International Journal of Science and Research (IJSR)
ISSN: 2319-7064
Impact Factor 2024: 7.101

Evaluation of Disability and Flexibility Among Ahilyanagar Mahanagar Pallika Workers

Dr. Pratik R. Ingle (PT)[1], Dr. Shyam D. Ganvir[2], Dr. Deepti C. Thokal (PT)[3]

[1]Masters in Community Physiotherapy at Dr. Vitthalrao Vikhe Patil Foundations College of Physiotherapy, Ahilyanagar.
Email: *prateekingle123456[at]gmail.com*

[2]PhD Principal and Professor at Dr. Vitthalrao Vikhe Patil Foundations College of Physiotherapy, Ahilyanagar.
Email: *shyam.ganvir[at]gmail.com*

[3]Associate Professor in Community Physiotherapy Department at Dr. Vitthalrao Vikhe Patil Foundations College of Physiotherapy, Ahilyanagar.
Email: *deeptithokal7[at]gmail.com*

Abstract: ***Introduction*: Outlines the significance of non-specific low back pain in municipal workers, the importance of comprehensive disability and flexibility assessment, and the validated tools used (ODI and sit-and-reach test). It emphasizes the role of physiotherapy-led fitness assessments in occupational health management. *Aims and Objectives*: Clearly states the primary aim to evaluate disability and flexibility among municipal workers and lists four specific objectives focused on disability assessment, correlation analysis, demographic factor identification, and intervention recommendations. *Methodology*: Describes the cross-sectional observational design, purposive sampling strategy targeting 184 workers aged 18-60 years with non-specific low back pain, data collection instruments, ethical considerations, and statistical analysis procedures including descriptive statistics, normality testing, Spearman's correlation, Mann-Whitney U tests, and chi-square analyses. *Results*: Presents key quantitative findings including participant demographics (mean age 42.49 ± 11.6 years; 79.9% male), disability distribution (60.3% minimal, 28.3% moderate, 7.6% severe, 3.8% crippled), flexibility classification (52.7% super, 44.6% excellent, 2.7% good), the significant moderate negative correlation ($r = -0.434$, $p < 0.001$), and critical demographic associations between gender/BMI and both disability and flexibility outcomes. *Discussion*: Interprets findings within broader occupational health context, explaining the moderate correlation's clinical significance, the role of biomechanical factors in gender disparities, and the particularly robust relationship between elevated BMI and disability (72% of obese workers experiencing severe/crippled status versus 0% of normal-weight workers). *Conclusion*: Synthesizes key findings and provides evidence-based recommendations for comprehensive occupational health programs incorporating weight management, targeted interventions, and multimodal rehabilitation approaches for municipal workers.***

Keywords: non-specific low back pain, occupational health, flexibility, Oswestry Disability Index, municipal workers, role of physiotherapy-led fitness assessments, multimodal rehabilitation approaches

1. Introduction

Non-specific low back pain (NSCLBP) represents a significant occupational health concern affecting workers across diverse professional settings, accounting for approximately 85-90% of all low back pain cases. The comprehensive evaluation of disability and flexibility in municipal workers requires validated assessment tools that can accurately measure functional limitations and physical capabilities related to workplace performance. (1) The integration of annual physiotherapy fitness assessments is a forward-looking strategy to proactively manage occupational health risks in municipal workers. These assessments, conducted and certified by licensed physiotherapists, facilitate early detection of musculoskeletal dysfunction, enable baseline health tracking, and reinforce the need for preventive and timely interventions. Issuing a fitness certificate each year serves both as objective documentation of the worker's physical capacity and as a quality assurance measure for job-specific fitness demands, supporting worker safety and functional longevity.

Non-specific low back pain, characterized by the absence of identifiable pathological cause, poses unique challenges in occupational health assessment. Municipal workers, particularly those employed by Ahilyanagar Mahanagar Pallika, face diverse physical demands including prolonged standing, lifting, bending, and repetitive movements that can contribute to the development and persistence of low back pain conditions. The multifactorial nature of NSCLBP necessitates comprehensive evaluation approaches that consider both disability levels and physical flexibility parameters. (2)

The Oswestry Disability Index (ODI) has established itself as the most widely utilized patient-reported outcome measure for assessing functional disability related to low back pain. Originally developed by Fairbank et al. in 1980, the ODI consists of ten domains evaluating pain intensity, personal care, lifting, walking, sitting, standing, sleeping, sex life, social life, and traveling capabilities. (3) The ODI demonstrates exceptional psychometric properties with excellent internal consistency reliability (Cronbach's alpha of 0.72-0.92) and outstanding test-retest reliability (ICC 0.891-0.9332). The questionnaire requires approximately 5 minutes to complete and 1 minute to score, making it highly practical for clinical and occupational health settings. Scores range from 0-100%, with higher percentages indicating greater disability: 0-20% (minimal disability), 21-40% (moderate disability), 41-60% (severe disability), 61-80% (crippled), and 81-100% (bed-bound). (4) Research demonstrates that the ODI effectively discriminates between varying levels of functional impairment in occupational populations. A study of security personnel revealed that 47.69% experienced

moderate disability (21-40% ODI scores), while 30.77% showed minimal disability, highlighting the instrument's sensitivity to occupational-related functional limitations. The ODI shows superior performance in assessing chronic and severely disabled patients compared to other disability questionnaires. [5] [6]

For Ahilyanagar Mahanagar Pallika workers, the combined use of ODI and sit-and-reach testing provides complementary information about functional status and physical capabilities. The ODI offers comprehensive disability assessment directly relevant to workplace activities, while flexibility testing provides objective measures of range of motion that may impact job performance and injury risk. The ODI's inclusion of work-related domains makes it particularly suitable for occupational health evaluations. Modified versions have been developed specifically for different cultural contexts, including Indian populations, where activities such as sitting on floors and bending forward are more culturally relevant. These modifications maintain the instrument's reliability while improving cultural appropriateness. [9]

However, the relationship between sit-and-reach performance and low back pain outcomes remains complex. Large-scale longitudinal studies involving over 2,700 adults found poor correlations between sit-and-reach test performance and subsequent low back pain development ($r = -0.043$), questioning its validity as a predictor of back health. Similarly, industrial worker studies demonstrated that while sit-and-reach tests showed moderate correlation with lumbar flexibility ($r = 0.42$), they were unable to distinguish between workers with and without histories of low back discomfort. [7] Meta-analytic evidence suggests that sit-and-reach tests demonstrate moderate criterion-related validity for estimating hamstring extensibility ($rp = 0.46$-0.67), but their utility as indicators of low back health remains questionable. The test's effectiveness appears to be joint-specific, with flexibility being highly localized to individual body segments rather than representing overall flexibility. [8]

The integration of both assessment tools enables comprehensive evaluation of workers' functional status, supporting evidence-based decisions regarding workplace accommodations, return-to-work planning, and targeted intervention strategies. Regular monitoring using these standardized instruments can track progress and identify workers at risk for developing chronic disability conditions. The evidence-based application of these assessment tools provides municipal administrators with objective data to support worker health initiatives, modify job requirements, and implement preventive strategies targeting both disability reduction and flexibility improvement among their workforce.

Need for a Study

This study proposes annual physiotherapy-led fitness assessments and mandatory issuance of fitness certificates for all municipal workers. Such practice supports preventive occupational health, regular monitoring, and documentation of work capacity. Physiotherapists play a key role in certifying fitness and implementing evidence-based protocols, ensuring that only physically eligible staff are allocated strenuous duties and risks are proactively managed. Municipal workers face unique occupational hazards including prolonged standing, manual lifting, repetitive bending movements, and exposure to varied environmental conditions that distinguish them from other occupational groups. The lack of targeted research on Indian municipal workers represents a significant knowledge gap, particularly given the cultural, ergonomic, and socioeconomic factors that may influence both pain perception and functional capacity in this population.

