

COMPARATIVE ANALYSIS OF PREVALENCE AND SEVERITY OF LOW BACK PAIN IN TEACHERS STANDING MORE VERUSES LESS THAN 4 HOURS DAILY

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Abstract

OBJECTIVE:

The study objective was to compare the analysis of low back pain severity and its prevalence in universities teachers standing more versus less than 4 hours daily in Bahawalpur.

MATERIALS AND METHODS:

It was a cross-sectional study in which we found the association of low back pain with prolonged standing among teachers. The duration was three months after the approval of synopsis. Simple convenient sampling technique was used to collect data from 313 teachers from different Universities and Colleges of Bahawalpur. SPSS version 25.0 was used, and results were demonstrated in terms of frequency tables.

RESULTS:

Study results showed that 65 participants had no low back pain, 120 participants had mild low back pain, 93 participants had moderate low back pain and 35 participants had severe low back pain. Chi-square test was used to find out the association between working hours and low back pain according to Numeric Pain Rating Scale (NPRS), the p value was less than 0.05, i.e. .002.

CONCLUSION:

It is concluded that there was a positive correlation between working hours and low back pain, as measured by a numeric pain rating scale, after using chi-square tests.

INTRODUCTION

Low back pain (LBP) is a publicly worldwide problem more than one-quarter of our working society faces the problems of low back pain. Low back pain also known as “lumbago” is one of the most reported problems in musculoskeletal (MSK) disorders. 11

It is estimated that about 70 to 85% of global population experience LBP in their lives. Those who have prolonged standing jobs are more prone to lumbar spine problems which may also lead to many other diseases like sciatica, piriformis syndrome and other MSK or postural problems like muscular fatigue and pain. LBP patients complain of aches, pain,

stiffness, and discomfort in the lumbar spine which aggravates the pain in those who ignore the pain until it gets worse. 15

Occupation that requires standing for longer duration is often associated with increased risk of low back pain. Teaching is one of the professions that show high prevalence of low back pain. 4

LBP is a common symptom appears mostly in every range of people where they have low income rates including countries such as Asia and middle-east. The disability factor is caused by LBP. Those with poor socioeconomic class are overrepresented in low back

pain that is immobilizing. The majority of people who experience new low back pain episodes recover quickly, but recurrence is common and in a small percentage of cases, low back pain develops into something that is persistent and immobilizing. The probability of developing persistent, impairing low back pain increases with initial high pain intensity, psychological distress, and chronic pain at numerous body sites. LBP is a non-specific still major factor of LBP includes no physical activity, smoking, and obesity. Such patients remain reserved in their work they can't carry heavy weights and even do not work for longer period of hours. 7

Approximately 70% of the population has acute low back pain. There is a maximum range of people who have moderate pain in their back, while there is a minimum range of those who experience severe pain. By enhancing their functional capabilities, those who are experiencing minor pain can rehabilitate. Acute low back pain is characterized by a duration of fewer than 12 weeks. With or without transmitted leg pain, low back pain is indicated by discomfort, muscle stiffness, or tension that is located over the inferior gluteal folds and below the costal boundary (sciatica). In order to lessen pain and its symptoms, NSAIDs and muscle relaxants are employed. Patients are encouraged to perform particular back exercises, bed rest, use TENS, and decrease low back pain. 10

Teachers have a wide range of responsibilities in their job description that could put them at risk for LBP. For instance, teachers may spend a lot of time sitting at their desks or homes while preparing lesson plans. They might adopt uncomfortable postures like bending, reaching, and twisting when giving lectures, or they might stand still for extended periods of time. They might be forced to use unsuitable equipment like stationary chairs with no back support and non-mechanical tables. Due to the constant strain on the back muscles, these various positions could result in back pain. 5

