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Prevalence and Functional Impact of Flat Foot among Medical and Nursing Students: Evaluation of Yoga and Ayurvedic Interventions

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Abstract

Flat foot (pes planus) is common in young adults and can impair function and health-related quality of life (HRQoL), yet its burden among medical and nursing students—who experience prolonged standing and walking—remains under-recognised. This narrative review synthesises evidence on the prevalence of flat foot in medical, nursing, and comparable student populations; summarises functional and quality-of-life consequences using validated assessment tools; and explores emerging integrative approaches incorporating exercise, yoga-based interventions, and Ayurvedic therapies. Available data indicate a non-trivial prevalence of pes planus in medical students, heterogeneous across studies due to variable definitions and tools, with symptomatic cases reporting pain, fatigue, reduced functional capacity, and impaired foot-specific HRQoL. Validated measures such as the Foot Posture Index-6 (FPI-6), Navicular Drop Test, Arch Index, and foot-specific HRQoL questionnaires (e.g. Foot Function Index–Revised, Foot Health Status Questionnaire) allow robust quantification of this burden. Exercise-based interventions, including "foot-core" strengthening and neuromuscular training, improve arch structure and function, and yoga-based programmes and Ayurvedic local therapies offer culturally congruent adjuncts for symptom relief and functional improvement, though high-quality trials in medical and nursing students are lacking. Well-designed longitudinal and interventional studies in health-professions students are needed to inform screening, prevention, and integrative management strategies.

Key words: Flat foot, Foot posture index, Foot function index, Yoga, Ayurveda.

Introduction

Flat foot, characterised by flattening of the medial longitudinal arch with hindfoot valgus and forefoot abduction, is one of the most frequent foot posture deviations encountered in clinical practice. Flexible pes planus predominates in children and young adults, with arch collapse under load but near-normal appearance in non–weight-bearing, while rigid deformities usually reflect tarsal coalition, inflammatory arthropathy, or neuromuscular disease (1-3). Deviations from normal foot posture are associated with altered plantar-pressure distribution, impaired shock absorption, and compensatory changes in lower-limb kinematics, predisposing to pain, overuse injuries, and functional limitations (1-5).

Medical and nursing students constitute a unique at-risk group due to long hours of standing in lecture halls, dissection rooms, and wards, as well as extensive walking during clinical postings and night duties (1-3). Early adulthood is also a critical window when lifestyle factors such as inactivity and rising body mass index (BMI) may interact with biomechanical predispositions to exacerbate pes planus and its consequences. At the same time, foot health is rarely prioritised in student wellness programmes, and evidence on integrative, contextually relevant interventions remains limited (6-10).

This narrative review aims to: (1) synthesise epidemiological data on the prevalence of flat foot in medical, nursing, and comparable student populations; (2) summarise functional and HRQoL impact using validated assessment tools; and (3) discuss current therapeutic options with a focus on exercise-based, yoga, and Ayurvedic interventions relevant to young health-professions trainees.

Methods

(Narrative Approach)

A narrative review framework was adopted to integrate heterogeneous data across epidemiology, biomechanics, quality of life, and integrative therapies. Peer-reviewed articles, theses, and high-quality narrative or systematic reviews dealing with flat foot prevalence, functional outcomes, HRQoL, and conservative interventions were considered, with particular attention to medical, nursing, and university students or young adults (1-5). Searches included terms related to "flat foot", "pes planus", "medical students", "nursing students", "university students", "quality of life", "Foot Posture Index", "navicular drop", "yoga", "Ayurveda", and "exercise therapy", supplemented by snowballing from reference lists. Given the narrative design, no formal quality scoring was applied; instead, emphasis was placed on studies using validated measurement tools or clear operational definitions.

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Epidemiology of Flat Foot in Students and Young Adults

Reported prevalence of flat foot in adults and late-adolescent populations ranges widely (approximately 5–30%), reflecting differences in age, ethnicity, footwear habits, and, crucially, diagnostic criteria (1-5). In a random adult sample, Pita-Fernández et al. found a prevalence of flexible flat foot associated with worse foot function and HRQoL, highlighting that even non-clinical populations may experience significant impact (1,2).