Despite the established prevalence of NSCLBP as a major occupational health concern globally, significant gaps exist in understanding the relationship between functional disability and flexibility among municipal corporation workers. While disability and flexibility assessments are important, the addition of annual physiotherapy fitness evaluations and the issuing of physiotherapy fitness certificates create a more rigorous health monitoring infrastructure. This not only supports evidence-based decision making but also sets a standard for preventive occupational health interventions. Such systematic fitness certification programs ensure only physically eligible workers are assigned to tasks with specific demands, reducing risk and enhancing overall workplace productivity and safety. The proposed study addresses the critical need for a comprehensive assessment protocol that integrates validated disability measures (ODI) with objective physical capacity assessments (sit-and-reach testing) specifically tailored to municipal worker populations. This integration would provide multidimensional understanding of how perceived disability relates to actual physical limitations in occupationally relevant contexts.

Current evidence indicates that low back pain affects 65.3% of office workers and represents the primary cause of activity limitation, accounting for one-third of all worker compensation claims. However, the unique occupational demands and health profile of municipal workers, particularly those employed in Indian municipal corporations like Ahilyanagar Mahanagar Pallika, remain inadequately investigated. [10] The proposed study would establish normative values and cut-off points for both disability and flexibility measures specifically relevant to municipal worker populations, enabling more accurate risk stratification and intervention targeting.

Aim:

To evaluate the degree of disability and the level of flexibility among Ahilyanagar Mahanagar Pallika workers suffering from non-specific low back pain using the Oswestry Disability Index and sit-and-reach flexibility test.

Objectives

To assess the functional disability related to low back pain among municipal workers using the Oswestry Disability Index (ODI). To analyse the correlation between disability (ODI scores) and flexibility (sit-and-reach scores) in this population. To identify demographic and occupational factors influencing disability and flexibility among the workers. To provide recommendations for occupational health interventions aimed at reducing disability and improving flexibility in municipal workers with low back pain.

Null Hypothesis (H_0):
There is no statistically significant association between sit-and-reach flexibility scores and Oswestry Disability Index scores among Ahilyanagar Mahanagar Pallika workers with non-specific low back pain.

Alternate Hypothesis (H_1):
There is a statistically significant association between sit-and-reach flexibility scores and Oswestry Disability Index scores among Ahilyanagar Mahanagar Pallika workers with non-specific low back pain.

Research question
"What is the relationship between non-specific low back pain-related functional disability as measured by the Oswestry Disability Index and physical flexibility as assessed by the sit-and-reach test among Ahilyanagar Mahanagar Pallika workers?"

2. Methods and Methodology

This study employs an observational, cross-sectional design conducted within a community setup, specifically targeting workers from the Ahilyanagar Mahanagar Pallika. The research utilizes purposive sampling methodology based on predetermined inclusion and exclusion criteria to select participants from the study population, which comprises Ahilyanagar Mahanagar Pallika workers aged 18–60 years who have been diagnosed with non-specific low back pain.

Data collection will be conducted using two primary instruments: the Oswestry Disability Index (ODI) for comprehensive assessment of functional disability related to low back pain, and the sit-and-reach flexibility test to measure hamstring and lower back flexibility. The research procedure involves systematic recruitment of eligible workers through purposive sampling methods, followed by supervised completion of the ODI questionnaire by all participants. Subsequently, the sit-and-reach test will be administered following standardized protocols to ensure accurate assessment of flexibility parameters.

Ethical considerations form a cornerstone of this research methodology, with written informed consent being obtained from all participants prior to their involvement in the study. The research protocol ensures strict maintenance of confidentiality and anonymity throughout the data collection and analysis process, adhering to established ethical guidelines for human subject research in community-based health studies.

Inclusion Criteria: Participants eligible for this study must be employed as full-time workers at Ahilyanagar Mahanagar Pallika and fall within the age range of 18 to 60 years. Additionally, participants must demonstrate the cognitive and linguistic ability to understand and complete the Oswestry Disability Index questionnaire in the local language, while also expressing willingness to perform the sit-and-reach test and provide informed consent for participation in the study.

Exclusion Criteria: Participants will be excluded from the study if they present with any history of specific spinal pathology, including but not limited to spinal infections, tumors, fractures, or inflammatory diseases. Those who have undergone previous spinal surgery or any invasive spinal procedures will also be excluded. The presence of neurological deficits such as radiculopathy, myelopathy, or diagnosed radicular pain constitutes grounds for exclusion. Furthermore, individuals with any lower-limb or pelvic injury or surgical intervention within the preceding six months will not be eligible for participation. Pregnant women and those with known systemic diseases that affect musculoskeletal function, such as rheumatoid arthritis or osteoporosis, will be excluded. Finally, participants who are unable to safely perform flexibility testing due to underlying cardiovascular, respiratory, or vestibular conditions will not be included in the study to ensure participant safety and data validity.

3. Data Analysis

The data are analyzed using SPSS version 25. Descriptive statistics, including mean, standard deviation, frequencies, and percentages, summarize participants' demographic characteristics, Oswestry Disability Index (ODI) scores, and sit-and-reach flexibility test scores.

Normality of the ODI and flexibility score distributions is assessed with the Shapiro-Wilk test. Since the distributions significantly deviate from normality, non-parametric statistical procedures are adopted for subsequent analyses.

Correlation analysis is performed using Spearman's rank correlation coefficient to evaluate the relationship between ODI disability scores and sit-and-reach flexibility scores. A statistically significant moderate negative correlation is observed between ODI and flexibility scores ($r = -0.434$, $p < 0.001$), indicating that higher disability is associated with lower flexibility.

Comparative analyses are carried out using the Mann-Whitney U test to compare ODI and flexibility scores across subgroups such as gender or BMI categories. Statistically significant associations are noted between gender, BMI categories, and both disability and flexibility levels.

Multiple linear regression analysis is considered to explore predictors of disability scores, including flexibility measurements and demographic or occupational variables. Statistical significance is set at a p-value less than 0.05.

4. Results

All results are presented in tables and graphical formats to illustrate disability levels, flexibility scores, and their associations among Ahilyanagar Mahanagar Pallika workers with non-specific low back pain. This comprehensive analytical approach provides insight into how functional disability relates to flexibility and additional factors, thereby informing occupational health needs and guiding targeted interventions.

Tests of Normality

	Kolmogorov-Smirnova			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
Flexibility No	0.122	184	0	0.963	184	0
ODI	0.14	184	0	0.893	184	0

Descriptive statistics

Demographic Variables		Frequency (f)	Percentage (%)
Age in Years (mean ± SD)	42.49 ± 11.6		
Gender	Female	37	20.1
	Male	147	79.9
BMI	Normal	84	45.7
	Obese	25	13.6
	Overweight	68	3.8
	underweight	7	10

Distribution of Participants According to Oswestry Disability Levels and Flexibility Scores

		Frequency (n)	Percentage (%)
Oswestry Disability Index	Crippled	7	3.8
	Minimal	111	60.3
	Moderate	52	28.3
	Severe	14	7.6
Flexibility Scores	Excellent	82	44.6
	Good	5	2.7
	Super	97	52.7

Correlation between Disability and Flexibility Scores

Variables	Mean ± SD	Correlation Coefficient (r)	p-value
Oswestry Disability Index	19 ± 17.6	-0.434	0.000*
Flexibility Scores	28.9 ± 5.9		

Spearman's Rank correlation test used. * Correlation is significant at the 0.05 level (2 tailed)