LBP creates a significant financial, social, and personal burden and is the leading cause of medical consultations worldwide. It does not only point to poor living quality but also to decreased labor productivity brought on by absenteeism from work and early retirement. According to the 2010 Global Burden of Disease Survey, low back pain is one of the top ten illnesses and injuries worldwide, accounting

for the highest number of years of life with a handicap. Teachers' jobs frequently require them to spend a lot of time with their heads down, such as when they are grading papers, writing on a chalkboard, or reading a lot. These actions entail continual trunk flexion and sustained mechanical strain. As a result, it has been discovered that low back diseases are more common in teachers. School teachers are recognized as one occupational category among which there appears to be a high prevalence of LBP. It has been estimated that this occupational exposure accounted for 37% of the worldwide burden of disease from LBP. 1

Discomfort in the lower back region includes a broad spectrum of symptoms, of which pain is the most distinct and most investigated. Low back pain (LBP) is a widespread disorder. Although LBP seems to be a general epidemic it was found to be more common in certain occupations compared to the general working population. work-related psychosocial factors contribute to LBP development, such as high job demands and low social support. Further, the prevalence of LBP seems to increase with age, and is more common in women than in men. 16

Patients with low back pain differ from healthy people in all aspects of core motor control, which are typically evaluated as variations in muscle activity and biomechanics. How successfully a posture is maintained or a movement is achieved in response to particular demands is an indication of the effectiveness of the control process. Motor control has been examined in relation to LBP at the level of the relevant cognitive structures and processes, but it has also frequently been studied at the level of the patterns of trunk muscle activity and trunk motions, which act as the results of these processes. 4

METHODS

This was an observational cross sectional study conducted after ethical approval from research committee of Head of Physiotherapy Department of Bahawalpur. The study was carried out at Physiotherapy Outpatient Department of Bahawal Victoria Hospital, Nawab Sir Sadiq Muhammad Khan Abbasi Hospital and private clinics of Bahawalpur from June 19, 2023 to October 22, 2023. The sample of 313 Teacher with low back pain was taken by using given data of population at confidence level of 95% and error of 5%. Non-probability convenient

sampling technique was used. The participants were both genders, in the age range of 30-60 years, with LBP. The Teachers with Chronic musculoskeletal disorders, signs and symptoms of systemic pain and Systemic Disorders such as continuous Hypertension, Disc Herniation, Degenerative Disc Diseases, Vertebral Fractures, Spinal Stenosis, Spondylitis, Spondylolisthesis and Disc Bulging. and recent history of surgery and trauma are excluded.

Respondents were guided about the questionnaire in simple language to respond well. Demographic information such as gender, age, socioeconomic status and occupation were noted. The data was collected using Nordic Musculoskeletal Questionnaire. In NMQ the body is divided into 9 regions. Patients were asked questions if they had pain in certain areas. Pain intensity numerical rating scale (PI-NRS), with 0 representing no pain and 10 representing the greatest possible suffering, is widely used to quantify pain intensity. We have estimated a clinically important difference on this scale by relating it to global assessments of change in multiple studies of chronic pain. 6

Participants were guided about the study before the collection of data. A consent form explaining the aim

of the research was elaborated verbally to the participants. Patients were ensured that the data provided by them was kept private and will be used for research purpose only. The data collection from the female patients was done in separate place within their moral values. Patients were not compelled to take part in the study if they were reluctant or shy about doing so. Participants were assured for privacy and informed that their information might be published without their identification.

Statistical analysis

Data analysis was done using SPSS (Statistical Package for Social Sciences) version 25.0. Tables and graphs were used to compute and display frequencies and percentages.

RESULTS

Table No. 1 AGE

In this study 136(43.5%) participants were from the age group of 25-34 years, 104 (33.2%) participants were from the age group of 35-44 years, 41 (13.1%) participants were from age group 45-54 and 32 (10.2%) participant were from the age group of 55-64 years.

Age Group	Frequency	Percent
25-34	136	43.5
35-44	104	33.2
45-54	41	13.1
55-64	32	10.2
Total	313	100.0

Table No. 2 GENDER

In this study out of 313 participants 186 (59.4%) were male and 127 (40.6%) were female.

