Original Article

Prevalence of Baxter's Nerve Syndrome in Baluchistan's Athletes and its Influence on their Performance

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ABSTRACT

OBJECTIVE: To determine the prevalence of BNS and its impact on performance among athletes of Quetta, Balochistan, Pakistan.

METHODOLOGY: 39 athletes, aged 18-40, from Musa and Ayub Stadiums of Quetta participated in the study. A self-administered questionnaire focused on population science, athletic chronicle, signs of BNS, level of cognizance, and characteristic events was used to collect the data. Each participant gave informed consent, and IRB approval was acquired prior to data collection. In SPSS analysis, Fisher's exact test was used to examine associations between categorical predictors and positive BNS.

RESULTS: The male participants were 32 (82%), with 29 (75%) aged between 18 and 25 years. Regarding pain, 23 (59%) participants revealed no heel while the remaining participants had encountered symptoms linked with BNS, such as tingling or numbness in the heel. Knowledge of BNS was very limited, with only 2 (5%) of the participants aware of the condition. Diagnostic tests such as Tinel's sign and the compression test were positive in a small number of cases.

CONCLUSION: The study discovered that heel pain did not remarkably affect performance for most athletes, but the findings were bound by the small sample size and lack of overarching diagnostic procedures. Further research with wide-ranging samples and improved diagnostic techniques is needed to better comprehend the prevalence and impact of BNS in athletes.

KEYWORDS: Heel pain, Inferior calcaneal nerve, Plantar heel pain, Baxter's Nerve Syndrome, Baxter's nerve, Athletic performance.

INTRODUCTION

Chronic recalcitrant plantar heel ache is the most prevalent and debilitating complaint of the ankle and foot, affecting the lower extremity in both primary and secondary medical and orthopedic occupations[1-4]. It is an impairing condition that is frequently misdiagnosed and mismanaged that is affecting a large number of the population in all stages of life, not only adults and children[1,2]. It not only affects physically active individuals but also affects people with a sedentary lifestyle[1]. In athletes, the prevalence ranges approximately between 5% and 18% [3]. Adults aged between 20 and 40 have the highest risk rate of prevalence of heel pain[3]. Worldwide, the Australian population experiences heel pain around 3.6%, the United States approximately 5%, and the United Kingdom 12.1%.[3] According to a study conducted by Nawaz et al. in Lahore (Pakistan) in 2023, 62.4% of young professionals, including athletes, professors, healthcare workers, and employees, faced different levels of heel pain, which had a significant amount of impact on their daily lives[4].

The differential diagnoses include calcaneus spurs, Achilles tendonitis, bursitis, stress fracture, osteomyelitis, peripheral neuropathy, calcaneal enthesophytes, Haglund deformity, Tarsal Tunnel Syndrome, Sever's disease, plantar fasciitis, and Baxter's nerve syndrome (BNS) [5,6]. The Baxter's nerve, also known as the inferior calcaneal nerve, is a small (approximately 2 mm) mixed nerve that provides sensory innervation to the calcaneal periosteum and long plantar ligament and motor innervation to the abductor digiti minimi, which helps toes abduct[7,8]. It is the first branch of the Lateral Plantar Nerve (LPN), which arises from the tibial nerve deep in the foot[7,8]. The nerve travels inferiorly between abductor hallucis and quadratus plantae professionals, takes a sharp turn medially, and courses along the underside of the calcaneus[7,8,9]. Its origin and course vary in individuals, as it may arise from the medial calcaneal nerve rather than the LPN[7,10]. It is responsible for up to 20-30% of calcaneus ache[1,7].

The aetiologies of BNS include space-occupying lesions, tenosynovitis, accessory or hypertrophic musculature, bony spurs, trauma, and systemic diseases such as diabetes[1,7,11,12]. Additionally, athletes with cavovarus feet are more susceptible to entrapment of Baxter's nerve due to altered foot biomechanics[12,13]. BNS has distinctive clinical representation from other heel ache pathologies via symptoms like sharp, burning pain in the medial calcaneal and plantar heel, often radiating to the toes. Symptoms also include tingling, numbness, pins and needles, or paraesthesia[7,13]. BNS causes a dull ache on the medial aspect of the foot arch and heel[13]. Symptoms could be aggravated by walking on hard surfaces, excessive pressure, excessive exercise,

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jumping, running, and repetitive weight-bearing exercises[14]. On physical examination, Baxter's nerve may elicit a positive Tinel's sign and compression test over the entrapment and paresthesias on the lateral foot[13,8,15]. Imaging can also help in diagnosis, as MRI may show atrophy and denervation edema of the abductor digiti minimi muscle in Baxter's neuropathy[14]. Ultrasound can confirm nerve thickening or hypoechoic appearance.[8,12] Nerve Conduction Study (NCS) and Electromyography (EMG) remain the gold standard tests for neuropathies[13,16].