Association between Disability Levels and Demographic Variables

Variables		Oswestry Disability Index				χ^2 value	p-value
		Crippled	Minimal	Moderate	Severe		
Gender	Female (37)	5 (13.5%)	17 (45.9%)	11 (29.7%)	4 (10.8%)	13.723	0.003*
	Male (147)	2 (1.4%)	94 (63.9%)	41 (27.9%)	10 (6.8%)		
BMI	Normal (84)	0 (0%)	71(84.5%)	12 (15.5%)	0 (0%)	99.122	0.000*
	Obese (25)	6(24.0%)	1 (4.0%)	9 (36.0%)	9 (36.0%)		
	Overweight (68)	1 (1.5%)	33 (48.5%)	29 (42.6%)	5 (7.4%)		
	Underweight (7)	0 (0%)	6 (85.7%)	1 (14.3%)	0 (0%)		

Association between Flexibility and Demographic Variables

Variables		Flexibility score			χ^2 value	p-value
		Excellent	Good	Super		
Gender	Female (37)	11 (29.7%)	0 (0%)	26 (70.3%)	6.252	0.044*
	Male (147)	71 (48.3%)	5 (3.4%)	71 (48.3%)		
BMI	Normal (84)	32 (38.1%)	1(1.2%)	51 (60.7%)	24.54	0.000*
	Obese (25)	12(48.0%)	4 (16.0%)	9 (36.0%)		
	Overweight (68)	36 (52.9%)	0 (0%)	32 (47.1%)		
	Underweight (7)	2 (28.6%)	0 (0%)	5 (71.4%)		

Participant Demographic Characteristics

A total of 184 municipal workers from Ahilyanagar Mahanagar Pallika participated in this cross-sectional observational study. The mean age of participants was 42.49 ± 11.6 years, with a predominantly male workforce comprising 147 participants (79.9%) compared to 37 female participants (20.1%). This gender distribution reflects the typical occupational demographic pattern observed in Indian municipal corporations, where males constitute the majority of the workforce engaged in physically demanding municipal operations. [11]

Body mass index classification revealed considerable variability in the study population's anthropometric profile. Normal BMI was observed in 84 participants (45.7%), while 68 participants (36.9%) were classified as overweight, 25 participants (13.6%) as obese, and 7 participants (3.8%) as underweight. It is noteworthy that there appears to be a discrepancy in the original data presentation where the overweight percentage was listed as 3.8%, which likely represents a typographical error given the frequency of 68 participants; the corrected percentage should be 36.9%. The combined prevalence of overweight and obesity (50.5%) in this study population aligns with emerging trends in Indian occupational settings, where sedentary components of work combined with physically demanding tasks contribute to elevated BMI. [12]

Tests of Normality

The distribution of both primary outcome variables significantly deviated from normality as assessed by the Kolmogorov-Smirnov and Shapiro-Wilk tests. For flexibility scores, the Kolmogorov-Smirnov test yielded a statistic of 0.122 (df = 184, $p < 0.001$), while the Shapiro-Wilk test produced a statistic of 0.963 (df = 184, $p < 0.001$). Similarly, the Oswestry Disability Index scores demonstrated significant non-normality, with Kolmogorov-Smirnov statistic of 0.140 (df = 184, $p < 0.001$) and Shapiro-Wilk statistic of 0.893 (df = 184, $p < 0.001$). These findings necessitated the application of non-parametric statistical procedures for subsequent correlation analyses, specifically the Spearman's rank correlation test.

Distribution of Disability Levels

The distribution of participants according to Oswestry Disability Index classification revealed that 111 participants (60.3%) experienced minimal disability (ODI score 0-20%), representing the largest category within the study population. Moderate disability (ODI score 21-40%) was observed in 52 participants (28.3%), while severe disability (ODI score 41-

60%) affected 14 participants (7.6%). A small proportion of participants, specifically 7 individuals (3.8%), were classified as crippled (ODI score 61-80%). The mean ODI score for the entire cohort was 19 ± 17.6%, indicating that on average, participants experienced disability at the upper boundary of the minimal disability category.

These findings demonstrate that while the majority of municipal workers maintained functional capacity with minimal disability, a substantial proportion (39.7%) reported moderate to crippled levels of disability related to low back pain. This distribution pattern is consistent with occupational health surveillance data from other manual labor populations, where chronic exposure to ergonomic stressors produces a spectrum of disability outcomes. [11]

Distribution of Flexibility Scores

Flexibility assessment using the sit-and-reach test revealed that 97 participants (52.7%) achieved "super" classification, while 82 participants (44.6%) demonstrated "excellent" flexibility. Only 5 participants (2.7%) achieved "good" classification. The mean flexibility score for the study population was 28.9 ± 5.9 cm. This distribution indicates that the majority of municipal workers (97.3%) maintained either excellent or super flexibility levels despite experiencing varying degrees of low back pain-related disability.

The relatively high flexibility scores observed in this population may reflect the physically active nature of municipal work, which inherently involves repetitive bending, lifting, and range-of-motion activities. However, the classification terminology ("super," "excellent," "good") used in the original data differs from standard ACSM normative categories, suggesting the application of a modified or population-specific grading system.

Correlation Between Disability and Flexibility

Spearman's rank correlation analysis revealed a statistically significant moderate negative correlation between Oswestry Disability Index scores and flexibility scores ($r = -0.434$, $p < 0.001$). This correlation coefficient of -0.434 falls within the moderate strength category according to established interpretation guidelines for medical research. The negative direction of the correlation indicates that as disability levels increase, flexibility scores tend to decrease, and conversely, higher flexibility is associated with lower disability levels. [13]

The statistical significance ($p < 0.001$) demonstrates that this relationship is highly unlikely to have occurred by chance, providing strong evidence for a genuine association between these variables in the study population. According to conventional interpretation frameworks, a Spearman correlation of 0.40-0.59 represents a moderate association, suggesting that flexibility accounts for a meaningful but not deterministic proportion of the variance in disability scores.

Association Between Disability Levels and Demographic Variables

Chi-square analysis demonstrated statistically significant associations between disability levels and both gender and BMI categories. For gender, the chi-square value was 13.723 ($p = 0.003$), indicating a significant relationship between gender and ODI classification. Female participants demonstrated a substantially higher prevalence of crippled status, with 5 of 37 females (13.5%) classified as crippled compared to only 2 of 147 males (1.4%). Conversely, male participants showed higher rates of minimal disability, with 94 of 147 males (63.9%) in this category compared to 17 of 37 females (45.9%). [14]

The association between BMI and disability levels was highly significant ($\chi^2 = 99.122$, $p < 0.001$). Notably, all participants with normal BMI (n=84) were distributed between minimal and moderate disability categories, with 71 (84.5%) experiencing minimal disability and 12 (15.5%) experiencing moderate disability; none reported severe or crippled status. In contrast, obese participants (n=25) demonstrated a dramatically different distribution: 6 (24.0%) were classified as crippled, 9 (36.0%) as severe, 9 (36.0%) as moderate, and only 1 (4.0%) as minimal disability. [15]

Overweight participants (n=68) showed an intermediate pattern with 33 (48.5%) experiencing minimal disability, 29 (42.6%) moderate disability, 5 (7.4%) severe disability, and 1 (1.5%) crippled status. Underweight participants (n=7) demonstrated relatively favorable outcomes with 6 (85.7%) reporting minimal disability and 1 (14.3%) moderate disability.

Association Between Flexibility and Demographic Variables

Gender demonstrated a statistically significant association with flexibility categories ($\chi^2 = 6.252$, $p = 0.044$). Male participants showed a more balanced distribution across flexibility categories, with 71 of 147 males (48.3%) achieving excellent flexibility, 5 (3.4%) good flexibility, and 71 (48.3%) super flexibility. Female participants demonstrated a different pattern, with 11 of 37 females (29.7%) achieving excellent flexibility, 0 (0%) good flexibility, and 26 (70.3%) super flexibility.

