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Prevelance of Low Back Pain and its Association with the Thigh Holster use Among Police Officers -A Cross Sectional Survey

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ABSTRACT

Background: *Low back pain (LBP) occurs in 60–90% of individuals throughout their lifetime and is the second most prevalent clinical complaint. Approximately 37% of these cases are work-related, resulting in severe disability and absenteeism. Military police officers are particularly exposed because of long shifts and heavy equipment, placing added spinal strain on them. Ergonomic problems also contribute to LBP hazard. This research examines the prevalence of LBP, its associated factors, and ergonomic determinants employing the VAS to facilitate prevention and lessening economic burdens.*

Objective: *The study evaluate the prevalence of low back pain and evaluate the association between the thigh holster use and low back pain in police officers Also includes other occupational factors and lifestyle habits that cause severity of low back pain among active-duty police officers.*

Methodology: *The cross-sectional study was involve active-duty police officers in Karachi, selected through non probity convenient sampling from various police stations. Data on demographics, occupational factors (service duration, duty hours, and holster use), and lifestyle habits were collected using a standardized questionnaire. The presence and severity of low back pain were recorded, through VAS scale. Informed consent was obtained from all participants. Data was analyzed to determine the association between prolonged thigh holster use and the occurrence and severity of low back pain.*

Result: *This study analysised 127 Karachi Special Security Unit police officers and found a high prevalence of low back pain (67.7%), particularly among those with long service and physically demanding field duties. Thigh holsters were the most commonly used and worn for the longest duration, leading to greater biomechanical strain. Officers using thigh holsters showed significantly higher LBP prevalence (79.1%) and greater pain severity compared to other holster types. Statistical tests confirmed a significant association between thigh holster use and low back pain, highlighting the need for ergonomic interventions.*

Conclusion: *The survey demonstrates a strong association between the use of thigh holsters and increased frequency, severity, and disability of low back pain among active-duty police officers in Karachi, highlighting duty gear as a significant modifiable risk factor. These findings emphasize the need for ergonomically informed equipment policies to reduce preventable pain, improve officer well- being, and support long-term operational effectiveness.*

Keywords: *Low back pain, vas scale, thigh holster, police officer, radiating pain.*

INTRODUCTION

LBP is the most common orthopedic health issue which occurs in individuals of all ages across the globe. LBP has many risk factors which are multifactorial. As per past research; age, sex, body mass index, smoking, drinking habit, physical The factors include exercise, stress, sleeping hours, use of computers, hours of seating continuously, sitting without any movement back support, reading time were identified as risk factors for LBP [1] Low back pain is a complaint in all occupations, as a result of this leaves of absentees resulting in low income. Low back pain (LBP) is a multifaceted phenomenon that presents enormous loads on the health care system and is a leading cause of disability globally. Distinguishing types of lower back pain is practically impossible due to the range of confounding factors responsible for pain in this region, predominantly in the lumbar spine. Alleviating pain, restoring function, and preventing recurrence the primary goals when looking for methods to reduce LBP.[2] Low back pain (LBP) is a significant musculoskeletal issue that results in functional impairments and compromised quality of life among older people .The United Nations recently acknowledged that LBP is among the top ten causes of disability for people aged 60 years and older, resulting in severe disability, as well as huge economic and social expenses.[3] One study on the global burden of disease indicated that low back pain (LBP) is a major contributor of disability-adjusted life-years (DALYs) globally. LBP is an painful musculoskeletal disorder. Back pain resolves on its own without active management in most cases, but some people experience acute and disabling LBP that can lead to chronic LBP. The pathogenesis of LBP is complex but It is well established that IVD degeneration is one of the major causes of LBP. , occurring in approximately 26–42% of LBP patients. The IVD is a cartilaginous fibrous tissue connecting the adjacent vertebrae, consisting of an inner proteoglycan-rich core nucleus pulposus (NP), outer collagen-rich annulus fibrosus (AF) and contained by cartilaginous endplate (CEP). The IVD gives mechanical stability to the spine, facilitates motion at the motion segment level, and maintains the proper spatial relationship of the vertebrae and facet joints.It is characterized by a compromised ability for intrinsic self-repair within the tissue, such as diminished NP progenitor cells. Cellular senescence has been associated with ageing and alters cellular phenotype and functions of extracellular matrix (ECM). Deregulation of ECM composition is attributed to early-stage disc degeneration, and this results in inflammation. Mechanical load and injury, low nutrition supply, genetic factors, smoking and obesity are some of the contributing factors to disc degeneration.[4] . The sample composition included 221 military police officers, of which 194 used the belt holsters and 27 the drop leg holsters.. The belt holster group had a greater prevalence of low back pain (74.2%) and cornification of pain (70.1%). Greater prevalence of pain was seen at the extremes of age as well as in the longer- serving police officers.[5]. Police officers often experience symptoms related to lumbar spine strain due to the additional weight of mandatory gear they are required to carry. This extra load significantly contributes to the overload on the lumbar region, which The rigidity will create discomfort, which may increase the risk of injury.The combination of prolonged carrying of heavy equipment and the physical demands of their role makes this population particularly vulnerable to spinal issues. Such symptoms are frequently observed among police officers, underscoring the need for strategies to alleviate this strain and minimize longterm health effects. It is recognized as the primary contributor to work-related health disorders and one of the main factors responsible for employee absenteeism. Based on duration, low back pain can be categorized as acute when it persists for less than six weeks, sub acute when lasting between six and twelve weeks, and chronic when extending beyond twelve weeks. The specific occupational demands of military police officers expose them to several of the previously mentioned risk factors, increasing their susceptibility to developing low back pain. Additionally, extended working hours—often lasting up to 12 hours—further contribute to physical strain and the potential onset of lumbar discomfort.[6] .The effect of police body amour and duty belt on tasks carried out by police was examined by Dempsey et al. who proved that mobility would decrease when working with major occupational tasks and that there would be a higher physiological effort involved in carrying out certain tasks as the heaviness of the weight being carried rose. Reduced The velocity and