Among medical students, a cross-sectional study in India reported bilateral pes planus in 11.6% and unilateral involvement in 3%, with higher BMI and body weight significantly associated with flat foot, but no clear relationship with age or sex (2). A study of first- and second-year medical students in a tertiary centre similarly observed a notable burden of pes planus using footprint indices and clinical assessment, underscoring that even young adults with health knowledge are not spared (2,3).

Data in college-going and university students also reveal substantial variability: one study reported flat foot in approximately one-fifth of students when using navicular drop criteria, but only around 5% when a stricter mid-longitudinal arch angle cut-off was applied (4). Foot health surveys in nursing students show that over 90% report some form of foot discomfort or pathology, and foot and ankle musculoskeletal disorders limit work activities in about one in six nurses, suggesting that structural conditions such as pes planus may be clinically relevant in this group (7-9). Direct prevalence estimates of flat foot in nursing students are, however, sparse and represent an important evidence gap.

Assessment Tools for Flat Foot and Function

Structural and Postural Measures

A range of clinical and footprint-based tools has been used to classify flat foot and quantify severity in epidemiological and clinical studies (1-3,4,5).

Arch Index (AI): The AI is derived from static footprints as the ratio of midfoot to total footprint area and enables inexpensive classification of high, normal, and low arches, making it suitable for large student cohorts (2)(3).

Navicular Drop Test (NDT): The NDT quantifies the difference in navicular tuberosity height between subtalar neutral in sitting and relaxed standing, with larger "drop" indicating increased pronation and medial arch collapse; it is widely used as a simple proxy for dynamic arch behavior (4)(5)(6).

Foot Posture Index-6 (FPI-6): The FPI-6 is a validated, multiplanar observational scale that scores six criteria (talar head palpation, malleolar curvature, calcaneal frontal plane position, talonavicular bulging, medial longitudinal arch congruence, and forefoot–rearfoot alignment). It demonstrates good intra-rater reliability and moderate diagnostic accuracy compared with radiographic measures and has been applied to young adults in community and clinical settings (3-8).

The choice and cut-off values of these tools profoundly influence prevalence estimates, and studies relying on a single measure may over- or under-estimate the true burden of functionally significant pes planus. Combining footprint indices, NDT, and FPI-6 provides a more comprehensive assessment of static morphology, dynamic pronation, and overall posture (4-10).

Functional and HRQoL Measures

To capture impact beyond morphology, several foot-specific and generic HRQoL instruments have been used.

Foot Function Index–Revised (FFI-R): The FFI-R assesses pain, disability, activity limitation, and social impact related to foot problems and has been used to quantify HRQoL in adults with flat feet aged 20–40 years (1-3).

Foot Health Status Questionnaire (FHSQ): The FHSQ evaluates foot pain, function, general foot health, and footwear, and has demonstrated sensitivity to differences in people with and without foot deformities (6,7,10,11).

SF-36 and Related Generic Instruments: The SF-36 provides physical and mental component summary scores and eight subscale scores and has been used in flat-foot surgical cohorts and university students to capture broader health impacts (4,9-12).

In adults with flat feet, FFI-R and FHSQ domains for pain, activity limitation, and social participation are significantly worse than in individuals without pes planus, while SF-36 may show more modest differences, indicating that foot-specific tools are more sensitive to local pathology (6,7,10-12). Among university students, foot problems are associated with lower general foot health and footwear scores and reduced overall health and vitality compared with physically active peers.

Functional Implications of Flat Foot

Altered foot posture in pes planus affects lower-limb biomechanics and can impair functional performance in daily and athletic activities. Excessive pronation and arch collapse shift plantar loads medially, increase midfoot and forefoot stress, and modify kinematics at the ankle, knee, and hip, contributing to pain, fatigue, and overuse injuries (3-10). In observational and interventional studies, greater navicular drop and more pronated FPI-6 scores correlate with poorer dynamic balance, increased risk of ankle instability, and reduced performance on hop and agility tests.