BMI category also showed a highly significant association with flexibility ($\chi^2 = 24.54$, $p < 0.001$). Participants with normal BMI (n=84) demonstrated 32 (38.1%) with excellent flexibility, 1 (1.2%) with good flexibility, and 51 (60.7%) with super flexibility. Obese participants (n=25) showed 12 (48.0%) with excellent flexibility, 4 (16.0%) with good flexibility, and 9 (36.0%) with super flexibility. Overweight participants (n=68) demonstrated 36 (52.9%) with excellent flexibility, 0 (0%) with good flexibility, and 32 (47.1%) with super flexibility. Underweight participants (n=7) showed 2 (28.6%) with excellent flexibility, 0 (0%) with good flexibility, and 5 (71.4%) with super flexibility. [16]

5. Discussion

Principal Findings and Interpretation

This cross-sectional observational study comprehensively evaluated the relationship between functional disability and flexibility among 184 Ahilyanagar Mahanagar Pallika workers experiencing non-specific low back pain. The principal finding—a statistically significant moderate negative correlation ($r = -0.434$, $p < 0.001$) between Oswestry Disability Index scores and sit-and-reach flexibility measurements—provides important empirical evidence regarding the interplay between hamstring-lower back

flexibility and perceived functional limitations in an occupational setting. [17]

The moderate strength of this correlation (r = -0.434) suggests that flexibility represents a meaningful but not exclusive determinant of disability in this population. According to established interpretation frameworks for correlation coefficients in medical research, values between 0.40-0.59 indicate moderate associations, implying that approximately 18.8% of the variance in disability scores ($r^2 = 0.188$) can be attributed to flexibility differences. This finding aligns with contemporary understanding of non-specific low back pain as a multifactorial condition influenced by biomechanical, psychosocial, occupational, and individual factors. [18]

The negative direction of the correlation—wherein increased disability corresponds with decreased flexibility—supports the clinical rationale underlying flexibility assessment and enhancement interventions for occupational low back pain management. However, the moderate rather than strong correlation magnitude underscores that flexibility alone cannot fully explain or predict disability levels, necessitating comprehensive multidimensional assessment approaches that incorporate additional risk factors and functional domains. [19]

Disability Distribution Patterns and Occupational Implications

The finding that 60.3% of participants experienced minimal disability (ODI 0-20%) while 39.7% reported moderate to crippled disability levels reveals a bimodal distribution pattern with important occupational health implications. This distribution suggests the existence of distinct subpopulations within the municipal workforce: a majority maintaining functional capacity despite low back pain, and a substantial minority experiencing clinically significant functional limitations that may impact work performance and productivity.

The mean ODI score of 19 ± 17.6% positions the study population at the boundary between minimal and moderate disability categories, indicating that while average functional impairment remains relatively low, considerable variability exists across individual workers. This variability, reflected in the large standard deviation (17.6%), highlights the heterogeneous nature of low back pain experiences within occupational populations and the importance of individualized assessment and intervention approaches.

Notably, 7.6% of workers reported severe disability and 3.8% reported crippled status, representing 21 workers with ODI scores exceeding 40%. These individuals likely require intensive intervention, potential workplace modifications, and possibly medical management to maintain employment and prevent progression to complete work disability. The identification of this high-risk subgroup through systematic ODI screening demonstrates the value of standardized disability assessment in occupational health surveillance programs.

From an occupational health perspective, the 39.7% prevalence of moderate to crippled disability represents a substantial burden on both individual workers and municipal operations. Previous research on Indian occupational populations has documented that moderate to severe disability levels are associated with increased absenteeism, reduced productivity, job modification requirements, and elevated risk of permanent work disability. The current findings suggest that approximately 73 of the 184 studied workers may benefit from targeted interventions including ergonomic modifications, physical therapy, pain management, and potentially job reassignment. [20]

Flexibility Assessment Results and Their Clinical Significance

The flexibility assessment revealed that 97.3% of participants achieved excellent or super flexibility classifications, with a mean sit-and-reach score of 28.9 ± 5.9 cm. This finding appears paradoxical given that 39.7% of the same population reported moderate to crippled disability levels, raising important questions about the relationship between objective physical capacity measures and subjective functional limitation reports. [21]

Several factors may contribute to this apparent discrepancy. First, the sit-and-reach test, while widely utilized, demonstrates only moderate criterion-related validity for predicting low back health outcomes. Large-scale longitudinal studies involving over 2,700 adults have documented poor correlations (r = -0.043) between sit-and-reach performance and subsequent low back pain development, questioning the test's validity as a predictor of back health. Similarly, industrial worker studies have shown that while sit-and-reach tests demonstrate moderate correlation with lumbar flexibility (r = 0.42), they fail to distinguish between workers with and without histories of low back discomfort. [22]

Second, the sit-and-reach test primarily measures hamstring and posterior thigh flexibility rather than isolated lumbar spine flexibility. Meta-analytic evidence suggests that sit-and-reach tests demonstrate moderate criterion-related validity for estimating hamstring extensibility (rp = 0.46-0.67), but their utility as indicators of low back health remains questionable. The test's effectiveness appears to be joint-specific, with flexibility being highly localized to individual body segments rather than representing overall flexibility. [23]

Third, the physically demanding nature of municipal work—involving repetitive bending, lifting, carrying, and varied movement patterns—may naturally maintain hamstring-hip flexibility even in workers experiencing pain and functional limitations. The occupational activities themselves may serve as ongoing flexibility training, preserving range of motion while simultaneously contributing to tissue stress, fatigue, and pain generation through chronic overload. [24]

The finding that only 2.7% of participants achieved "good" flexibility while the majority achieved "excellent" or "super" classifications suggests either that the normative standards employed may not align with established ACSM guidelines, or that the municipal worker population demonstrates exceptional flexibility characteristics compared to general population norms. Standard ACSM normative data for adults indicates that excellent flexibility for males aged 40-49 years is ≥24 cm and for females ≥27 cm. The mean score of 28.9 cm observed in this study exceeds these thresholds,

supporting the interpretation that this occupational population maintains above-average flexibility levels.

Gender Differences in Disability and Flexibility Patterns

The statistically significant association between gender and disability levels ($\chi^2 = 13.723$, $p = 0.003$) revealed that female municipal workers experienced substantially higher rates of severe functional limitation compared to their male counterparts. Specifically, 13.5% of female participants were classified as crippled compared to only 1.4% of males, while females also demonstrated lower rates of minimal disability (45.9%) compared to males (63.9%). [25]

These gender disparities align with extensive literature documenting that women experience more severe low back pain manifestations, including higher prevalence rates, greater disability levels, and more complex complications. Multiple mechanisms contribute to these observed differences. Biomechanically, women's unique lumbopelvic characteristics, including greater lumbar lordosis, different disc geometry, and hormonal influences on ligamentous laxity, confer greater susceptibility to repetitive loading injuries. [26]

Occupationally, female municipal workers face dual ergonomic stressor exposures from both workplace demands and domestic responsibilities, creating a distinctive cumulative injury profile. Societal gender roles typically assign primary household management, childcare, and family caregiving responsibilities to women regardless of employment status, resulting in extended daily physical demands that compound occupational exposures. This "double burden" phenomenon has been consistently associated with elevated musculoskeletal disorder risk in working women across diverse occupational settings.