GENDER	Frequency	Percent
Male	186	59.4
Female	127	40.6
Total	313	100.0

Table No. 3 WORKING HOURS

Out of 313 participants 10 (3.2%) had 2-3 working hours, 75 (24.0%) had 4-5 working hours, 186 (59.4%) had 6-7 working hours and 42 (13.4%) had 7-8 working hours

WORKING HOURS	Frequency	Percent
2-3 hours	10	3.2

4-5 hours	75	24.0
6-7 hours	186	59.4
7-8 hours	42	13.4
Total	313	100.0

Table No.4 SOCIOECNOMIC STATUS

Our study shows that out of 313 participants, 30(9.6%) participant were from upper class, 261 (83.4%) were from middle class and 22(7.0%) were from lower class.

SOCIOECNOMIC STATUS	Frequency	Percent
upper class	30	9.6
middle class	261	83.4
lower class	22	7.0
Total	313	100.0

Table No.5 NUMERIC PAIN RATING SCALE

This study shows that 65 (20.8%) participants had no pain, 120 (38.3%) had mild pain, 93 (29.7%) had moderate pain and 35 (11.2%) had severe pain.

NUMERIC PAIN RATING SCALE	Frequency	Percent
no pain	65	20.8
mild pain	120	38.3
moderate pain	93	29.7
severe pain	35	11.2
Total	313	100.0

Table No.6 NECK-HEAD TROUBLE IN LAST 12 MONTHS

In this study 190 (60.7%) participants had neck trouble and 123 (39.3%) had no neck pain.

NECK-HEAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	190	60.7
no	123	39.3
Total	313	100.0

Table No.7 SHOULDER-HAD TROUBLE IN LAST 12 MONTHS

This study shows that 164 (52.4%) had shoulder trouble and 149 (47.6%) had no trouble.

SHOULDER-HAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	164	52.4
no	149	47.6
Total	313	100.0

Table No.8 ELBOW-HAD TROUBLE IN LAST 12 MONTHS

This study shows that 68 (21.7%) had elbow trouble and 245 (78.3%) had no trouble.

ELBOW-HAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	68	21.7

no	245	78.3
Total	313	100.0

Table No.9 WRIST & HAND- HAD TROUBLE IN LAST 12 MONTH

This study shows that 89 (28.4%) had wrist and hand trouble and 224 (71.6%) had no trouble

WRIST & HAND- HAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	89	28.4
no	224	71.6
Total	313	100.0

Table No.10 UPPER BACK-HAD TROUBLE IN LAST 12 MONTHS

This study shows that 94(30.0%) had upper back trouble and 219 (70%) had no trouble.

UPPER BACK-HAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	94	30.0
no	219	70.0
Total	313	100.0

Table No.11 LOWER BACK- HAD TROUBLE IN LAST 12 MONTHS

This study shows that 162 (51.8%) had lower back trouble and 151 (48.2%) had no trouble.

LOWER BACK- HAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	162	51.8
no	151	48.2
Total	313	100.0

Table No.12 HIPS & THIGHS- HAD TROUBLE IN LAST 12 MONTHS

This study shows that 91 (29.1%) had hips and thighs trouble and 222 (70.9%) had no trouble.

HIPS & THIGHS- HAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	91	29.1
no	222	70.9
Total	313	100.0

Table No.13 KNEE- HAD TROUBLE IN LAST 12 MONTHS

This study shows that 135 (43.1%) had knee trouble and 178 (56.9%) had no trouble

KNEE- HAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	135	43.1
no	178	56.9
Total	313	100.0

Table No.14 ANKLE & FEET- HAD TROUBLE IN LAST 12 MONTHS

This study shows that 77 (24.6%) had trouble in ankle and feet and 236 (75.4%) had no trouble

ANKLE & FEET- HAD TROUBLE IN LAST 12 MONTHS	Frequency	Percent
yes	77	24.6
no	236	75.4
Total	313	100.0

Table No. 15.1 Age group * Numeric pain rating scale

Out of 313 participants maximum participants were from age group 25-34 and minimum participants were from age group 55-64.

