psychosocial influences to enhance pain management. A holistic, proactive approach can significantly improve outcomes and quality of life for women experiencing LBP.

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