Additionally, female-dominated municipal occupations (such as waste sorting, cleaning, and sanitation tasks) typically involve sustained low-intensity loading exposures characterized by prolonged awkward postures, repetitive movements, and static muscle activation. In contrast, male-dominated roles (such as heavy lifting, equipment operation, and infrastructure maintenance) involve intermittent high-intensity demands with recovery intervals. The chronic, unrelieved nature of low-intensity exposures may produce greater cumulative tissue stress and pain sensitization. [27]

Psychosocial factors also influence gender-specific disability patterns. Research suggests that women demonstrate greater healthcare utilization and more detailed symptom reporting compared to men, potentially reflecting both genuine differences in pain experience and differential social acceptability of pain expression. Gender norms may suppress symptom reporting in men, while women's openness about health concerns may more accurately capture the true disability burden. [25]

The gender differences in flexibility distribution ($\chi^2 = 6.252$, $p = 0.044$) revealed that 70.3% of female participants achieved super flexibility compared to 48.3% of males, despite females reporting higher disability levels. This finding reinforces the conclusion that flexibility alone does not determine functional status and that the relationship between physical capacity measures and disability outcomes differs between genders. These observations underscore the necessity for gender-sensitive assessment frameworks and interventions that address both biological and sociocultural determinants of occupational low back pain.

Body Mass Index as a Critical Determinant of Disability

The highly significant association between BMI categories and disability levels ($\chi^2 = 99.122$, $p < 0.001$) represents one of the most robust findings of this study and has substantial implications for occupational health intervention strategies. The dramatic gradient observed across BMI categories—from zero participants with normal BMI experiencing severe or crippled disability, to 72% of obese participants reporting severe or crippled status—demonstrates that elevated body mass represents a critical modifiable risk factor for low back pain-related functional limitation. [12]

These findings align with extensive epidemiological evidence documenting positive associations between obesity measures and both low back pain intensity and disability. A large prospective Australian study involving 5,058 participants demonstrated that BMI, waist circumference, percent fat, and fat mass were each positively associated with low back pain intensity and disability, with significant dose-response relationships across sex-specific quartiles. For example, women in the highest fat mass quartile demonstrated 78% higher odds of low back pain intensity compared to the lowest quartile. [28]

Multiple mechanisms explain the relationship between elevated BMI and increased disability in low back pain populations. First, excess body mass increases mechanical loading on spinal structures, particularly the lumbar intervertebral discs, facet joints, and supporting musculature. This increased loading accelerates degenerative processes, promotes disc herniation, and contributes to chronic pain states. Second, adipose tissue functions as an active endocrine organ, producing pro-inflammatory cytokines including tumor necrosis factor-alpha, interleukin-6, and C-reactive protein. These inflammatory mediators contribute to systemic low-grade inflammation that sensitizes pain pathways and may directly affect intervertebral disc metabolism and degeneration. [29]

Third, obesity frequently coexists with metabolic syndrome, insulin resistance, and vascular compromise, all of which impair tissue healing, reduce exercise tolerance, and limit rehabilitation outcomes. Fourth, the biomechanical disadvantages of excess abdominal adiposity—including altered center of gravity, increased lumbar lordosis, and reduced core stability—compromise spinal mechanics and increase injury risk during occupational tasks. [28]

The current finding that no participants with normal BMI experienced severe or crippled disability suggests that maintaining healthy body composition may serve a protective function against progression to high-level functional limitation. Conversely, the observation that 72% of obese participants reported severe or crippled disability indicates that obesity represents a critical risk factor requiring aggressive intervention. [25]

From an occupational health perspective, these findings support the implementation of comprehensive workplace wellness programs targeting weight management, nutritional education, and physical activity promotion. Research has demonstrated that multimodal rehabilitation approaches for chronic low back pain can achieve comparable clinical outcomes across BMI categories when interventions address obesity concurrently with pain management. However, the substantially higher baseline disability levels observed in obese workers underscore the importance of prevention strategies that address weight management before severe functional limitation develops. [40]

Implications of the Moderate Correlation Between Disability and Flexibility

The observed moderate negative correlation (r = -0.434) between disability and flexibility, while statistically significant, reveals important limitations regarding flexibility as a determinant or predictor of functional status in occupational low back pain. The correlation magnitude suggests that flexibility accounts for approximately 19% of the variance in disability scores, leaving approximately 81% of variance attributable to other factors. [18]

This finding aligns with contemporary biopsychosocial models of low back pain that emphasize the multifactorial nature of disability, incorporating physical, psychological, social, and occupational dimensions. Meta-analytic evidence and systematic reviews have consistently demonstrated that disability in low back pain populations is influenced by factors including pain intensity, fear-avoidance beliefs, depression, anxiety, job satisfaction, workplace social support, physical job demands, and perceived control over work conditions.

The moderate correlation also reflects methodological limitations inherent to the sit-and-reach test as a measure relevant to low back health. As previously discussed, this test demonstrates poor discrimination between individuals with and without low back pain histories, suggesting that the specific aspect of flexibility it measures may not be the most relevant parameter for low back function. Lumbar-specific flexibility measures, such as the modified Schober test or inclinometer-based segmental range of motion assessment, may demonstrate stronger relationships with disability outcomes by more directly measuring the range of motion of spinal structures implicated in low back pain. [19]

Furthermore, flexibility represents a physical capacity measure, while the Oswestry Disability Index captures perceived functional limitation across multiple life domains including pain intensity, personal care, lifting, walking, sitting, standing, sleeping, social life, and travel. The relationship between objective physical capacity and subjective functional limitation is mediated by numerous psychological and contextual factors including pain catastrophizing, self-efficacy, coping strategies, and social support. Two individuals with identical flexibility may report vastly different disability levels based on these psychological and social determinants.

The clinical implication is that while flexibility enhancement through stretching, yoga, or other interventions may contribute to disability reduction, comprehensive treatment approaches must address the multiple dimensions of the low back pain experience. Evidence-based management of occupational low back pain typically incorporates flexibility training within multimodal programs that also include strengthening exercises, aerobic conditioning, ergonomic modifications, pain education, cognitive-behavioral interventions, and workplace accommodations.

Comparison with Existing Literature

The prevalence of moderate to severe disability (39.7%) observed in this study population is comparable to rates documented in other occupational populations experiencing chronic low back pain. A study of municipal solid waste workers in Chennai, India, reported that 70% experienced musculoskeletal pain in one or more body regions during the preceding 12 months, with 50.9% specifically reporting lower back symptoms. Similarly, research on female brick field workers in West Bengal documented that 70% reported low back pain attributable to awkward working posture for prolonged periods. [31]

The mean ODI score of 19 ± 17.6% in the current study is lower than that reported in many clinical populations seeking specialized care, which typically demonstrate baseline ODI scores of approximately 42%. This difference likely reflects the community-based occupational nature of the current sample, which includes workers across the full spectrum of disability rather than only those seeking medical intervention. The inclusion of workers with minimal disability (60.3% of the sample) reduces the overall mean while still identifying a substantial subpopulation with clinically significant functional limitation. [32]

The finding that female workers demonstrated higher disability levels aligns with global epidemiological trends. A comprehensive review of gender-related issues in low back pain management concluded that female patients consistently show worse baseline disability and quality of life compared to male patients, though they demonstrate equal or greater improvement following intervention. These gender disparities reflect the complex interaction of biological, occupational, and sociocultural factors previously discussed. [33]

The strong association between BMI and disability observed in this study ($\chi^2 = 99.122$, $p < 0.001$) demonstrates an even more robust relationship than reported in some previous studies. A systematic review examining BMI effects on chronic low back pain treatment outcomes found that while obese individuals demonstrated significantly higher pre-treatment disability, multivariate analysis suggested that other covariates (age, treatment sessions, pre-treatment pain and disability scores) showed stronger associations with outcomes than BMI alone. However, the dramatic gradient observed in the current study—with zero normal-weight participants experiencing severe/crippled disability compared to 72% of obese participants—suggests that in this specific occupational population, BMI may represent a particularly critical determinant. [34]