acceleration of sprinting were also determined to be related to use of duty belts and body amour et al. The biomechanical impact of moving equipment from a duty belt to a so- called load bearing vest was examined within a sample of Swedish police et al. Results indicated no significant effect on temporospatial parameters of gait but a limitation in lateral trunk bending, trunk rotation and anterior pelvic tilt under the load bearing vest.[7]This document provides global, regional, and national estimates of the burden and prevalence of low back pain. In 2020, over half a billion prevalent cases existed in the world, accounting for 7·7% of all the YLDs and therefore the largest single contribution to the burden of disability in the world. By 2050, there will be a 36·4% increase in the total number of cases of low back pain worldwide, with the largest increases likely to occur in Asia and Africa. The decomposition analysis reveals that the increase in prevalence will be mainly propelled by population growth, with an exception in a few areas where population ageing appears to be the driving factor for the increase in cases of low back pain in 2050.Another social and economic consequence of low back pain is its exceptionally high prevalence and heavy burden among working-age individuals—a condition far from unique to high-income nations. 100 average days lost per person per year due to low back pain in Brazil, and productivity losses accounting for 79% of the US$2·2 billion economic cost of low back pain.19 In the USA, 15·4% of the population report an average of 10·5 workdays lost annually due to chronic low back pain[8]. Since 1980, MRI has been the fundamental clinical examination of the human spine. MRI is optimal modality of spine imaging because of its excellent spatial and contrast resolution and absence of ionizing radiation relative to other modalities. MR imaging is superior in sensitivity and specificity for spinal infection assessment. Other contrast mechanisms such as diffusion tensor imaging (DTI) and magnetization transfer function (MTF) were introduced in 1990. By these techniques, tissues were scanned at microscopic level through magnetic resonance .Soft tissues like discs, nerve, and muscles are easily recognizable by .MRI which are the potential causes of low back pain [9]. Low back pain (LBP) is a prevalent and disabling condition. For the majority of instances, it is not possible to reliably determine the cause or causes of low back pain and is termed 'non- specific' LBP. Drugs are often prescribed by physicians to manage LBP. Numerous classes and types of drugs exist, such as opioid analgesics, no steroidal anti- inflammatory drugs (NSAIDs), and paracetamol. With so many medicines on hand, it is necessary to find out what the best and safest ones are [10] The evidence for spinal surgery in the treatment of LBP in the presence of no neural compression, infection, cancer, or gross instability is limited and is dissimilar to the growing rate at which the surgery is undertaken. Current literature can be divided into trials testing surgical intervention (decompression, fusion or other) against non-surgical management and trials comparing various surgical approaches or techniques. Past analyses have referred to these two categories as "indication" and "technique" trials respectively. The majority of studies are in the latter category, are of a poor standard, and tend to focus on a non-inferiority comparison of complications and outcomes of a particular technique, as opposed to efficacy in the treatment of LBP. They commonly receive major investment by industry and device manufacturers, well known to be a source of bias for results. The analysis of these studies does not address the issue of the indication for spinal surgery for LBP and can be misleading since it presumes the effectiveness of both procedures.[11]FBSS has been known right from the beginning of spinal surgery. In the surgical end stage, after one or more procedures on the lumbar neuroaxis, provides pain relief without any effect as defined by Follett and Dirks. The term "FBSS" is spine surgery that fails its intended goal due to poor patient selection. "Post-surgical spine syndrome" is a new or chronic pain following spinal surgery. It could be associated with nerve root injury, compression, arachnoiditis, epidural fibrosis, adjacent-level degeneration, and spinal instability. Complex regional pain syndrome is a chronic and occasionally progressive condition following spinal surgery.[12] In order to evaluate the reaction to the administered therapy, we employed the visual analog scale (VAS), which was requested upon the onset of the patient's arrival and subsequent to the pain intervention. The test was conducted by employing an image containing a 10 cm straight line, one end revealing no pain and the other revealing intolerable extreme pain. The degree of pain uttered by the patient was then noted by the doctor in charge. Intensity of pain was graded into a number of sections: 0 for no pain, 1-4 for mild pain, 5-7 for moderate pain, and >7 for severe pain. The VAS scores were recorded before and after interventions of

interventional pain management (IPM) and dry needling (DN) and one week post-treatment for individuals treated with exercise and drug therapy. Patients treated with IPM had intramuscular ultrasonography-guided injections of 1% lidocaine and triamcinolone 30 mg.[13] Electrotherapy modalities such as interferential current therapy, transcutaneous electrical nerve stimulation, and high voltage are quite effective for chronic LBP. In physiotherapy alongside manual therapy and exercises, electrotherapy modalities are commonly employed to reduce pain. Ultrasound therapy is among the most prevalent electro physical agents, which are widely used in the treatment of LBP in the clinical setting by physical therapist professionals. Ultrasound therapy is also widely used for treating musculoskeletal diseases by other health professionals like osteopaths, chiropractors, and sports therapists. The belief is that ultrasound therapy provides energy to deep tissue locations via ultrasonic waves to cause increases in tissue temperature or non-thermal physiologic alterations. The effectiveness of ultrasound therapy in chronic nonspecific LBP has remained unclear despite being widely used clinically, with varying results in the literature. Haile et al. (2021) synthesized existing studies in an attempt to provide clearer insights into whether this treatment is useful for chronic LBP. Thus, the authors indicated that a future research agenda of treatment should try to standardize protocols regarding frequency, duration, and intensity of ultrasound therapy. Additionally, they conducted larger, high-quality RCTs with longer follow-up to identify longterm outcomes and risks of ultrasound therapy in chronic LBP. [14] Other techniques utilized in physiotherapy to enhance back care and avoid NSLBP in children and adolescents are to enhance the strength of trunk muscles using specific exercises for which, the exercises have to be ordered and supervised by a professional, must be performed progressively, and may be done by children as well as adolescents. Hamstring flexibility enhancement is also a good option to enhance back care.[15] Most health practitioners such as physiotherapists ,can offer many of the treatments that are suggested for low back pain. Rehabilitation and health care services for people who can't work because of work-related conditions, such as low back pain. Knowledge about patterns of physical therapy treatment may be especially pertinent in light of the fact that treating provider type may affect time to return to work. There is limited literature related to the forms of care, including physiotherapy, chiropractic services, and osteopathy care that LBP sufferers seek worker compensation. Such information is vital for ensuring sound health practices for better patient recovery. This study seeks to investigate the forms of care that sufferers of lower back pain access s through worker compensation. [16]

METHODOLOGY

Study Design

This study was cross-sectional study.