In adults aged 20–40 years with flexible flat foot, pain is commonly reported on uneven ground, during fast walking and running, and when maintaining balance, and these functional limitations are reflected in elevated FFI-R pain and activity scores (2-5). Among medical students, those classified as flat foot

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demonstrate higher navicular drop and more pronated arch indices, coupled with increased reports of discomfort during prolonged standing, though formal performance-based metrics are less consistently reported (2). For nursing staff, foot and ankle musculoskeletal disorders are associated with reduced work productivity and functional limitations, implying similar risks for nursing students during intensive clinical postings (7-9).

Quality-of-Life Impact

HRQoL is increasingly recognised as an essential outcome in flat-foot research, especially in otherwise healthy young adults. Quality-of-life studies in adults with flat feet reveal significantly worse FFI-R scores for pain, activity limitation, and social domains, with frequent complaints of difficulty walking on uneven surfaces, walking fast, running, maintaining balance, and cosmetic concerns. Participants also report reduced participation in leisure activities and sports, particularly when symptoms are moderate to severe (2,10-12).

In university students, poorer foot health (measured by FHSQ and related tools) is associated with lower overall health and vitality, even when absolute HRQoL levels remain relatively high compared with older populations (9)(10)(12). Surgical cohorts of young adults treated for severe flat foot demonstrate persistent HRQoL deficits compared with healthy controls, despite postoperative improvement, suggesting that pes planus can impart a lasting burden on physical and psychosocial well-being (4,9,10,12). For medical and nursing students, the interplay between foot pain, fatigue, reduced physical activity, and academic and clinical demands may further compound HRQoL impact, though direct evidence in these specific groups is sparse.

Therapeutic Interventions: Exercises and Orthoses

Conservative management is the mainstay for flexible flat foot, with interventions targeting symptom relief, structural support, and neuromuscular control. A recent systematic review of flatfoot deformity from exercise to therapeutic interventions concluded that corrective exercises and orthoses can meaningfully improve arch shape and function and reduce pain (3,4,13-15). Exercise therapies encompass intrinsic and extrinsic foot-muscle strengthening, calf and hamstring stretching, balance and proprioceptive training, and hip and core strengthening, often delivered as "comprehensive reinforcement" programmes. Network meta-analysis suggests that combinations of orthoses with stretching and progressive resistive training of tibialis posterior and lower limb musculature may be particularly effective in improving foot function indices (13-15).

Foot orthoses and insoles redistribute plantar pressures, support the medial arch, and can reduce pain and fatigue during standing and walking, although long-term structural effects remain debated (2,7-9,14,15). For medical and nursing students, appropriately prescribed insoles and structured exercise programmes could reduce discomfort during prolonged ward duties, enhance tolerance for clinical work, and potentially reduce absenteeism, but formal trials in this population are lacking.

Yoga-Based Interventions for Flat Foot
Mechanistic Rationale

Yoga-based interventions provide a culturally congruent, low-cost adjunct to conventional exercise therapy, emphasising alignment, intrinsic muscle activation, and balance. Yoga-therapy approaches to flat feet emphasise grounding the three key foot contact points (beneath the hallux, lateral forefoot, and heel) and gently lifting the medial arch, thereby engaging intrinsic plantar muscles and tibialis posterior while promoting neutral alignment of the knee and hip. Standing asanas such as *Tadasana, Virabhadrasana I/II, Trikonasana,* and *Utkatasana* are often used as "laboratories" for retraining foot posture in weight-bearing (16-21).

Although direct clinical trials of yoga for flat feet are limited, somatic and therapeutic yoga programmes in other populations have improved balance, functional gait, and HRQoL, supporting the concept that yoga-based movement can enhance neuromuscular control and perceived function. Given that exercise therapies for flexible flat foot already incorporate similar components (stretching, strengthening, balance training), integrating yoga principles may provide an accessible route for students to maintain regular practice.

Practical Elements for Students

For medical and nursing students, yoga can be packaged into brief, supervised sessions that integrate seamlessly into institutional wellness programmes. Suggested components include:

- **Foot-core activation drills** (toe spreading, towel curls, banded inversion/eversion) integrated into mindful warm-up (22-24).
- **Alignment-focused standing asanas** with explicit foot cues to correct pronation and promote medial arch lift (18,19,21).
- **Calf and Achilles stretches** (e.g. *Adho Mukha Svanasana, Parsvottanasana*) and single-leg balance poses (*Vrksasana*) to improve flexibility and postural stability (17,18,20).