The moderate correlation between disability and flexibility (r = -0.434) is stronger than the correlations reported in several

large-scale studies examining sit-and-reach relationships with low back outcomes. Jackson et al. found essentially no correlation ($r = -0.043$, $p = 0.03$) between sit-and-reach performance and subsequent low back pain in a prospective study of 2,747 adults. Grenier et al. reported a moderate correlation ($r = 0.42$) between sit-and-reach and lumbar flexibility but found that the test could not distinguish between workers with and without low back discomfort histories. The stronger correlation observed in the current study may reflect the cross-sectional design measuring concurrent disability and flexibility rather than predictive relationships, or may indicate that in populations with active low back pain, flexibility demonstrates stronger associations with functional status than in general populations. [21]

6. Strengths and Limitations

This study demonstrates several important methodological strengths. The sample size of 184 participants provides adequate statistical power for detecting moderate correlations and associations. The use of validated, widely recognized assessment instruments—the Oswestry Disability Index and the sit-and-reach test—enhances comparability with existing literature and supports reliable measurement of the constructs of interest. The comprehensive assessment of demographic variables including age, gender, and BMI enables exploration of important subgroup differences. The application of appropriate non-parametric statistical procedures (Spearman's correlation) following normality testing demonstrates methodological rigor.

However, several limitations warrant consideration in interpreting these findings. The cross-sectional design precludes causal inference regarding the relationships observed; while disability and flexibility are correlated, this study cannot determine whether reduced flexibility contributes to increased disability, whether disability leads to reduced flexibility through activity limitation, or whether both are influenced by common underlying factors. Longitudinal designs following workers over time would provide stronger evidence regarding causal pathways and temporal relationships. [35]

The reliance on a single flexibility measure (sit-and-reach test) limits comprehensive assessment of flexibility domains relevant to low back function. As discussed, this test primarily measures hamstring and hip flexibility rather than lumbar-specific range of motion, and demonstrates only moderate validity for low back health assessment. Inclusion of additional flexibility measures targeting lumbar flexion-extension, lateral bending, and rotation would provide more complete characterization of spinal mobility. [36]

The study population was drawn from a single municipal corporation (Ahilyanagar Mahanagar Pallika), which may limit generalizability to other occupational settings or geographic regions. Municipal work encompasses diverse job categories with varying physical demands, ergonomic exposures, and injury risks. The current study did not stratify analyses by specific job categories (e.g., sanitation workers, road maintenance, administrative staff), potentially obscuring important occupation-specific patterns. [37]

The predominance of male participants (79.9%) reflects the actual gender distribution in municipal employment but limits statistical power for detecting gender differences and evaluating gender-specific relationships. The small number of female participants (n=37) means that subgroup analyses within females (e.g., examining BMI effects separately by gender) lack precision.

The study did not assess several important variables known to influence low back pain disability, including pain duration, previous injury history, specific occupational exposures (lifting frequency, prolonged sitting or standing, whole-body vibration), psychosocial factors (depression, anxiety, fear-avoidance beliefs, catastrophizing), workplace factors (job satisfaction, supervisor support, work control), and treatment history. These unmeasured confounders may influence the observed relationships and limit comprehensive understanding of disability determinants in this population.

Finally, the disability and flexibility classifications employed in the original data presentation used terminology ("crippled," "super," "excellent," "good") that differs somewhat from contemporary standard nomenclature, though the underlying scoring systems appear consistent with established ODI interpretation and sit-and-reach norms.

Clinical and Occupational Health Implications

The findings of this study have several important implications for clinical practice and occupational health programming in municipal corporations. The significant negative correlation between flexibility and disability, while moderate in strength, supports the inclusion of flexibility assessment and enhancement in comprehensive low back pain management programs for municipal workers. Workplace-based stretching programs, particularly those targeting hip flexors, hamstrings, and lumbar extensors, may contribute to disability reduction when implemented as components of multimodal interventions. [38]

However, the moderate correlation magnitude ($r = -0.434$) indicates that flexibility training alone will be insufficient for many workers, particularly those with moderate to severe disability. Evidence-based occupational low back pain management should incorporate flexibility enhancement within comprehensive programs that also address strengthening (particularly core stabilization), aerobic conditioning, ergonomic modifications, pain education, psychological factors, and workplace accommodations.

The strong associations between BMI and disability ($\chi^2 = 99.122$, $p < 0.001$) and between BMI and flexibility ($\chi^2 = 24.54$, $p < 0.001$) underscore the critical importance of weight management in occupational musculoskeletal health. Municipal corporations should consider implementing workplace wellness initiatives targeting healthy eating, physical activity promotion, and weight loss support for overweight and obese workers. Given that 50.5% of the study population was classified as overweight or obese, such programs could benefit a substantial proportion of the workforce. [30]

Workplace wellness programs demonstrate greatest effectiveness when they address multiple health behaviors

simultaneously, provide environmental supports (e.g., healthy cafeteria options, physical activity facilities), incorporate social support mechanisms, and align with organizational culture and priorities. For municipal workers, who may have limited access to gyms or structured exercise programs due to shift work, economic constraints, or transportation barriers, workplace-based interventions may be particularly valuable. [11]

The gender differences observed in disability distribution—with females demonstrating substantially higher rates of severe functional limitation—highlight the need for gender-sensitive occupational health approaches. Interventions should recognize that female municipal workers face unique challenges including dual burden from workplace and domestic responsibilities, gender-specific biomechanical vulnerabilities, and potential barriers to accessing care and accommodations. Organizational policies supporting work-life balance, flexible scheduling, and equitable distribution of physically demanding tasks may help address gender disparities in disability outcomes. [25]

The identification of 21 workers (11.4%) experiencing severe or crippled disability suggests the need for targeted case management, intensive rehabilitation services, and potential job modifications for this high-risk subgroup. Early identification through systematic ODI screening could enable proactive intervention before progression to permanent work disability. Municipal corporations might consider implementing annual or biennial disability screening programs, particularly for workers in high-risk occupations (heavy lifting, waste collection, road maintenance).

7. Future Research Directions

Several important research questions emerge from this study that warrant investigation in future work. Longitudinal cohort studies following municipal workers over time would enable examination of temporal relationships between flexibility, BMI, and disability progression, providing stronger evidence regarding causal pathways and identifying modifiable risk factors for disability onset and progression. Such studies could also evaluate the effectiveness of preventive interventions implemented before significant disability develops. [39]

Intervention trials evaluating the effectiveness of workplace-based flexibility training programs, weight management initiatives, and multimodal rehabilitation approaches specifically for municipal workers would provide evidence regarding optimal intervention strategies for this population. Comparative effectiveness research examining different intervention combinations could help determine the relative contributions of flexibility training, strengthening, aerobic exercise, ergonomic modifications, and psychosocial interventions to disability reduction. [15]

Research examining occupation-specific patterns within municipal work would enhance understanding of how different job categories (sanitation, road maintenance, parks and recreation, administrative support) experience varying disability risks and may require tailored interventions. Detailed assessment of occupational exposures including lifting frequency and loads, awkward posture duration, whole-body vibration, repetitive movements, and shift schedules would enable identification of modifiable workplace factors. [40]

Investigation of psychosocial factors including pain catastrophizing, fear-avoidance beliefs, depression, anxiety, self-efficacy, social support, job satisfaction, and workplace social capital would provide more comprehensive understanding of disability determinants and inform development of cognitive-behavioral and organizational interventions. Given the substantial unexplained variance in disability scores after accounting for flexibility (81%), these psychosocial factors likely represent important targets for intervention.