Age group		Numeric pain rating scale				Total
		no pain	mild pain	moderate pain	severe pain	
	25-34	25	56	40	15	136
	35-44	24	38	30	12	104
	45-54	13	16	12	0	41
	55-64	3	10	11	8	32
Total		65	120	93	35	313

Table No. 15.2 Chi-Square Tests

On applying chi-square test to find the association between age and low back pain according to numeric pain rating scale, the p value obtained was greater than 0.05 ie 0.064. Hence there is no significant association between the two.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	16.131 ^a	9	.064
Likelihood Ratio	19.487	9	.021
Linear-by-Linear Association	.530	1	.467
N of Valid Cases	313		

Table No. 16.1 Working hours * Numeric pain rating scal

Out of 313 participants 65 participants had no pain, 120 participants had mild pain, 93 participants had moderate pain and 35 participants had severe pain

Working hours		Numeric pain rating scale				Total
		no pain	mild pain	moderate pain	severe pain	
	2-3 hours	6	4	0	0	10
	4-5 hours	15	38	18	4	75
	6-7 hours	31	67	64	24	186
	7-8 hours	13	11	11	7	42

Total	65	120	93	35	313
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Table No.16.2 Chi-Square Tests

On applying chi-square tests to find out the association between working hours and low back pain according to numeric pain rating scale the p value was less than 0.05 ie .002. Hence there is significant association between the two.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	26.281 ^a	9	.002
Likelihood Ratio	27.992	9	.001
Linear-by-Linear Association	6.906	1	.009
N of Valid Cases	313		

Table No.17.1 Socio-economic status * Numeric pain rating scale

This study showed that majority of the participants (261) who suffered from low back pain were from the middle class while those from upper and lower class were comparatively less.

Socio-economic status		Numeric pain rating scale				Total
		no pain	mild pain	moderate pain	severe pain	
	upper class	16	8	2	4	30
	middle class	47	100	87	27	261
	lower class	2	12	4	4	22
Total		65	120	93	35	313

Table No 17.2 Chi-Square Tests

On applying chi-square test to find out the association between socio-economic status and low back pain according to numeric pain rating scale the p value was less than 0.05 ie 0.000. Hence there is significant association between the two.

	Value	df	Asymp. Sig. (2-sided)
Pearson Chi-Square	29.046 ^a	6	.000
Likelihood Ratio	27.199	6	.000
Linear-by-Linear Association	7.716	1	.005
N of Valid Cases	313		

DISCUSSION

This cross sectional study aimed to find association of low back pain with prolonged standing among teachers of Govt.S.E College Bahawalpur, Islamia University of Bahawalpur and Govt.Sadiq College Women University Bahawalpur. The results were acquired on a total sample of 313 individuals to assess musculoskeletal pain and discomfort. This was done by using Nordic Musculoskeletal Questionnaire and Numeric Pain Rating scale (NPRS). Several results were acquired from the study, more profoundly, positive association between Low back pain and

different variables which included Prolonged standing among with other variables such as Age, Working hours and Socioeconomic status. All these factors had a positive role in the development of Low back pain. Our study reveals that prolonged standing causes low back pain. It is concluded that there was a positive correlation between working hours and low back pain that shows more hours in standing position causes more low back pain, as measured by a numeric pain rating scale, after using chi-square tests. It can be supported by the study in which there is long term effect both in sitting and standing among individuals

including both male and female by using electromyography (EMG) and servomotor measuring tool for trunk stiffness that showed prolonged sitting and standing protocol changes trunk stiffness, low back discomfort and muscle activation associated with LBP which is common in most working environments.⁶ According to our results, there were variations among individuals with and without non-specific LBP in a number of postural control characteristics, including the centre of pressure displacement, postural control technique, and muscle activation patterns. The findings indicate that while none of the measures alone had any apparent effects, the interaction of neuromuscular and biomechanical factors was linked to a decrease in postural control among people who have LBP when standing. On the other hand our research study concluded which is based on a systemic review, comparing healthy adults and adults with non-specific LBP with neuromuscular or biomechanical problems were examined in lab studies. This research showed that both neuromuscular and biomechanical factors have significant role in causing low back pain with standing.⁹