Despite the existing literature on etiologies of heel pain, research on BNS remains limited, with very few studies focusing on its prevalence among athletic populations. This gap is especially notable in regions like Balochistan, where studies on musculoskeletal conditions affecting athletes have not been conducted before. The aim of this study is to evaluate the knowledge and prevalence of BNS in running athletes in Quetta and its influence on their athletic performance.

METHODOLOGY

A cross-sectional observational study was conducted among professional and recreational sports players and athletes attending various gymnasiums and athletic stadiums in Quetta, Balochistan, Pakistan, from September 2024 to February 2025. Determining the prevalence of BBNS and its possible impact on athletic performance were the goals of the study. Participants who met the inclusion requirements of being regular runners or active athletes who had been training for at least six months before enrollment were chosen using a non-probability convenience sampling technique. To ensure uniformity among all participants, a systematic questionnaire and standardized clinical evaluation techniques conducted by qualified physiotherapists were used to gather data.

Based on existing epidemiological data, the baseline prevalence of chronic plantar heel pain in active running and athletic populations is approximately 13% (Taunton et al., 2002)[17], with BNS accounting for roughly 20% of those cases (Chundru et al., 2008[18]; Rodrigues et al.[19], 2015). This yields a literature-derived expected BBNS prevalence of 2.6% within the general athletic cohort. Utilizing Cochran's sample size formulation with this 2.6% expected prevalence, a 95% confidence level (Z = 1.96), and a 5% margin of error (d = 0.05), the necessary required sample size was calculated to be 39 participants.

The sports players and athletes from Balochistan were included if they were aged between 18 and 40 years, had a minimum of one year of consistent training in their respective sports, had a history of regular running, had a history of long-time routine footwear, had no prior surgeries or traumas affecting the ankle or foot region, and had no presence of space-occupying mass lesions in the ankle or foot region. The exclusion criteria were athletes over 40 years old; people with occupations requiring standing for long hours (such as teachers, policemen, and security guards); a history of foot trauma and direct falls in the heel suspected of acute calcaneal fractures or soft tissue contusions; a history of sudden weight loss; pain and burning sensations in the medial plantar region suspected of tarsal tunnel syndrome; numbness and tingling sensations due to diabetes mellitus, peripheral neuropathies, and vitamin deficiency with a history of pain in multiple joints suspected of systemic arthritides such as rheumatoid arthritis.

In order to ensure the accurate and comprehensive gathering of pertinent data, the data-collecting procedure for this study used a structured method. 39 participants who met the inclusion criteria were selected for this study. These athletes were chosen from Musa and Ayub stadiums in Quetta, Balochistan. Prior to data collection, each participant gave their informed consent. A self-administered questionnaire focused on population science, athletic chronicle, signs of BNS, level of cognizance, and characteristic events was used to collect the data. SPSS software was used to handle the acquired data and was used to produce the results.

All statistical analyses were performed using IBM SPSS Statistics, version 26. Descriptive statistics were computed to summarize participant demographics and study variables. Categorical variables were expressed as frequencies and percentages. The normality of continuous data was evaluated using the Shapiro–Wilk test to determine appropriate statistical procedures. Given the relatively small sample size (N = 39) and the low number of expected positive outcomes for BNS, Fisher's exact test was employed in place of the Pearson Chi-square test to examine associations between categorical predictors (e.g., years of athletic participation, orthotic use, plantar fasciitis diagnosis, and training limitations due to heel pain) and the presence of a positive compression test. This approach ensured robust inference despite sparse cell counts and preserved test accuracy for small samples. All p-values were two -tailed, and statistical significance was established at $p < 0.05$. Results were presented in the form of text, and figures will also be created to present the results in a visual manner.

Prior to data collection, the Institutional Review Board (IRB) of the University of Balochistan, Quetta's Department of Physical Therapy, provided ethical approval for this study (Letter# 1616 E/DPT/2024). Every technique involving human subjects was carried out in compliance with the Declaration of Helsinki and the institutional and national research committees' ethical guidelines. All athletes were informed of the goals and methods of the study prior to their participation. Each participant gave their written informed consent, guaranteeing their voluntary participation and their freedom to exit at any time without consequence or interference with their athletic

career. During the research process, at no point was any personally identifiable information captured or shared.