Gender-specific research examining the mechanisms underlying observed disparities in disability outcomes could inform development of more effective interventions for female municipal workers. Investigation of the relative contributions of biomechanical factors (e.g., lumbopelvic anatomy, hormonal influences), occupational factors (e.g., task allocation, dual burden), and psychosocial factors (e.g., gender norms regarding pain expression, healthcare access) would enhance understanding of these complex relationships.

Finally, research evaluating alternative flexibility assessment methods that may demonstrate stronger relationships with low back-specific function—including lumbar-specific measures (modified Schober test, inclinometer assessment), hip flexibility tests targeting different movement planes, and dynamic movement screening—could enhance clinical assessment approaches and improve prediction of disability outcomes. [12]

8. Conclusions

This cross-sectional observational study of 184 Ahilyanagar Mahanagar Pallika workers experiencing non-specific low back pain demonstrates a statistically significant moderate negative correlation ($r = -0.434$, $p < 0.001$) between Oswestry Disability Index scores and sit-and-reach flexibility measurements. While this correlation supports the clinical relevance of flexibility assessment and enhancement in occupational low back pain management, the moderate strength indicates that flexibility represents only one component of a multifactorial disability profile.

Approximately 40% of municipal workers reported moderate to crippled disability levels, representing a substantial burden of functional limitation within this occupational population. Body mass index emerged as a critical determinant of disability, with highly significant associations demonstrating that no normal-weight participants experienced severe or crippled disability compared to 72% of obese participants. Female workers demonstrated significantly higher rates of severe functional limitation compared to males, highlighting important gender disparities requiring targeted intervention approaches.

These findings support implementation of comprehensive occupational health programs that address flexibility, body composition, gender-specific needs, and the

multidimensional nature of low back pain-related disability. Systematic disability screening, workplace wellness initiatives targeting weight management and physical activity, gender-sensitive intervention approaches, and multimodal rehabilitation programs incorporating flexibility training alongside strengthening, aerobic conditioning, ergonomic modifications, and psychosocial interventions represent evidence-based strategies for reducing the disability burden among municipal workers. Future longitudinal research and intervention trials are needed to establish causal relationships and optimal treatment approaches for this important occupational population.

References

[1] Zhang S, Yang H, Luo B, Cheng Y, Niu S, Yang C. Factors affecting functional disability in patients with non-specific chronic low back pain: a cross-sectional study. Front Neurol. 2024 May 1;15:1367400. doi: 10.3389/fneur.2024.1367400. PMID: 38751880; PMCID: PMC11094354.

[2] Tait RC, Chibnall JT, Andresen EM, Hadler NM. Disability determination: validity with occupational low back pain. J Pain. 2006 Dec;7(12):951-7. doi: 10.1016/j.jpain.2006.05.007. PMID: 17157782.

[3] Sandal D, Jindal R, Gupta S, Garg SK. Reliability and validity of Punjabi version of Oswestry Disability Index in patients with mechanical low back pain. J Clin Orthop Trauma. 2020 Nov 20;13:163-168. doi: 10.1016/j.jcot.2020.11.011. PMID: 33717889; PMCID: PMC7920106.

[4] Tonosu J, Takeshita K, Hara N, Matsudaira K, Kato S, Masuda K, Chikuda H. The normative score and the cut-off value of the Oswestry Disability Index (ODI). Eur Spine J. 2012 Aug;21(8):1596-602. doi: 10.1007/s00586-012-2173-7. PMID: 22298236; PMCID: PMC3535252.

[5] Vianin M. Psychometric properties and clinical usefulness of the Oswestry Disability Index. J Chiropr Med. 2008 Dec;7(4):161-3. doi: 10.1016/j.jcm.2008.07.001. PMID: 19646379; PMCID: PMC2697602.

[6] Fairbank JC, Couper J, Davies JB, O'Brien JP. The Oswestry low back pain disability questionnaire. Physiotherapy. 1980 Aug;66(8):271-3. PMID: 6450426.

[7] Grenier SG, Russell C, McGill SM. Relationships between lumbar flexibility, sit-and-reach test, and a previous history of low back discomfort in industrial workers. Can J Appl Physiol. 2003 Apr;28(2):165-77. doi: 10.1139/h03-013. PMID: 12825327.

[8] Jackson AW, Morrow JR Jr, Brill PA, Kohl HW 3rd, Gordon NF, Blair SN. Relations of sit-up and sit-and-reach tests to low back pain in adults. J Orthop Sports Phys Ther. 1998 Jan;27(1):22-6. doi: 10.2519/jospt.1998.27.1.22. PMID: 9440037.

[9] Aithala JP, Kumar S, Aithal S, Kotian SM. Development of a Modified Disability Questionnaire for Evaluating Disability Caused by Backache in India and Other Developing Countries. Asian Spine J. 2018 Dec;12(6):1106-1116. doi: 10.31616/asj.2018.12.6.1106. Epub 2018 Oct 16. PMID: 30322245; PMCID: PMC6284133.

[10] Salihu, M. N., Lawal, M. M., Musa, A. A., Abdullahi, Y. M., Umar, M. D., Amaka, O. C., Addi, J. J., & Muhammad, F. (2021). Prevalence of low back pain and associated factors among office workers in Kano city, Nigeria. *International Journal of Research in Orthopaedics*, *7*(5), 907–913. https://doi.org/10.18203/issn.2455-4510.IntJResOrthop20213375

[11] Reddy EM, Yasobant S. Musculoskeletal disorders among municipal solid waste workers in India: A cross-sectional risk assessment. J Family Med Prim Care. 2015 Oct-Dec;4(4):519-24. doi: 10.4103/2249-4863.174270. PMID: 26985409; PMCID: PMC4776602.

[12] Hussain SM, Urquhart DM, Wang Y, Shaw JE, Magliano DJ, Wluka AE, Cicuttini FM. Fat mass and fat distribution are associated with low back pain intensity and disability: results from a cohort study. Arthritis Res Ther. 2017 Feb 10;19(1):26. doi: 10.1186/s13075-017-1242-z. PMID: 28183360; PMCID: PMC5301404.

[13] Akoglu H. User's guide to correlation coefficients. Turk J Emerg Med. 2018 Aug 7;18(3):91-93. doi: 10.1016/j.tjem.2018.08.001. PMID: 30191186; PMCID: PMC6107969.

[14] Wu M, Wu P, Lu H, Han L, Liu X. Global burden of occupational ergonomic factor-induced low back pain, 1990~2021: data analysis and projections of the global burden of disease. Front Public Health. 2025 May 27;13:1573828. doi: 10.3389/fpubh.2025.1573828. PMID: 40496462; PMCID: PMC12148919.

[15] Shetty GM, Jain S, Shah N, Ram CS, Thakur H. Does Patient Body Mass Index Affect the Outcome of Multimodal Rehabilitation in Chronic Mechanical Low Back Pain? Spine (Phila Pa 1976). 2021 Oct 1;46(19):1336-1343. doi: 10.1097/BRS.0000000000004000. PMID: 34517403.

[16] Chou L, Brady SRE, Urquhart DM, Teichtahl AJ, Cicuttini FM, Pasco JA, Brennan-Olsen SL, Wluka AE. The Association Between Obesity and Low Back Pain and Disability Is Affected by Mood Disorders: A Population-Based, Cross-Sectional Study of Men. Medicine (Baltimore). 2016 Apr;95(15):e3367. doi: 10.1097/MD.0000000000003367. PMID: 27082599; PMCID: PMC4839843.

[17] Grenier SG, Russell C, McGill SM. Relationships between lumbar flexibility, sit-and-reach test, and a previous history of low back discomfort in industrial workers. Can J Appl Physiol. 2003 Apr;28(2):165-77. doi: 10.1139/h03-013. PMID: 12825327.

[18] Papageorgiou SN. On correlation coefficients and their interpretation. J Orthod. 2022 Sep;49(3):359-361. doi: 10.1177/14653125221076142. PMID: 36017900; PMCID: PMC9420886.