It is concluded that our study found that about two out of every three teachers experienced back pain. This discovery is significant. Workload, which included the number of working days and hours, was particularly highly linked with the prevalence of back discomfort. Even though the majority of the study's professors had advanced degrees and some teaching experience, they lacked adequate knowledge of and had a wrong attitude towards pain management.. Similarly our research shows that in a cross-sectional study was conducted using a sample of 312 teachers from the Asir region to investigate the beliefs and treatment of low back pain. pre-structured questionnaire was used of teachers reported having experienced low back pain in the past year, and reported having been affected by it at work.. The study showed Back pain was reported by about two in three teachers and highlights the need to raise awareness among teachers about seeking medical advice for low back pain and non-pharmacological treatments such as physical therapy.¹⁴

According to our study teachers are more prevalent to have LBP because of their static posture, prolong standing and working hours. They are more prone to

have MSK problems that may cause serious health problems. On the other hand our research study concluded that regardless of age or gender teachers can suffer from LPB. In another study that was conducted in various schools also showed high prevalence of msk pain in shoulder knee and back. 16 Our study shows positive association of LBP with long term standing. Static standing can cause muscle fatigue and increase pressure in low back. In Another study that was conducted in fasialabad based upon a self made questionnaire also confirm the corelation between long term standing and LBP in addition to other factors like ergonomic and work related risk factors.⁸

Our study showed that prolonged standing leads to low back pain due to different ergonomic factors. About 79.2% individual out of 313 were reported to have low back pain due to prolong standing. This is caused by constant pressure on lumbar area and lower extremities in order to balance this the body assume poor posture which leads to Low back pain. We determine this by using Nordic Questionnaire and pain rate scale to assess the level of pain perceived by these individuals there was an association of prolong standing and low back pain. A cross sectional study conducted in 2015 among randomly selected 120 teachers in Putrajaya. Using a standardized Nordic Questionnaire the prevalence of LBP among the respondents was 72.9%. This study gives evidence that work tasks and job satisfaction are significant predictors of LBP among secondary school teachers.²

Our study further showed that prolonged working hours also lead to increased low back problem and as the working hour increase there was a gradual increase in low back pain. Our research contained 4 different categories of working hours which determines the individual who have more work related back pain. Most of the individual who worked for about 6-7 hours a day reported low back pain. This is supported by the cross sectional study conducted in 2020 to investigate the relationship between prolonged standing and low back pain among university professors in Cairo, Egypt. This used a cross sectional survey design and recruited 300 university professors from three universities in Cairo that showed prolonged standing was a significant risk factor for low back pain among university professors.

(Radwan,et.al,2020).and this is also supported by a cross-sectional study conducted in 2022 among 15,276 teachers in public schools in the Brazilian state of Minas Gerais which showed that 58% of school teachers reported low back pain that associated with back pain, female gender, longer working hours, overwork, difficulties concerning distance working, negative changes in health status and quality of sleep and other factors.This was determined by using online questionnaire and Pearsons chi-square test. 3

Main limitations of our study were that some of the patients were unable to recall symptoms during the past 12 months (recall bias). Patients were non-cooperative. There were time and financial constraints.

CONCLUSIONS

It is concluded that there was a positive correlation between working hours and low back pain, as measured by a numeric pain rating scale, after using chi-square tests.

DECLARATIONS

Conflict of interest

The authors declare that there is no professional, personal or financial conflict of interest regarding the publication of this article.

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Author Contribution:

- Anila Zanib was responsible for conceptualizing the study, as well as writing and editing the manuscript.
- Gull Shoaib collected data.

Recommendations:

- Further studies should be conducted on this topic in Bahawalpur by using large sample size and multi centred approach through different colleges and universities
- Other associated factors like poor posture, vigorous activities ,age limitations, degeneration process in spine etc. must be

addressed to find their influence on its development

- Randomized control trial and follow up studies should be carried out to check their effects