RESULTS

A total of 39 competitive runners were enrolled in the study (N = 39). The age distribution represented 29/39 (74%) young participants aged 18-25 years, with males making up 32/39 (82%) of the sample (**Figure 1**). Occupationally, 12 (31%) identified as professional athletes, while 11 (28%) were student athletes. The sports distribution highlighted cricketers and footballers equally, each accounting for 12 (31%) of participants (**Figure 2**). The number of athletes that had been involved in their sport for one to three years was 13 (31%), while 10 (26%) reported over 10 years of participation.

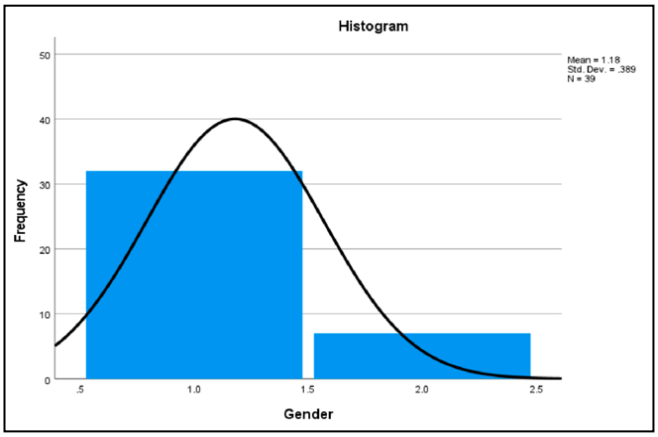

Figure 1:
The histogram showing gender distribution

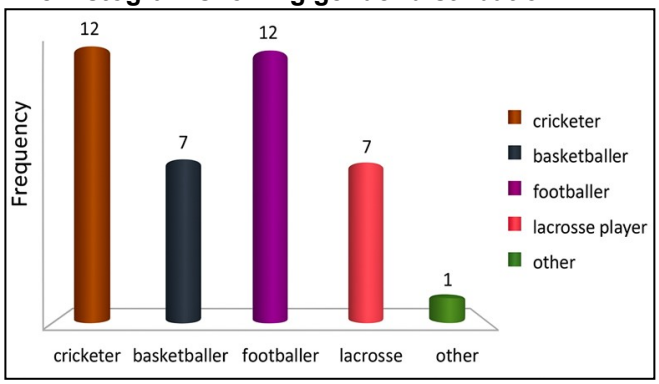

Figure 2: Bar chart showing the distribution of runner athletes

Training frequency varied among the athletes, with only 13 (33%) training daily. Heel pain duration was less than one month for seven (18%) athletes, with pain levels described as mild or moderate in 14 (36%) of the cases. Although 23 (59%) of the athletes reported no significant impact on performance, five (13%) experienced moderate to severe effects on their activities. Awareness of BNS was low, as only two (5%) athletes were familiar with the condition, while 37 (95%) reported no awareness of the disease. Diagnostic screenings like X-rays and physical exams were limited to 11 (28%) of the participants, and 34/39 (87%) had never undergone regular foot screenings. Non-invasive treatments were preferred, with seven (18%) having tried physical therapy, while 23 of the participants (59%) had not pursued any treatment options. Use of specialized footwear was minimal, with only three (8%) reporting its use. Furthermore, 39 (93%) of the participants found orthotic interventions ineffective in symptom relief. Awareness of plantar fasciitis was also low, and familiarity with diagnostic indicators such as Tinel's sign and compression tests was limited, with positive results only in five (13%) of the cases.

Regarding heel symptoms and their effect on performance, 28 (72%) reported no impact on athletic performance, while minor, moderate, and major impact categories were observed in six (16%), three (8%), and two (5%) of the participants, respectively **(Figure 3)**. In clinical testing, five (13%) of the participants had a positive Tinel's sign at the medial ankle, and five (13%) of the participants demonstrated sensitivity on the compression test (**Figure 4**). A small proportion of participants had a formal diagnosis of plantar heel conditions; diagnostic and treatment histories were infrequent. Use of orthotics or specialized footwear was uncommon, and reported effectiveness was minimal, and 36/39 (92.3%) reported no symptomatic relief from orthotics.