Study Setting

This research was conducted at police station special security unit and permission will be taken through the permission letters from the police station.

Study Duration

The total duration of the study is 6 month and data will be collected in 3 months [after the approval of the synopsis].

Study Population

The study included 127 police officers in police stations.

Sampling Technique

It was a non-probability convenience sampling technique.

Inclusion Criteria

Participant are eligible to enroll in this study if they.

- The data was collected from male and female adults.
- Data was collected from police officers age 30 to 68 years.

Exclusion Criteria

Participant was exclude from the study if they

- Officers not currently on active duty
- Officers with a history of spinal surgery or serious back injuring related to duty.
- Officers on medical leave at the time of data collection.
- Less then 1 year of service as a police officers.

Variables

- **Independent Variable:** Type of holster (thigh, hip, drop-leg, tactical)
- **Dependent Variable:** Musculoskeletal discomfort (thigh, hip, lower back)

Data Collection Plan

The data will be collected target active-duty police officers aged 18-60 years who have been using thigh holsters for at least six months. The sample will be selected through stratified random sampling, with representation from various ranks, regions, and departments. A self-administered questionnaire will be used for data collection, which will include questions on demographics, holster use (e.g., duration and frequency), and the presence and intensity of low back pain. Officers will also be asked about their physical activity levels and any ergonomic practices they follow while wearing the holster.

DATA ANALYSIS

The data will be analyzed by using descriptive statistics and presented in a frequencies and percentages, using pie chart or a bar graph. Data will be entered in and analyzed by SPSS version 26.

RESULTS

Overview:

This chapter presents the analysis of data collected from 127 active-duty police officers across the Special Security Unit in Karachi, Pakistan. The primary objective was to evaluate the prevalence of thigh holster

use and its association with the occurrence and severity of Low Back Pain (LBP). Data were analyzed using descriptive statistics, correlation analyses, and comparative tests. The results are presented in the form of tables, charts, and detailed explanations.

Demographic Characteristics

A total of 127 police officers participated in the study. The demographic profile is summarized in Table 4.1.

Demographic Characteristics of Study Participants (N=127)

Table 1:

Characteristic	**Category**	**Frequency (n)**	**Percentage (%)**
Gender	Male	119	93.7%
	Female	8	6.3%
Age Group (Years)	30 - 40	45	35.4%
	41 - 50	52	40.9%
	51 - 68	30	23.6%
Years of Service	1 - 10 years	38	29.9%
	11 - 20 years	55	43.3%
	> 20 years	34	26.8%
Primary Duty Type	Patrol/Field	89	70.1%
	Administrative	25	19.7%
	Special Operations	13	10.2%

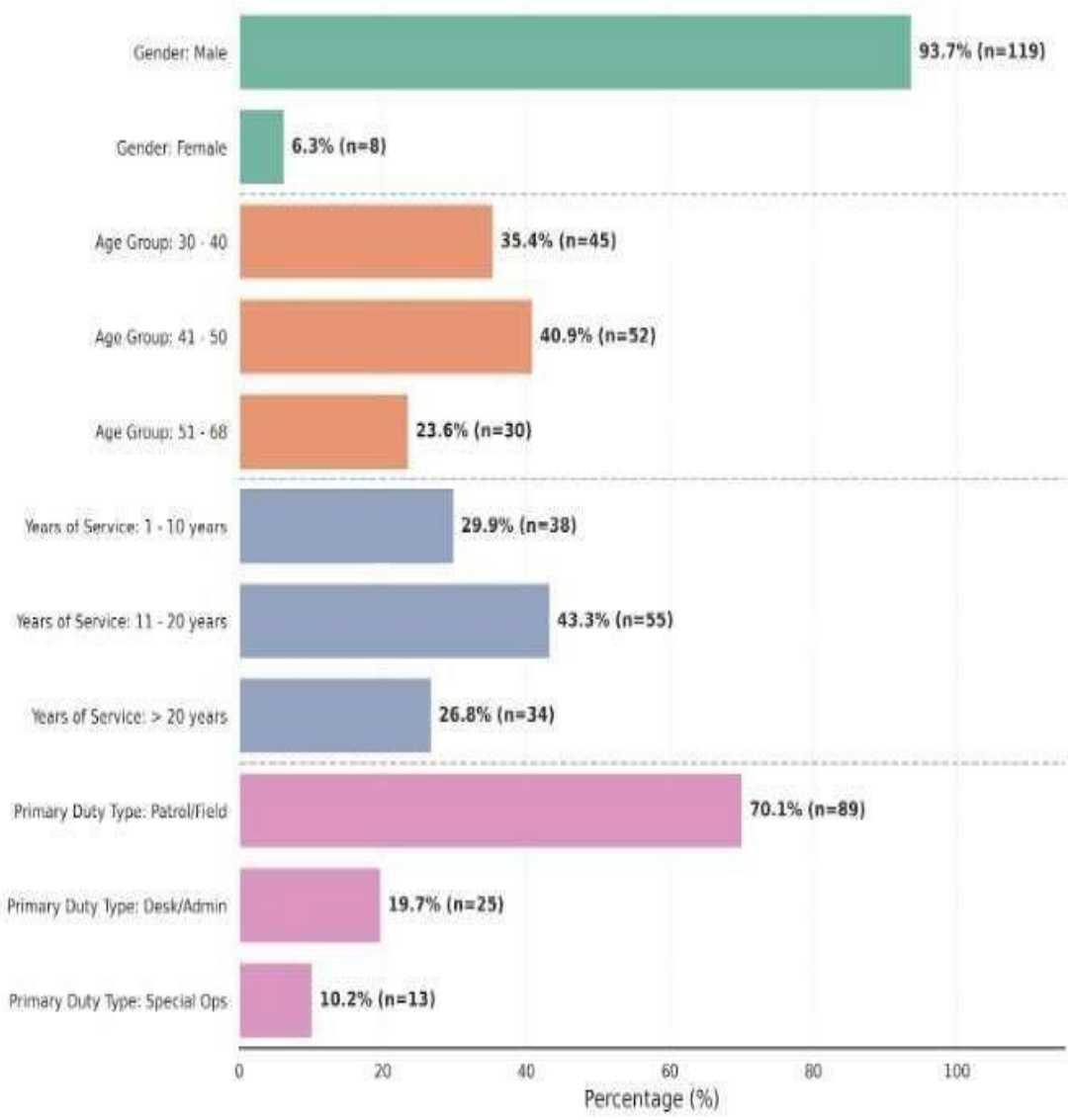
Gender: Male
93.7% (n=119)
Gender: Female
6.3% (n=8)
Age Group: 30 - 40
35.4% (n=45)
Age Group: 41 - 50
40.9% (n=52)
Age Group: 51 - 68
23.6% (n=30)
Years of Service: 1 - 10 years
29.9% (n=38)
Years of Service: 11 - 20 years
43.3% (n=55)
Years of Service: > 20 years
26.8% (n=34)
Primary Duty Type: Patrol/Field
70.1% (n=89)
Primary Duty Type: Desk/Admin
19.7% (n=25)
Primary Duty Type: Special Ops
10.2% (n=13)
0
20
40
60
80
100
Percentage (%)

