JMSR
Journal of Medical and Surgical Research

Research Article

ISSN: 2351-8200

JMSR 2026 Vol XIII. n 1: 12..-12..

# FOOT HEALTH ASSESSMENT IN PEDIATRIC AND ADOLESCENT POPULATION WITH DISABILITIES IN MOROCCO: A CROSS-SECTIONAL STUDY

Marta Grela-Fariña, Cristina González-Martin, Sonia Pertega-Diaz, Rocio Seijo-Bestilleiro, Vanesa Balboa-Barreiro, MT Garcia-Rodriguez

Universidade da Coruña, Rheumatology and Health Research Group, Department of Health Sciences, Faculty of Nursing and Podiatry, Esteiro; Instituto de Investigación Biomédica de A Coruña (INIBIC), Nursing and Health Care Research Group, Spain.

**Corresponding author:** Cristina González-Martin, **Affiliation:** Universidade da Coruña, Rheumatology and Health Research Group, Department of Health Sciences, Faculty of Nursing and Podiatry, Esteiro; Instituto de Investigación Biomédica de A Coruña, Nursing and Health Care Research Group, Spain. E-mail: Cristina.gmartin@udc.es

Published *in* March 2026

## Abstract

**Purpose:** Determine the prevalence of podiatric pathology in pediatric and adolescent populations with disabilities in Morocco and its impact on their quality of life, considering age and sex. **Matherial and Methods:** Observational prevalence study was conducted at the "Complexe Regionale des Personnes en Situation d´Handicap" in Azrou, Morocco, included 102 pediatric and adolescent populations with functional diversity. Podiatric conditions examined were first radius alterations(hallux valgus, limitus, rigidus, extensus, flexus), finger deformities(claw, mallet, hammer toes), rearfoot alterations (Sever's disease, Haglund deformity, Achilles tendon retraction), foot position (Foot Posture Index), structural alterations(equine, talus, clubfoot), plantar footprint, and quality of life(Foot Health Status Questionnaire). **Results:** The mean age was 8.5 years (40.2% females), with neurological disease being the most common(53.1%). Flatfoot was most prevalent among children aged 1 to 4 years(75%). Hallux valgus(18.4%) and claw toes(15.8%) were more common in the 10-19 years age group. Quality of life scores were favorable in pain, functionality, and footwear domains, but lower in general foot health, with no statistically significant differences by age or sex. **Conclusion:** Flatfoot is frequent in younger children, whereas hallux valgus predominates in older adolescents and females. General foot health decreases in older adolescents and males.

**Keywords:** Foot disorders, pediatric podiatry, functional disability, quality of life, Foot Health Status Questionnaire, Foot Posture Index, Morocco.

## Introduction

Podiatric pathology in children has been widely described in European literature. Among the pathologies studied in this population are dermal alterations or superficial onychodystrophies [1-2], forefoot alterations, such as hallux valgus [3], and infectious alterations [4-5]. Several prevalence studies of podiatric pathology and biomechanical studies in the pediatric population have been carried out [6-8].

In the last 25 years, the overall progress in healthcare worldwide has been remarkable, but not uniform. Mortality and morbidity from common pathologies in need of treatment continue to increase in the poorest regions of the world, and the reduction of mortality and disability depends, largely, on access to surgical care [9].

In podiatry, as in other health disciplines, it is essential to treat most conditions as early as possible; as the prognosis will depend on how early, diagnosis and treatment are made. Most of the disorders seen in children's feet can be corrected, and the earlier treatment is started, the more effective and faster it will be, as the percentage of cartilage is greater [10].

Throughout history, there is a large literature on podiatric pathology in the pediatric population, and it is a common subject of study in the European Union [11]. However, the published literature on this subject is very limited.

In order to obtain an overview of previous research conducted in this continent, a search was conducted in several databases to identify studies on the occurrence or incidence rate of foot pathologies, as well as research on biomechanical alterations or functionality

of the foot in the Moroccan pediatric population. As a neighboring country of Spain and a bridge between Europe and North Africa, the geographical proximity of Morocco makes it a relevant context for comparison. However, despite being only 14.4 km away at its narrowest point, no studies on the subject were found. The only available evidence consists of studies focused on onychomycotic and diabetic foot pathology [12].

One of the persistent structural problems in Morocco is the social exclusion of people with functional diversity. This exclusion significantly contributes to the inequalities and difficulties these individuals face in Moroccan society, limiting their access to essential opportunities and resources [13].