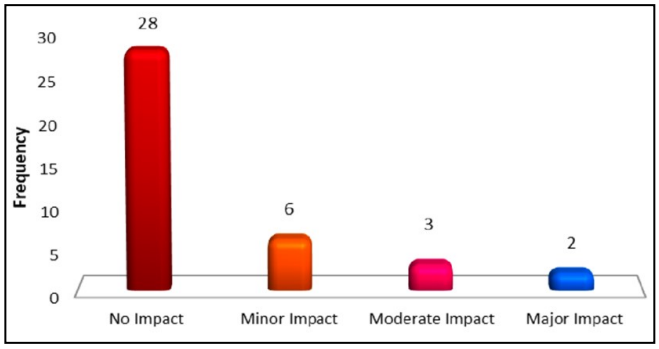

Figure 3: Impact of Heel Pain on Athletic Performance

Overall, 5/39 (12.8%) athletes had a positive compression test, which is a sign of BNS (Figure 4). Fisher's exact test showed that the majority of participant outcomes, including decreased training because of heel discomfort and a previous diagnosis of plantar fasciitis, were not significantly associated with the presence of BNS ($p > 0.05$). The reported effectiveness of orthotics or specialized footwear, however, showed a statistically significant association ($p = 0.04$), indicating that athletes who believed their orthotics were more successful were more likely to have a favorable compression reaction. Neither Tinel's sign at the medial ankle nor knowledge of Baxter's neuropathy was shown to be significantly associated. These results collectively imply that while BNS was relatively uncommon in this sample of runners, footwear-related interventions may play a contributory role in symptom manifestation.

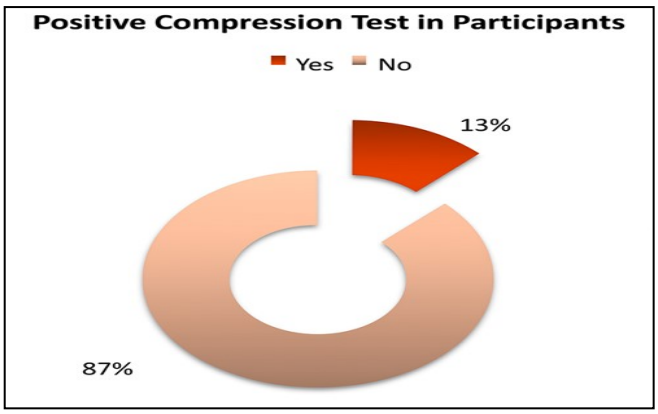

Figure 4: Doughnut chart illustrating the results of the compression test among participants

DISCUSSION

This research analyses various demographic, training, and health-related factors among running athletes in Quetta, Pakistan, focusing on heel discomfort and its impact. Most of the individuals selected were young people aged between eighteen and twenty-five years, with males forming the majority of the population. Routine and rigorous daily training was widespread, with cricket and football being the most common sports. Participants showed varying levels of experience in sports, with most having been active for one to three years, though a significant portion had over 10 years of experience. Heel ache was common, with a significant number experiencing it for less than a month. The degree of pain was mild or moderate in most cases, with only a few individuals describing it as severe. Despite the prevalence of pain, most participants reported no notable effect on their athletic performance. This study also shows a substantial gap in awareness, assessment, and treatment of BNS. Although it is a prevalent cause of heel pain, only a small proportion of respondents were aware of BNS. Clinical tests, such as X-rays or medical assessments, were done in the past in slightly over one quarter of participants; most had never undergone regular foot examinations. Long-term heel pain affected athletic performance for some individuals, with just over one-tenth reporting a moderate to severe impact. Clinical tests, such as the compression test and Tinel's sign, yielded positive results in just over one-tenth of cases, indicating possible BNS. However, advanced diagnostic tools were not utilized. Most athletes relied on non-invasive treatments, such as rest and exercise therapy, while only a few used supportive devices, reflecting limited resources in the region.

The study by Landge and Salunkhe on heel pain in farmers mirrors this research, showing that farmers, like athletes, experience heel pain due to prolonged stress, extended standing, and uneven terrain, with a prevalence of nearly one-quarter[17]. This aligns with our findings for athletes, where chronic heel pain impacted just over one-tenth of participants. Both studies demonstrated limited awareness of specific conditions and their treatment, such as BNS or plantar fasciitis, highlighting a shared gap in understanding and early detection among the populations[20]. Rodrigues et al. support the findings of this research by identifying BNS as a leading cause of chronic heel pain, often overlapping with plantar fasciitis and findings highlighting the importance of advanced imaging techniques, such as MRI, to detect nerve entrapment and associated ADQ muscle wasting[12]. Rasenberg et al. corroborate this study by showing that plantar heel pain accounts for approximately one-eighth of foot problems and limited use of diagnostic measures and assisted devices[21]. Both studies emphasise underdiagnoses, limited awareness, and inconsistent interventions for problems and the affected populations[21]. Matthew S. et al. (2021) contradict this research, as it shows that three-fourths of athletes are aware of BNS, while our study found only five percent awareness among athletes in Balochistan, indicating a significant regional educational gapx[13]. Furthermore, Matthew S. et al. showed a predominance of surgical interventions, with up to 60 percent of athletes undergoing surgery for BNS, while our study found that non-surgical management and preventive measures were preferable, with three-quarters of athletes benefiting from conservative treatments[13]. These differences underscore the need for region-specific approaches to improve awareness and management of BNS.