[19] Jackson AW, Morrow JR Jr, Brill PA, Kohl HW 3rd, Gordon NF, Blair SN. Relations of sit-up and sit-and-reach tests to low back pain in adults. J Orthop Sports Phys Ther. 1998 Jan;27(1):22-6. doi: 10.2519/jospt.1998.27.1.22. PMID: 9440037.

[20] Article Public Health Journal of Orthopaedic & Sports Physical Therapy, Volume 27, Issue 1, 1998, pages 22-26. Jackson, A. W., Morrow, Jr., J. R., Brill, P. A., Kohl, III, H. W., Gordon, N. F., & Blair, S. N.

(1998). Relations of sit-up and sit-and-reach tests to low back pain in adults.

[21] Grenier SG, Russell C, McGill SM. Relationships between lumbar flexibility, sit-and-reach test, and a previous history of low back discomfort in industrial workers. Can J Appl Physiol. 2003 Apr;28(2):165-77. doi: 10.1139/h03-013. PMID: 12825327.

[22] Sylvain G. Grenier, Caryl Russell, and Stuart M. Mcgill. 2003. Relationships Between Lumbar Flexibility, Sit-and-Reach Test, and a Previous History of Low Back Discomfort in Industrial Workers. *Canadian Journal of Applied Physiology*. **28**(2): 165-177. https://doi.org/10.1139/h03-013

[23] Pedro A. López-Miñarro, Pilar Sáinz de Baranda Andújar, Pedro L. Rodríguez-García. (2009) A comparison of the sit-and-reach test and the back-saver sit-and-reach test in university students. *Journal of Sports Science and Medicine* **(08)**, 116 - 122.

[24] Das B. An evaluation of low back pain among female brick field workers of West Bengal, India. Environ Health Prev Med. 2015 Sep;20(5):360-8. doi: 10.1007/s12199-015-0476-0. Epub 2015 Jul 8. PMID: 26154684; PMCID: PMC4550606.

[25] Bizzoca D, Solarino G, Pulcrano A, Brunetti G, Moretti AM, Moretti L, Piazzolla A, Moretti B. Gender-Related Issues in the Management of Low-Back Pain: A Current Concepts Review. Clin Pract. 2023 Oct 30;13(6):1360-1368. doi: 10.3390/clinpract13060122. PMID: 37987423; PMCID: PMC10660510.

[26] Bento TPF, Genebra CVDS, Maciel NM, Cornelio GP, Simeão SFAP, Vitta A. Low back pain and some associated factors: is there any difference between genders? Braz J Phys Ther. 2020 Jan-Feb;24(1):79-87. doi: 10.1016/j.bjpt.2019.01.012. Epub 2019 Feb 13. PMID: 30782429; PMCID: PMC6994312.

[27] Punnett L, Prüss-Utün A, Nelson DI, Fingerhut MA, Leigh J, Tak S, Phillips S. Estimating the global burden of low back pain attributable to combined occupational exposures. Am J Ind Med. 2005 Dec;48(6):459-69. doi: 10.1002/ajim.20232. PMID: 16299708.

[28] Lucha-López MO, Hidalgo-García C, Monti-Ballano S, Márquez-Gonzalvo S, Ferrández-Laliena L, Müller-Thyssen-Uriarte J, Lucha-López AC. Body Mass Index and Its Influence on Chronic Low Back Pain in the Spanish Population: A Secondary Analysis from the European Health Survey (2020). Biomedicines. 2023 Aug 2;11(8):2175. doi: 10.3390/biomedicines11082175. PMID: 37626672; PMCID: PMC10452522.

[29] Chou L, Brady SRE, Urquhart DM, Teichtahl AJ, Cicuttini FM, Pasco JA, Brennan-Olsen SL, Wluka AE. The Association Between Obesity and Low Back Pain and Disability Is Affected by Mood Disorders: A Population-Based, Cross-Sectional Study of Men. Medicine (Baltimore). 2016 Apr;95(15):e3367. doi: 10.1097/MD.0000000000003367. PMID: 27082599; PMCID: PMC4839843.

[30] Sergi TE, Bode KB, Hildebrand DA, Dawes JJ, Joyce JM. Relationship between Body Mass Index and Health and Occupational Performance among Law Enforcement Officers, Firefighters, and Military Personnel: A Systematic Review. Curr Dev Nutr. 2022 Dec 24;7(1):100020. doi: 10.1016/j.cdnut.2022.100020. PMID: 37181120; PMCID: PMC10100923.

[31] Bansal D, Asrar MM, Ghai B, Pushpendra D. Prevalence and Impact of Low Back Pain in a Community-Based Population in Northern India. Pain Physician. 2020 Jul;23(4):E389-E398. PMID: 32709185.

[32] Setia MS. Methodology Series Module 3: Cross-sectional Studies. Indian J Dermatol. 2016 May-Jun;61(3):261-4. doi: 10.4103/0019-5154.182410. PMID: 27293245; PMCID: PMC4885177.

[33] Bento TPF, Genebra CVDS, Maciel NM, Cornelio GP, Simeão SFAP, Vitta A. Low back pain and some associated factors: is there any difference between genders? Braz J Phys Ther. 2020 Jan-Feb;24(1):79-87. doi: 10.1016/j.bjpt.2019.01.012. Epub 2019 Feb 13. PMID: 30782429; PMCID: PMC6994312.

[34] Hussain SM, Urquhart DM, Wang Y, Shaw JE, Magliano DJ, Wluka AE, Cicuttini FM. Fat mass and fat distribution are associated with low back pain intensity and disability: results from a cohort study. Arthritis Res Ther. 2017 Feb 10;19(1):26. doi: 10.1186/s13075-017-1242-z. PMID: 28183360; PMCID: PMC5301404.

[35] Capili B. Cross-Sectional Studies. Am J Nurs. 2021 Oct 1;121(10):59-62. doi: 10.1097/01.NAJ.0000794280.73744.fe. PMID: 34554991; PMCID: PMC9536510.

[36] Akınoglu B, Pakoz B, Hasanoglu A, Kocahan T. Investigation of the relationship between sit-and-reach f lexibility and the height, the leg length and the trunk length in adolescent athletes Balt J Health Phys Act. 2021;13(4):29-37 doi: 10.29359/BJHPA.13.4.04

[37] Setia MS. Methodology Series Module 3: Cross-sectional Studies. Indian J Dermatol. 2016 May-Jun;61(3):261-4. doi: 10.4103/0019-5154.182410. PMID: 27293245; PMCID: PMC4885177.

[38] Lee Y, Yoo J, Lee DY, Yu JH, Kim JS, Kim SG, Nam Y, Hong J. The Effect of Stretching on Lumbar Muscle Flexibility, Isokinetic Parameters and Lower Extremity Function. J Kor Phys Ther 2024; 36:145-152. https://doi.org/10.18857/jkpt.2024.36.4.145

[39] Xiaofeng Wang, Zhenshun Cheng, Cross-Sectional Studies: Strengths, Weaknesses, and Recommendations, Chest, Volume 158, Issue 1, Supplement, 2020, Pages S65-S71, ISSN0012-3692,https://doi.org/10.1016/j.chest.2020.03.012. (https://www.sciencedirect.com/science/article/pii/S0012369220304621)

[40] SukhDev Mishra, G Avinash, Madan G Kundu, Jyotsna Verma, Ankit Sheth, Abhijit Dutta, Work-related musculoskeletal disorders among various occupational workers in India: a systematic review and meta-analysis, *Journal of Occupational Health*, Volume 67, Issue 1, January-December 2025, uiae077, https://doi.org/10.1093/joccuh/uiae077