The International Classification of Functioning, Disability and Health (ICF) [14] defines disability as a generic term that encompasses impairments, activity limitations and participation restrictions. Disability is understood as the interaction between people with a disease and personal and environmental factors.

It is estimated that some form of functional diversity [14] affects more than one billion people, or 15% of the world's population.

From a podiatric point of view, it is difficult to determine precisely whether the incidence and prevalence of foot pathology is higher in individuals with functional diversity. However, gaining a better understanding of this relationship could facilitate a more targeted and effective allocation of healthcare resources. Identifying the magnitude of the problem would allow for more specialized training of healthcare professionals, the establishment of podiatric health promotion and prevention programs by the relevant health authorities, and the provision of valuable guidance for future research efforts.

The objective of this study was to analyze podiatric characteristics and foot health–related quality of life in pediatric and adolescent populations in Morocco with and without neurological disease, and to examine whether neurological impairment is associated with specific foot deformities or biomechanical alterations.

## Materials and Methods

A descriptive observational study of prevalence was conducted at the "Complexe Regionale des Personnes en Situation d'Handicap" (CRPSH) located in the city of Azrou. Morocco. This is a center specialized in physical and cognitive therapy for pediatric and adolescent populations with disabilities. Participants were voluntarily recruited.

A total of 102 participants were enrolled between July 2020 and 2022. This sample size allowed us to estimate the prevalence of podiatric pathology with a 95% confidence level ($\alpha = 0.05$) and a precision of ±10%, accounting for an expected 5% loss.

Inclusion and exclusion criteria

The study population comprised all the pediatric and adolescent populations between 1 and 19 years of age who attended the CRPSH during the study period and who gave their consent to participate in the study (participants or legal guardians).

Participants with neurological conditions precluding upright posture were excluded. All subjects were contacted one week before data collection to explain the study in detail and to sign the informed consent form.

### Variables studied

Participants were identified with a code, thus maintaining the confidentiality of their personal data. To obtain the necessary information for the study, a clinical examination was conducted in unloading and loading, in dynamic and static, to determine the podiatric pathology. Additionally, a personal interview with the patient or his or her legal representative was carried out, along with a quality of life questionnaire and a physical examination. Based on this, the following variables were collected:

- Sociodemographic characteristics: age, sex.
- Anthropometric variables: weight, height, body mass index (BMI), foot length, foot width, respiratory diseases, neurological diseases (Down's syndrome, autism, cerebral palsy, developmental delay), biomechanical alterations.
- Podiatry pathology: first radius disorders (hallux valgus according to the Manchester's scale, hallux limitus by Danamberg test [15], hallux rigidus, hallux extensus. flexus), toe deformities (claw toe, hammer toe, mallet toe), hindfoot disorders (Sever's disease, Haglund's deformity, Achilles tendon retraction), foot position according to the Foot Posture Index (FPI) [16], structural disorders (clubfoot, talus). The digital and metatarsal formula of the foot was also collected.
- The remaining alterations were determined by clinical diagnosis, which allows for a comprehensive and detailed assessment of the condition of the feet, crucial to properly identify the various podiatric pathologies. This assessment includes observation of symptoms, analysis of foot biomechanics and collection of medical history, providing a complete understanding of the patient's podiatric health.
- The Foot Posture Index (FPI) [16] and the medial arch were used to assess foot position. The latest approved version of the FPI consists of six items, each scored between -2 and +2. The foot posture index includes palpation of the talus head, curvature of the malleolus, calcaneus position, talonavicular joint protrusion, medial arch height and congruence, and forefoot abduction/adduction. All observations were made with the subjects standing on both lower limbs. Possible postures were noted as neutral, pronated and supinated.
- The measurement of the degrees of inversion and eversion of the calcaneus with respect to the ground was determined; it is not necessary to define this variable, as it will be quantified due to the number

of authors who consider a hindfoot with more than 5° of valgus in relaxed loading to be pathological.
- Structural alterations of the foot were also recorded. all following a clinical diagnosis (clubfoot. talus and clubfoot).
- Quality of life: assessed using the Foot Health Status Questionnaire (FHSQ) [17].

The Foot Health Status Questionnaire (FHSQ) [17] was used to determine quality of life. This questionnaire presents 13 questions on a Likert scale including four dimensions related to foot health: pain (4 questions), foot function (4 questions), footwear (3 questions) and general foot health (2 questions). A score from 0 to 100 is obtained for each of the domains. Zero represents the worst state of foot health and 100 the best possible state of health.