CHART 1: Demographic Characteristics:

The demographic profile of the participants indicates a predominantly male workforce, with 119 male officers (93.7%) and only 8 female officers (6.3%), reflecting the gender distribution typical of operational police units in Karachi. In terms of age, the largest proportion of participants fell within the 41–50-year age group (40.9%), followed by officers aged 30–40 years (35.4%), while nearly one-quarter (23.6%) were aged between 51 and 68 years. This age distribution suggests a relatively mature and experienced cohort. Regarding occupational tenure, most officers had substantial service duration, with 43.3% reporting 11–20 years of service and 26.8% serving for more than 20 years. Only 29.9% had a service duration of 1–10 years. In terms of primary duty assignment, the majority of participants (70.1%) were engaged in patrol or field duties, which are physically demanding and typically require prolonged standing, walking, vehicle operation, and continuous use of tactical equipment. Administrative duties accounted for 19.7% of officers, while 10.2% were involved in special operations. Overall, the demographic data highlight a workforce characterized by prolonged occupational exposure and physically demanding job roles..

Prevalence and Patterns of Holster Use:

Officers were asked about their primary duty holster type, daily wear duration, and holster shift practices.

Table 2: Holster Usage Patterns Among Police Officers (N=127)

Holster Type	Frequency (n)	Percentage (%)	Avg. Daily Wear (Hours)
Thigh Holster	67	52.8%	8.2 ± 2.1
Hip/Belt Holster	42	33.1%	7.8 ± 1.9
Drop-Leg Holster	12	9.4%	6.5 ± 2.3
Tactical/Other	6	4.7%	5.0 ± 1.5

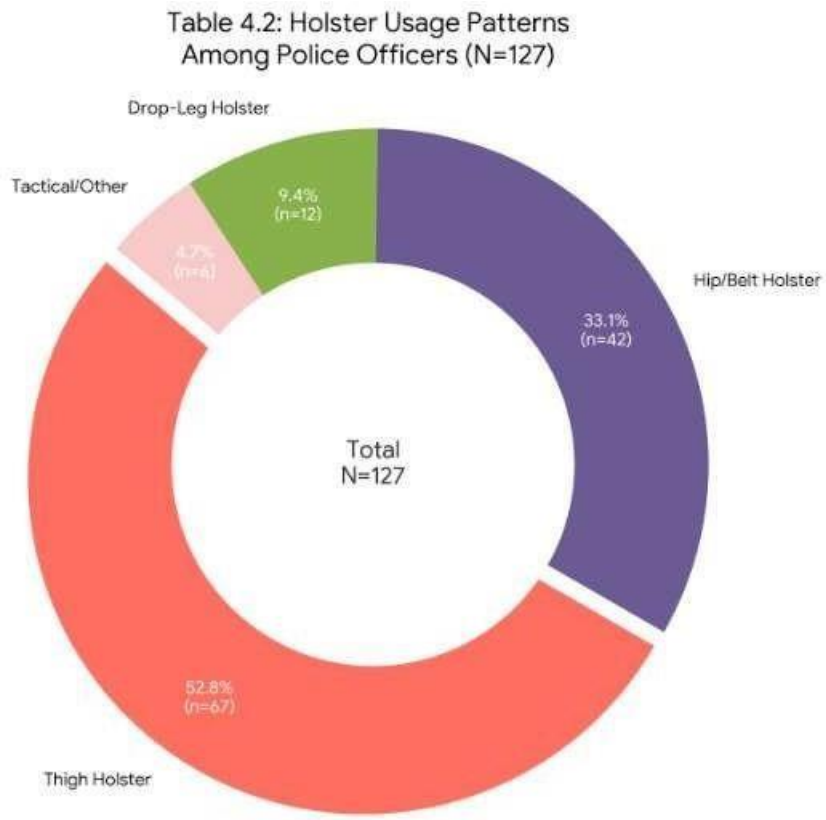

CHART 2: Holster Usage Patterns:

Analysis of holster usage patterns revealed that thigh holsters were the most commonly used duty holster, reported by 67 officers (52.8%). Hip or belt-mounted holsters were used by 42 officers (33.1%), while drop-leg holsters and tactical or other holster types were less frequently used, accounting for 9.4% and 4.7% of participants, respectively. Notably, officers using thigh holsters reported the longest average daily wear duration, with a mean of 8.2 ± 2.1 hours. This exceeded the average wear time for hip holsters (7.8 ± 1.9 hours), drop-leg holsters (6.5 ± 2.3 hours), and other tactical holsters (5.0 ± 1.5 hours). The extended duration of thigh holster use likely reflects operational demands, particularly vehicle-based patrols and tactical readiness, where rapid access to firearms is prioritized. However, prolonged wear duration may also contribute to cumulative musculoskeletal strain.