Although current evidence is primarily experiential and based on expert opinion, such programmes are low-risk, potentially beneficial, and easily evaluated in institutional research using objective (NDT, FPI-6, Arch Index) and subjective (FFI-R, FHSQ, SF-36) outcomes (3,6,9-11).

Ayurvedic Perspectives and Interventions

In Ayurveda, chronic heel and plantar pain are commonly described under entities such as *vatakantaka and pada shula*, attributed to vitiated *vata dosha* affecting the heel and plantar fascia. While structural pes planus per se is not explicitly categorised, the symptomatic overlap with plantar fasciitis and mechanical heel pain renders Ayurvedic management concepts relevant to symptomatic flat feet (25).

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Case reports and small clinical series document substantial pain relief with therapies such as *Raktamokshana* (local bloodletting) and *Agnikarma* (therapeutic cauterisation) in vatakantaka, often accompanied by improved functional ability. More broadly, Ayurvedic management of plantar fasciitis includes local *abhyanga* (oil massage), *swedana* (fomentation), *avagaha* (herbal foot soaks), and internal medications targeting vata and inflammatory processes (25-30).

For young adults with flat feet, these modalities are best conceptualised as adjuncts aimed at pain relief and improved tolerance for standing and walking rather than structural correction of the arch. By reducing plantar pain and stiffness, they may enable better participation in exercise and yoga programmes, thereby indirectly contributing to improved function and HRQoL(25,26).

Implications for Medical and Nursing Students

Medical and nursing students face prolonged standing, heavy clinical workloads, and often suboptimal footwear, all of which may exacerbate flat-foot–related symptoms. Evidence that higher BMI and flat foot co-occur in medical students underscores the need for early identification and counselling on weight management, footwear, and activity (7-12).

An integrative model for this population could include routine screening using FPI-6, NDT, and simple footprint indices at entry into training; brief educational sessions on foot health and footwear; and referral pathways to physiotherapy, yoga-based exercise programmes, and, where culturally appropriate, Ayurvedic pain-relief therapies. Institutional studies could compare standard advice with structured exercise plus yoga (with or without adjunct Ayurvedic local therapy) in students with flexible pes planus, tracking changes in foot posture measures, pain, function, and HRQoL. Such research would provide much-needed data to guide policy and practice in student wellness (3,4,7,31-36).

Limitations of Current Evidence

The existing literature is limited by heterogeneity in diagnostic criteria, reliance on cross-sectional designs, and underrepresentation of nursing and medical students as distinct populations. Many studies rely on a single structural measure and do not integrate multiplanar or dynamic assessments such as FPI-6 or gait analysis (3-5,7-11,32-36).

HRQoL outcomes are often captured with generic instruments that may not be sensitive to foot-specific impacts, and few studies examine longitudinal trajectories as students' progress through more demanding clinical postings. Evidence for yoga and Ayurvedic interventions in pes planus is largely extrapolated from general exercise science, musculoskeletal conditions, or plantar fasciitis case series rather than robust randomized trials in flat-footed young adults (3,4,7,26,32-36).

Conclusions

Flat foot is prevalent among young adults and present at meaningful rates in medical students, with likely similar or greater burdens among nursing students and other health-professions trainees. When symptomatic, pes planus is associated with pain, functional limitation, and reduced foot-related quality of life, with validated tools such as FPI-6, NDT, Arch Index, FFI-R, FHSQ, and SF-36 enabling multidimensional assessment (2-12). Conservative management centered on exercise-based rehabilitation and orthoses is effective in improving function, and integrative approaches involving yoga-based programmes and Ayurvedic local therapies offer culturally congruent adjuncts that warrant rigorous evaluation in medical and nursing students (3,7,13-15,25,26). There is a clear opportunity for longitudinal, multicenter studies to define burden, optimise screening, and test integrative interventions, supporting sustainable foot health and quality of life in future healthcare providers (2-15,25,26,38).

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