In contrast, a study conducted in Lahore by Iram Nawaz on heel pain showed a higher prevalence of heel pain among females (nearly four-fifths) and professions such as teachers and nurses[9]. The majority of participants in this study reported no pain, while chronic pain was found in over one-third of participants lasting five to seven months[9]. In comparison, just over one-quarter of participants in our study experienced discomfort during prolonged standing, but only one-twentieth reported severe pain. Treatment preferences also varied, as half of the participants in our study did not seek medical guidance, opting for self-care, while one-quarter in the Lahore study reported positive outcomes from care[9]. These findings underscore a lack of awareness and access to appropriate healthcare in Quetta, highlighting the need for region-specific education and interventions for conditions like BNS.

Study Limitations:

Despite the targeted focus of this research, this study has some notable limitations. Most participants had only one to three years of experience in running, whereas BNS is often linked to long-term wear and tear. The sample included more male athletes than female runners, mostly young with limited health literacy. This imbalance may affect the generalizability and contribute to a lower observed prevalence, as younger athletes might not fully exhibit the condition. A small sample size and lack of advanced diagnostic tools, such as EMG and NCS, limit the study's generalizability and diagnostic accuracy. Additionally,

the male-dominated sample may reduce applicability to a broader or a female athletic population.

Recommendations and Clinical Implications:

Our recommendations include spreading awareness about BNS among medical carers and fitness trainers to ensure better evaluation and therapy for running athletes as well as emphasizing the importance of exercise medicine and fitness training courses in recognizing and addressing heel discomfort and performance concerns. In their clinics, physiotherapists should apply standardized diagnostic protocols using advanced visualization methods such as ultrasound and diagnostic tests like EMG and NCT for early detection. Sports bodies should organize academic events and workshops for running athletes to raise awareness and understanding of BNS and other causes of heel pain as well as highlight the significance of early diagnosis and therapy in mitigating heel discomfort and preventing performance concerns. Finally, on a large scale, there is a need to formulate uniform treatment guidelines that include both non-surgical and surgical approaches. Non-surgical intervention could be R.I.C.E. and NSAIDs for pain and swelling reduction, followed by physical therapy. There is a significant gap in research in BNS and other heel pain conditions, especially on a local level. Future research should have a bigger sample size to enhance the validity and reliability of the results. A longitudinal design should be implemented to assess changes in symptoms, treatment outcomes, and athletic performance over time.

CONCLUSION

The study sought to evaluate the prevalence of BNS and raise awareness regarding this situation in athletes in Quetta, Pakistan. The results showed that most participants revealed no heel pain and reported that heel pain had no impact on their athletic performance. Only a small portion were detected with BNS. The study also found that most participants were not aware of BNS as a condition or its treatments. This study highlights the need for tailored awareness initiatives, regular assessments, and access to advanced diagnostics and treatments, especially in low-resource regions like Balochistan. Addressing these gaps can improve the timely identification and treatment of BNS, reducing its impact on sports performance and enhancing long-term musculoskeletal health.

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Informed Consent Statement:

Before participation, all athletes were informed about the study's objectives and procedures. Written informed consent was obtained from each participant, ensuring their voluntary participation and the right to withdraw at any stage without any penalty or impact on their athletic activities.

Ethical permission: Bahria University Medical and Dental College, Karachi, Pakistan, The study has been approved by ERC/IRB.

Conflict of interest: There is no conflict of interest between the authors.

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Data Sharing Statement: The corresponding author can provide the data proving the findings of this study on request. Privacy or ethical restrictions bound us from sharing the data publicly.

AUTHOR CONTRIBUTION

Roheen Shahid: Conceptualization, Methodology, Validation, Data Curation, Writing – Original Draft Preparation, Writing – Review & Editing, Visualization, Supervision, Project Administration

Neha Gulshan: Conceptualization, Validation, Data Curation, Writing – Original Draft Preparation

Safi Ullah Khan: Software, Formal Analysis, Data Curation, Writing – Original Draft Preparation, Writing – Review & Editing

Asma Zafar: Data Curation, Writing – Original Draft Preparation,

Atika Aijaz: Data Curation, Writing – Original Draft Preparation,

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