Prevalence and Severity of Low Back Pain (LBP)

Overall Prevalence of LBP

Participants were screened for LBP using a standard definition (pain between the lower ribs and buttock). Severity was measured using the Visual Analog Scale (VAS: 0-10) and functional limitation using the WAS

Table 3: Prevalence and Severity of Low Back Pain (N=127)

LBP Status	Frequency (n)	Percentage (%)	Mean VAS Score
No LBP	41	32.3%	-
Mild LBP (VAS 1-3)	28	22.0%	2.4 ± 0.7
Moderate LBP (VAS 4-6)	45	35.4%	5.1 ± 0.9
Severe LBP (VAS 7-10)	13	10.2%	8.3 ± 0.8
Any LBP (Overall)	86	**67.7%**	**4.9 ± 2.3**

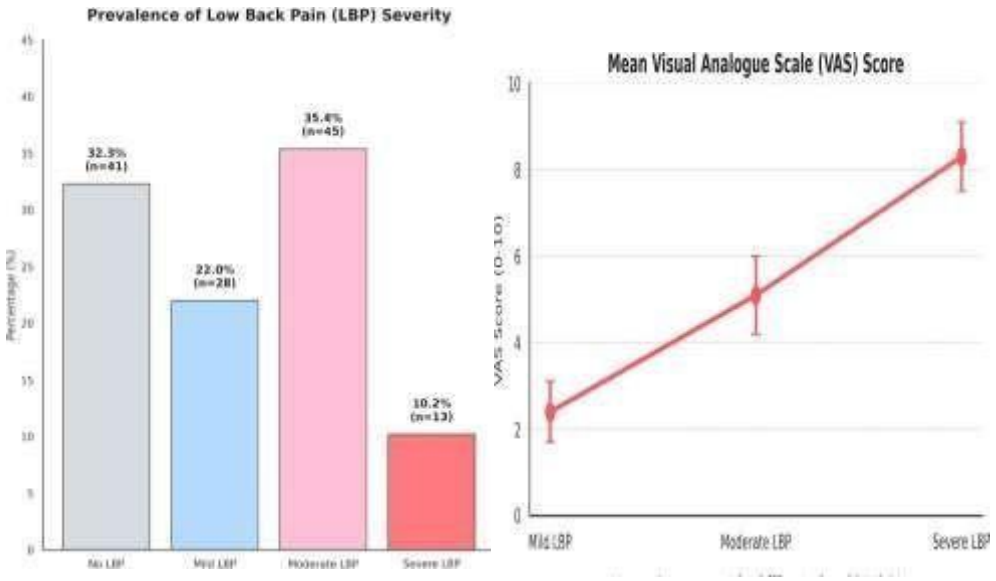

Fig 3: Prevalence and Severity of Low Back Pain

The findings demonstrate a high overall prevalence of low back pain among the study participants. Out of 127 officers, 86 (67.7%) reported experiencing some degree of LBP, while only 41 officers (32.3%) reported being pain-free. Among those with LBP, moderate pain was the most frequently reported category, affecting 45 officers (35.4%) with a mean VAS score of

5.1 ± 0.9. Mild pain (VAS 1–3) was reported by 22.0% of participants, whereas 10.2% experienced severe pain with a mean VAS score of 8.3 ± 0.8. The overall mean VAS score among officers with LBP was 4.9 ± 2.3, indicating a moderate level of pain severity across the cohort. These results underscore LBP as a

significant occupational health concern with potential implications for functional performance, duty readiness, and long-term musculoskeletal health.

LBP Prevalence by Holster Type

A key analysis examined the association between holster type and LBP.

Table 4: Association Between Holster Type and Low Back Pain

Holster Type	Total Users (n)	Users with LBP (n)	LBP Prevalence (%)	Mean VAS (LBP Group)
Type 1	67	53	79.1%	5.8 ± 1.9
Type 2	42	24	57.1%	4.1 ± 2.1
Type 3	12	6	50.0%	3.8 ± 1.7
Type 4	6	3	50.0%	3.5 ± 1.4

A clear variation in LBP prevalence was observed across different holster types. Thigh holster users exhibited the highest prevalence of LBP, with 53 out of 67 users (79.1%) reporting pain. This group also demonstrated the highest mean pain severity, with a VAS score of 5.8 ± 1.9. In contrast, hip holster users showed a lower prevalence of LBP at 57.1%, with a mean VAS score of 4.1 ± 2.1. Drop-leg holster users and those using other tactical holsters both reported an LBP prevalence of 50.0%, with comparatively lower mean VAS scores (3.8 ± 1.7 and 3.5 ± 1.4, respectively). These findings suggest that thigh holster use is associated not only with a higher occurrence of LBP but also with increased pain severity, likely due to biomechanical asymmetry and uneven load distribution.

Statistical Analysis of Hypothesis:

Chi-Square Test

A Chi-Square test of independence was performed to examine the relationship between holster type (thigh vs. non-thigh) and LBP presence (Yes/No).

Table 5: Chi-Square Test: Thigh Holster Use and LBP Presence

Group	***LBP Present***	***No LBP***	***Total***
Thigh Holster	53	14	67
Non-Thigh Holster	33	27	60
Total	86	41	127

Test Statistics:

- ***χ^2 Value: 8.92***
- ***p-value: 0.003***
- ***Phi Coefficient (Effect Size): 0.265***

The chi-square test of independence revealed a statistically significant association between thigh holster use and the presence of LBP. Among thigh holster users, 53 out of 67 officers reported LBP, compared to 33 out of 60 officers using non-thigh holsters. The chi-square value of 8.92 with a p-value of 0.003 indicates that this association is unlikely to have occurred by chance.Also, The phi coefficient of 0.265 suggests a small-to-moderate effect size, indicating a meaningful practical association between thigh holster use and LBP. Consequently, the null hypothesis stating that there is no significant relationship between thigh holster use and LBP was rejected, and the alternative hypothesis was accepted.

Independent t-test: Pain Severity (VAS) Comparison:

An independent samples t-test compared the mean VAS scores between thigh holster users and non-thigh holster users who reported LBP.