### Ethical-legal aspects

The ethical standards for the evaluation of epidemiological studies and biomedical research involving human subjects were followed. Additionally, the information regarding the identification of the participants was kept, confidential to ensure that their identities could not be revealed or disclosed, in accordance with the provisions of the Organic Law on Protection of Personal Data. The Institutional Ethics Committee has approved the study (code UCV/2019/2020/090).

### Statistical analysis

An exploratory analysis of the data was carried out. Quantitative variables are described using measures of central tendency (mean and median) and measures of dispersion (standard deviation and minimum and maximum values), while the qualitative variables are expressed as absolute and relative frequencies with their corresponding 95% confidence intervals (95% CI). In the bivariate analysis, parametric tests (T-Student or ANOVA) or non-parametric tests (Mann-Whitney or Kruskall-Wallis U) were used to compare mean values in the event that the variables do not follow a normal distribution (Kolmogorov-Smirnov test). Differences in footprint and podological pathology prevalence between age and gender groups were estimated using chi-squared or Fisher's exact statistics.
Two-tailed statistical tests were used, with p values <0.05 considered statistically significant. Statistical analysis was performed using SPSS v28.0 statistical software.

## Results

General characteristics of the studied population
A total of 102 children and adolescent were included in the study, with a mean age of 8.5 ± 4.1 years. Fifty percent were older than 8 years, and there were a slight predominance of males (59.8%). Forty-three point one percent (43.1%) of cases were found with neurological disease, the most prevalent being cerebral palsy (29.5%) and Down syndrome (20.5%). (Table I) According to the metatarsal formula, around 75% were classified as Index plus minus in both feet, and more than 50% had the Egyptian foot following the criteria of the digital formula (Table II). A flat footprint was observed in at least one out of every three records, both in the right and left foot (38.8% and 33.7% respectively). Regarding podiatric pathologies, the most frequent were Achilles tendon retraction (13.9%) and metatarsal adduct (12.9%), followed by clubfoot (9.2).
In the FHSQ questionnaire on quality of life related to the foot, scores close to 100 were obtained in the domains that refer to pain, functionality and footwear, revealing absence of pain, good functionality and ease of obtaining footwear. The lowest average score was in 'General state of health of the foot,' indicating that health perception is the main concern when respondents view their foot health negatively (77.7 ± 33.5). It should be noted that around 5% said they had severe limitations, difficulty finding footwear and poor foot health (scores 0 in the three domains of the questionnaire), while no records indicated extreme pain.

**Table I. Characteristics of the sample (n=102)**

| | Mean±SD | Median | Range |
|---|---|---|---|
| **Age** (years) | 8.5± 4.1 | 8.0 | 2-19 |
| **Weight** (kg) | 32.1±17.8 | 26.5 | 8-76 |
| **Height** (cm) | 129.5±28.7 | 129.7 | 70-197 |
| **BMI** (Kg/m2) | 17.5±4.3 | 16.6 | 10.4-31.6 |
| **Length of the LE** | | | |
| Right foot (cm) | 18.6±4.3 | 18.0 | 7-30 |
| Left foot (cm) | 17.9±4.8 | 17.0 | 2-27 |
| **Width of the LE** | | | |
| Right foot (cm) | 8.5±3.2 | 8.0 | 5-29 |
| Left foot (cm) | 8.0±1.8 | 8.0 | 5-17 |
| | **n (%)** | **95% CI** | |
| **Age** | | | |
| 1-4 years | 23 (22.5) | 13.9-31.1 | |
| 5-9 years | 40 (39.2) | 29.2-49.2 | |
| 10-19 years | 39 (38.2) | 28.3-48.1 | |
| **Sex** | | | |
| Man | 61 (59.8) | 49.8-69.8 | |

| | | |
|---|---|---|
| Woman | 41 (40.2) | 30.2-50.2 |
| **Comorbidity**: | | |
| Respiratory Disease | 1(1.0) | 0.0-5.3 |
| Neurological Disease | 44 (43.1) | 33.0-53.2 |
| Cerebral Palsy | 13 (29.5) | 5.8-19.7 |
| Down Syndrome | 9 (20.5) | 2.8-14.8 |
| Developmental delay | 7 (15.9) | 1.5-12.3 |
| Autism | 4 (9.1) | 1.1-9.7 |
| **Neurological Disease (type)** | | |
| Neurological Motor | 32 (72.7) | 58.4-84.1 |
| Developmental Disorder | 12 (27.3) | 15.9-41.6 |
| **Biomechanical alterations** | 4 (3.9) | 1.1-9.7 |
| Vertical Astragalus | 2 (50.0) | 0.2-6.9 |
| Leg amputation | 1 (25.0) | 0.0-5.3 |
| Hip Dysplasia | 1 (25.0) | 0.0-5.3 |