REFERENCES

- Abeba, Tsega-Ab & Gebremichael, Bereket & Abaerei, Admas. (2018). Prevalence and Associated Factors of Low Back Pain Among Teachers Working at Governmental Primary Schools in Addis Ababa, Ethiopia: A Cross Sectional Study. *Biomedical Journal of Scientific & Technical Research*. 10. 10.26717/BJSTR.2018.10.001886.
- Anuar, N. F. M., Rasdi, I., Saliluddin, S. M., &Abidin, E. Z. (2016). Work task and job satisfaction predicting low back pain among secondary school teachers in Putrajaya. *Iranian Journal of Public Health*, 45(Supple 1), 85-92.
- Barbosa, R.E.C., Fonseca, G.C., Souza e Silva, N.S., Silva, R.R.V., Assunção, A.Á. and Haikal, D.S.A., 2022. Back pain occurred due to changes in routinary activities among Brazilian schoolteachers during the COVID-19 pandemic. *International Archives of Occupational and Environmental Health*, pp.1-12.
- Chung, W.Y.C., 2022. Active bodysuit for adult degenerative scoliosis (ADS).
- Diallo SYK, Mweu MM, Mbuya SO and Mwanthi MA. Prevalence and risk factors for low back pain among university teaching staff in Nairobi, Kenya: a cross-sectional study [version 1; peer review: 1 approved, 2 approved with reservations]. *F1000Research* 2019, 8:808 (<https://doi.org/10.12688/f1000research.19384.1>)
- Farrar, J.T., Young Jr, J.P., LaMoreaux, L., Werth, J.L. and Poole, R.M., 2001. Clinical importance of changes in chronic pain intensity measured on an 11-point numerical pain rating scale. *Pain*, 94(2), pp.149-158.

- Hartvigsen, J., Hancock, M.J., Kongsted, A., Louw, Q., Ferreira, M.L., Genevay, S., Hoy, D., Karppinen, J., Pransky, G., Sieper, J. And Smeets, R.J., 2018. What low back pain is and why we need to pay attention. *The Lancet*, 391(10137), pp.2356-2367.
- Kashif, M., Darain, H., Sharif, F., Jamil, M., Majeed, S. and Ullah, I., 2017. Association between low back pain and prolonged standing in university teachers. *Annals of Allied Health Sciences*, 3(1), pp.8-13.
- Koch, C. and Hänsel, F., 2019. Non-specific low back pain and postural control during quiet standing—a systematic review. *Frontiers in psychology*, 10, p.586
- Mcintosh, G. And Hall, H., 2011. Low back pain (acute). *BMJ clinical evidence*, 2011.
- Nieminen, L.K., Pyysalo, L.M. and Kankaanpää, M.J., 2021. Prognostic factors for pain chronicity in low back pain: a systematic review. *Pain reports*, 6(1).
- Park, J.H. and Srinivasan, D., 2021. The effects of prolonged sitting, standing, and an alternating sit-stand pattern on trunk mechanical stiffness, trunk muscle activation and low back discomfort. *Ergonomics*, 64(8), pp.983-994
- Radwan, I. A., Hasan, M. Y., Mohamed, H. A., & El-Desouky, T. (2020). A study of the relationship between prolonged standing and low back pain among university professors in Cairo, Egypt. *Journal of Back and Musculoskeletal Rehabilitation*, 33(1), 123-129
- Raizah, A., Alzahrani, F., Albarqi, B., Abusaq, I., Alqarni, H., Alyami, I., Ahmad, I. and Reddy, R.S., 2023, January. Treatment Beliefs and Practices towards Low Back Pain among Teachers in Asir Region, Saudi Arabia—A Cross-Sectional Study. In *Healthcare* (Vol. 11, No. 3, p. 383). MDPI.
- Sığlan, Ü. And Çolak, S., 2022. Effects of diaphragmatic and iliopsoasmyofascial release in patients with chronic low back pain: A randomized controlled study. *Journal of Bodywork and Movement Therapies*
- Vaghela, N.P. and Parekh, S.K., 2018. Prevalence of the musculoskeletal disorder among school teachers. *National Journal of Physiology, Pharmacy and Pharmacology*, 8(2), pp.197-201
- Wall, R., Läubli, T., Seibt, R., Rieger, M.A. and Steinhilber, B., 2019. Associations between low back muscle activity, pelvic movement and low back discomfort development during prolonged standing—An exploratory laboratory study. *International Journal of Industrial Ergonomics*, 72, pp.380-389.