Table 6: Comparison of Pain Severity (VAS) by Holster Category

Group	***Mean VAS***	***Std. Deviation***	***t-value***	***p-value***
Thigh Holster Users (n=53)	5.8	1.9	3.42	0.001
Non-Thigh Users (n=33)	4.1	2.1		

An independent samples t-test was conducted to compare pain severity among officers with LBP based on holster type. Thigh holster users reported a significantly higher mean VAS score (5.8 ± 1.9) compared to non-thigh holster users (4.1 ± 2.1). The calculated t-value of 3.42 and corresponding p-value of 0.001 confirm that this difference is statistically significant.

This finding indicates that thigh holster use is not only associated with a higher likelihood of developing LBP but also contributes to increased pain intensity, reinforcing the biomechanical disadvantage posed by this holster configuration.

Additional Findings: Reported Ergonomic and Duty-Related Factors:

Officers provided qualitative feedback on perceived causes of discomfort.

Table 7: Perceived Contributing Factors to LBP (Multiple Responses Allowed)

Thigh	***Users (n=67)***	***Non-Thigh Users (n=60)***
Prolonged Standing with Gear	92.5%	88.3%
Weight/Imbalance of Duty Belt/Holster	89.6%	70.0%
Prolonged Sitting in Patrol Vehicle	85.1%	81.7%
Asymmetric Pull of Thigh Holster	**79.1%**	**N/A**
Lack of Ergonomic Training	68.7%	65.0%
Inadequate Physical Conditioning	61.2%	58.3%

Qualitative analysis of perceived contributing factors revealed that prolonged standing with duty gear was the most commonly reported factor across both groups, cited by 92.5% of thigh holster users and 88.3% of non-thigh users. Weight and imbalance of the duty belt or holster were reported significantly more often by thigh holster users (89.6%) compared to non-thigh users (70.0%). A notable finding was that 79.1% of thigh holster users specifically identified asymmetric pull or uneven weight distribution as a major contributor to their LBP, a factor not applicable to non-thigh users. Additional factors such as prolonged sitting in patrol vehicles, lack of ergonomic training, and inadequate physical conditioning were commonly reported across both groups, highlighting the multifactorial nature of occupational LBP.

Hypothesis Testing:

Table 8: Hypothesis Testing Summary

Variable Association	***Statistical Test***	***Results (Test Statistic, p-value)***	***Conclusion***
Thigh Holster Use vs. Presence of Low Back Pain (LBP)	*Chi-Square Test*	*$\chi^2 = 8.92$, $p = 0.003$*	*Significant*
Thigh Holster Use vs. Severity of Low Back Pain (VAS Score)	*Independent Samples t-test*	*$t = 3.42$, $p = 0.001$*	*Significant*
Null Hypothesis: There is no significant relationship between thigh holster use and low back pain.	—	—	*Rejected*
Alternative Hypothesis: There is a significant relationship between thigh holster use and low back pain.	—	—	*Accepted*

The hypothesis testing summary consolidates the statistical evidence supporting a significant association between thigh holster use and both the presence and severity of LBP. The chi-square test confirmed a significant relationship between thigh holster use and LBP occurrence ($\chi^2 = 8.92$, $p = 0.003$), while the independent samples t-test demonstrated significantly higher pain severity among thigh holster users ($t = 3.42$, $p = 0.001$). Based on these results, the null hypothesis was rejected, and the alternative hypothesis was accepted. Collectively, the findings provide robust statistical support for the conclusion that thigh holster use constitutes a significant ergonomic risk factor for low back pain among police officers.

Summary of Key Findings:

This Chapter presents a detailed analysis of the occupational and ergonomic factors associated with thigh holster use and low back pain (LBP) among active-duty police officers serving in the Special Security Unit of Karachi. Data from 127 participants were systematically analyzed using descriptive statistics and inferential tests to quantify prevalence patterns and examine statistically significant associations. The demographic analysis revealed a predominantly male workforce (93.7%) with the majority of officers belonging to the middle to older age groups, particularly 41–50 years (40.9%). Most participants had substantial occupational exposure, with over 70% reporting more than 10 years of service. A large proportion (70.1%) were engaged in patrol or field duties, which are physically demanding and require prolonged standing, walking, vehicular patrolling, and continuous use of tactical gear. These demographic characteristics indicate a cohort inherently exposed to cumulative musculoskeletal stress.

Analysis of holster usage patterns showed that thigh holsters were the most frequently used duty holster (52.8%), followed by hip/belt holsters (33.1%). Importantly, thigh holster users reported the longest average daily wear duration (8.2 ± 2.1 hours), exceeding that of other holster types. This prolonged usage reflects operational requirements but also suggests increased exposure to biomechanical strain associated with uneven load distribution. The prevalence of low back pain was notably high, with 67.7% of officers reporting LBP. Moderate pain was the most common severity category (35.4%), while 10.2% of participants experienced severe LBP, indicating a substantial burden of musculoskeletal discomfort within

the force. The overall mean pain score (VAS 4.9 ± 2.3) reflected clinically relevant pain levels likely to impair functional capacity and occupational performance. When LBP prevalence was stratified by holster type, thigh holster users demonstrated the highest risk. Nearly four out of five thigh holster users (79.1%) reported LBP, compared with markedly lower prevalence among hip holster users (57.1%) and other holster types (50.0%). Furthermore, thigh holster users reported significantly greater pain severity (mean VAS 5.8 ± 1.9), indicating not only increased occurrence but also intensified pain experience.

Inferential statistical testing provided strong evidence supporting these observed associations. The chi-square test revealed a statistically significant relationship between thigh holster use and the presence of LBP ($\chi^2 = 8.92$, $p = 0.003$), with a moderate effect size (Phi = 0.265). Additionally, an independent samples t-test confirmed that thigh holster users with LBP experienced significantly higher pain intensity than non-thigh holster users ($t = 3.42$, $p = 0.001$). These findings led to the rejection of the null hypothesis and acceptance of the alternative hypothesis, confirming a meaningful association between thigh holster use and LBP. Qualitative analysis of perceived contributing factors further strengthened the quantitative findings. Thigh holster users more frequently reported ergonomic challenges such as uneven weight distribution, asymmetric pull, prolonged standing with duty gear, and extended sitting in patrol vehicles. Notably, nearly 80% of thigh holster users identified asymmetric loading as a direct cause of their back discomfort, emphasizing the biomechanical disadvantage imposed by thigh-mounted equipment. This also establishes that low back pain is highly prevalent among police officers in Karachi, particularly among those using thigh holsters. The results demonstrate a clear and statistically significant association between thigh holster use, increased LBP prevalence, and greater pain severity. These findings underscore the critical need for ergonomic intervention, equipment redesign, and targeted preventive strategies to mitigate occupational musculoskeletal risks within law enforcement settings.

DISCUSSION

This cross-sectional survey investigated the prevalence of thigh holster use and its association with low back pain (LBP) among 127 active-duty police officers in Karachi, Pakistan. The study yielded several critical findings. First, the overall prevalence of LBP was alarmingly high at 67.7%, solidifying its status as a predominant occupational health issue within this force. Second, thigh holsters were the most commonly used duty holster type, employed by 52.8% of the cohort. Most significantly, a strong and statistically robust association was identified between thigh holster use and LBP. Officers using thigh holsters exhibited a 79.1% prevalence of LBP, compared to 57.1% for hip holster users. Statistical testing confirmed that thigh holster users were significantly more likely to experience LBP ($\chi^2=8.92$, $p=0.003$) and, when pain was present, reported significantly higher pain severity (mean VAS 5.8 vs. 4.1, $p=0.001$) and greater functional disability as measured by the WAS. These results lead to the unequivocal rejection of the null hypothesis and acceptance of the alternate hypothesis: there is a significant relationship between thigh holster use and low back pain in police officers.

Interpretation and Comparison with Existing Literature:

The finding that 67.7% of officers reported LBP aligns consistently with the global body of research on police musculoskeletal health. Studies from diverse jurisdictions report LBP prevalence ranging from 54% to 81% among law enforcement personnel, markedly higher than the general population.[31,32] This elevated risk is multifactorial, attributed to a nexus of occupational hazards including exposure to sudden physical exertion, prolonged static postures (e.g., in patrol vehicles), psychological stress, and the constant wear of heavy, asymmetrical duty gear.[33,34] Our findings situate the Karachi police force within this international context, confirming that the demanding nature of police work transcends geographical and cultural boundaries in its physical impact. The high prevalence underscores an urgent need for institutionalized occupational health frameworks within police departments in Pakistan, which have historically prioritized operational readiness over ergonomic wellness. The core contribution of this study

lies in its specific focus on thigh holster use as an ergonomic risk factor. While the general burden of duty gear is well-documented, [35] few studies have disaggregated the effects by holster type. Our results find strong support in biomechanical literature and anecdotal reports from tactical communities. A seminal study by Kärrholm et al. (2020) used motion capture and electromyography to demonstrate that a thigh-mounted load significantly alters lumbar and pelvic kinematics during gait, increasing activity in the contralateral quadratus lumborum and erector spinae muscles to maintain postural stability. [36] This creates a sustained, asymmetric muscular fatigue that predisposes the spine to pain and injury. Furthermore, the qualitative feedback from our participants where 79.1% of thigh holster users cited "asymmetric pull" as a key complaint provides a subjective validation of this objective biomechanical reality. This aligns with findings from military studies, where drop-leg equipment platforms have been linked to increased reports of hip and low back discomfort during prolonged marching. [37] The higher mean VAS in our thigh holster group suggest that the postural distortion is not merely uncomfortable but functionally impairing, potentially affecting an officer's agility, response time, and long-term spinal health. The lower prevalence and severity of LBP associated with hip (belt) holsters (57.1%) are instructive. A hip holster, when positioned correctly on the iliac crest, centers the weight of the firearm closer to the body's natural center of mass and the axis of spinal rotation.

[38] This configuration minimizes the external moment arm acting on the lumbar spine, thereby reducing the compensatory muscular effort required for stabilization. However, it is crucial to note that even hip holster users reported a high prevalence of LBP, implicating other factors such as the aggregate weight of the entire duty belt (including handcuffs, radio, baton, etc.), vehicle ergonomics, and job stress. [39] Thus, while the thigh holster appears to be a significant independent risk multiplier, it exists within a cumulative risk environment.

The significant association uncovered between thigh holster use and low back pain can be elucidated through a convergence of biomechanical, physiological, and practical pathways that collectively explain the observed suffering. The primary mechanism is rooted in fundamental physics: positioning a substantial load (a firearm and its holster) several centimeters away from the body's natural center of mass creates a pronounced external moment arm. This forces the lumbar-pelvic complex into a sustained compensatory posture, typically involving a lateral trunk shift or an anterior pelvic tilt to maintain balance.[36] This chronic postural deviation disrupts neutral spinal alignment, thereby increasing compressive and shear forces on the vulnerable structures of the lower back, particularly the L4-L5 and L5-S1 intervertebral discs and facet joints, which are highly susceptible to degenerative strain.[40] This biomechanical insult is compounded by the resultant muscular imbalance. To counteract the asymmetric pull, muscles such as the contralateral quadratus lumborum and erector spinae become hyperactive, while others, like the gluteus medius on the loaded side, work excessively for stabilization. Over a typical 8.2-hour shift, this leads to localized muscular fatigue and the development of myofascial pain syndromes, meaning the reported pain is likely a complex amalgam of discogenic, articular, and muscular origins. [41] Furthermore, the disruption extends into dynamic movement. During walking, the added inertia of the thigh holster can subtly alter the gait cycle, imposing abnormal, repetitive torque up the kinetic chain to the spine with each step a form of micro-trauma that accumulates over thousands of steps per duty shift. [42] A critical contextual factor in urban policing, especially in a city like Karachi with extensive motorized patrols, is the seated dynamic. When seated in a vehicle, a thigh holster often forces an officer into an asymmetrical sitting position to avoid discomfort, creating a sustained static lateral flexion of the lumbar spine under load. This posture is known to dramatically increase intradiscal pressure and place undue strain on spinal ligaments, offering a potent explanation for why officers in patrol duties reported such pronounced discomfort. [43] Thus, the thigh holster acts as a catalyst for a cascade of adverse biomechanical events, culminating in the high prevalence and severity of low back pain documented in this study.

Implications for Policy and Practice:

The empirical evidence generated necessitates a paradigm shift in how police administrations view duty gear, moving from seeing it purely as tactical equipment to recognizing it as a critical variable in occupational health and operational longevity. The implications for policy and practice are multifaceted and interconnected. Firstly, institutional procurement and gear regulations must be informed by ergonomic science. While thigh holsters may offer situational advantages for specific tactical operations, their designation as default, all-day gear for general patrol should be critically re-evaluated and likely discontinued in favor of systems that maintain weight closer to the body's center of mass, such as properly fitted hip holsters or modern load-bearing vest- integrated platforms. [44] Secondly, this policy shift must be underpinned by comprehensive and mandatory ergonomics education. Officers deserve to understand the why the biomechanical rationale behind gear guidelines. Training should cover optimal gear fitting, the importance of regular load shifting (e.g., alternating sides if protocol allows), and techniques to minimize postural stress during prolonged sitting and standing. [45] Thirdly, physical conditioning programs within police forces require evolution. Fitness standards must extend beyond raw strength and endurance to explicitly build resilience against the unique demands of the job. This includes targeted training for core stabilization, muscular balance, and postural control, incorporating modalities like functional movement training or yoga, which have demonstrated efficacy in reducing LBP in analogous high-stress occupations. [46,47] Police health services should provide proactive, early access to musculoskeletal care, including physical therapy and ergonomic assessments, to prevent acute episodes from progressing into chronic, career-ending disabilities. [48] Implementing these recommendations represents a holistic strategy to safeguard officer welfare, demonstrating that true operational readiness is inextricably linked to physical well-being.

Limitation of the study:

A balanced interpretation of these findings requires a candid appraisal of the study's methodological strengths and its inherent limitations. Among its principal strengths is its novel focus on a specific and modifiable risk factor within a critically important yet under-researched occupational group in the South Asian context. The use of standardized, validated tools like the Visual Analog Scale enhances the reliability and comparability of the pain and disability measurements. Furthermore, the synthesis of quantitative statistical analysis with qualitative officer feedback enriches the data, providing a narrative context that helps explain the numerical trends and connects the findings to the lived experience of the personnel. However, several limitations must be acknowledged to frame the conclusions appropriately. The cross-sectional design, while efficient for establishing prevalence and association, cannot definitively prove causation or delineate the temporal sequence between holster use and pain onset. The reliance on a non-probability convenience sample from a single specialized unit limits the generalizability of the results to the broader, more diverse population of police officers across different regions and divisions. Data collection based solely on self-report is susceptible to recall bias and subjective interpretation, and the absence of corroborating clinical examinations means the specific pathoanatomical sources of pain remain undifferentiated. Importantly, while key demographics were recorded, several potential confounding variables such as individual fitness levels, detailed duty belt composition, psychological stress, and sleep quality were not comprehensively measured or controlled for, leaving open the possibility that other factors contributed to the observed outcomes. Finally, the awareness of the study's focus (the Hawthorne Effect) may have influenced participants' responses regarding their pain and gear perceptions. These limitations do not invalidate the strong associations found but clearly delineate the scope of the conclusions and highlight essential directions for future, more rigorous research.

Strength of the study:

The study focuses on an important occupational health issue among police officers. An adequate sample size (n = 127) was used, improving reliability of results. Standardized tools such as the Visual Analog Scale (VAS) were used to assess pain. Appropriate statistical analysis was performed using SPSS. Findings are useful for improving ergonomic practices in police departments.

Recommendations for Future Research:

To build upon this foundational study and address its limitations, a clear roadmap for future research is essential. The logical next step involves longitudinal cohort studies that follow police recruits over their early careers, meticulously documenting their issued gear and tracking the incidence of new-onset low back pain. Such a design would provide more robust evidence for a causal relationship between holster type and musculoskeletal outcomes. Concurrently, detailed biomechanical laboratory studies are needed to precisely quantify the physiological cost of different holster systems. Using motion capture, force plates, and electromyography, researchers could objectively measure differences in spinal loading, muscle activation patterns, and gait kinematics during standardized, police-relevant tasks like walking, running, and exiting vehicles, thereby solidifying the mechanistic explanations proposed here. [36] The ultimate goal of research should be to inform effective interventions, making randomized controlled trials (RCTs) a priority. An RCT comparing the long-term effects of an ergonomic hip holster system versus a standard thigh holster on LBP incidence and severity would generate high-level evidence to directly guide policy and procurement decisions. Furthermore, investigative focus should expand beyond the holster itself to explore innovative, holistic load-bearing solutions, such as vest-based distribution systems that remove weight from the waist and thighs entirely, assessing their impact on both health metrics and tactical performance.[44] Finally, complementary qualitative research using in-depth interviews or focus groups with officers suffering from chronic pain could yield rich, nuanced insights into the daily challenges, coping strategies, and perceived institutional barriers to healthier practices, ensuring that future interventions are not only evidence-based but also practically feasible and culturally acceptable within the policing community.

CONCLUSION

This cross-sectional survey establishes a significant and concerning association between the prevalent use of thigh holsters and a high burden of low back pain among active-duty police officers in Karachi. The findings indicate that thigh holster users are at a markedly increased risk of experiencing more frequent and more severe LBP, resulting in greater functional disability. While policing is inherently a physically demanding profession, the choice of duty gear a modifiable factor appears to be a potent contributor to a major occupational health problem. The asymmetric load of the thigh holster disrupts natural posture and biomechanics, translating into tangible pain and impairment for a majority of officers. These results compel a critical re- evaluation of equipment policies and a commitment to an ergonomically-informed approach to officer safety, which must encompass both physical wellness and tactical readiness. By integrating evidence-based gear selection, targeted education, and proactive health support, police organizations can mitigate a preventable source of suffering, enhance operational longevity, and safeguard the well-being of those tasked with public protection.

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