BMI: Body Mass Index; LE: Lower extremities

**Table II. Podological characteristics and foot-related and generic quality of life of the sample.**

| FHSQ questionnaire: | Mean±SD | Median | Range |
|---|---|---|---|
| Foot pain | 91.2±15.9 | 100.0 | 25-100 |
| Foot function | 86.5±26.8 | 100.0 | 0-100 |
| Footwear | 87.6±27.8 | 100 | 0-100 |
| General health of the foot | 77.7±33.5 | 100 | 0-100 |
| | **n (%)** | **95% CI** | |
| **Metatarsal formula RF** | | | |
| Index plus minus | 77(76.2) | 66.6-84.3 | |
| Index plus | 8(7.9) | 2.1-13.5 | |
| Index minus | 16(15.8) | 8.1-23.2 | |
| **Metatarsal formula LF** | | | |
| Index plus minus | 75(74.3) | 64.5-82.6 | |
| Index plus | 8(7.9) | 2.1-13.5 | |
| Index minus | 18(17.8) | 9.8-25.5 | |
| **Digital Formula RF** | | | |
| Square | 25(24.8) | 15.7-33.3 | |
| Greek | 22(21.8) | 13.1-30.0 | |
| Egyptian | 54(53.5) | 42.7-63.1 | |
| **Digital Formula LF** | | | |
| Square | 23(22.5) | 13.9-31.1 | |
| Greek | 27(26.5) | 17.4-35.5 | |
| Egyptian | 52(51.0) | 40.8-61.2 | |
| **Footprint RF** | | | |
| Normal | 52(61.2) | 40.8-61.2 | |
| Flat | 33(38.8) | 22.8-41.9 | |
| **Footprint LF** | | | |
| Normal | 57(66.3) | 45.7-66.0 | |
| Flat | 29(33.7) | 19.2-37.7 | |
| **RPCS RF** | | | |
| Normal | 40(45.5) | 29.2-49.2 | |
| Pronate | 40(45.5) | 29.2-49.2 | |
| Supine | 8(9.1) | 2.1-13.5 | |
| **RPCS LF** | | | |
| Normal | 40(46.0) | 29.2-49.2 | |
| Pronate | 40(46.0) | 29.2-49.2 | |
| Supine | 7(8.0) | 1.5-12.2 | |
| **Patology:** | | | |
| HV | 9(8.9) | 2.8-14.8 | |
| HE | 1(1.0) | 0.0-5.3 | |
| HL | 6(5.9) | 0.8-10.9 | |
| Claw fingers | 7(6.9) | 1.5-12.2 | |
| Infraductus | 5(5.0) | 1.6-11.1 | |
| Supraductus | 5(5.0) | 1.6-11.1 | |
| Metatarsus aductus | 13(12.9) | 5.8-19.7 | |
| Achilles Tendon Retraction | 30(29.4) | 21.2-38.7 | |
| Talo foot | 3(3.4) | 0.6-8.3 | |
| Clubfoot | 1(1.1) | 0.0-5.3 | |
| Equine foot | 29(28.4) | 20.4-37.8 | |

| | | |
|---|---|---|
| Position of the foot: | | |
| Rearfoot varus | 7(6.9) | 1.5-12.2 |
| Rearfoot valgo | 20(19.6) | 11.4-27.8 |
| **Gate:** | | |
| Tiptoe walking | 9(10.3) | 2.8-14.8 |
| Adduction | 9(10.3) | 2.8-14.8 |
| Abduction | 7(8.0) | 1.5-12.2 |

FHSQ: Foot Health status questionnaire; RF: Right foot; LF: Left foot; HV: Hallux valgus; HE: Hallux extensus; HL: Hallux limitus; RPCS: Relaxed position of the calcaneous in support

## Results according to age and sex

Regarding the podiatric characteristics according to the age group (table III), a high prevalence of flat footprint was observed in the youngest (1-4 years) and a greater presence of pathologies such as the retraction of the Achilles tendon and the equine foot (31, 7% and 25.7% respectively). Among adolescents (10-19 years), an increase in alterations was observed, with a predominance of Hallux Valgus (18.4%), claw toes (15.8%) and retraction of the Achilles tendon (13.2%) (Figure 1). Regarding the quality of life assessed by the FHSQ, marginally lower scores were observed, in all domains among adolescents (10-19 years), although this trend is not statistically significant.

**Table III. Podological characteristics of the sample according to age.**

| FHSQ questionnaire: | 1-4 years Mean±SD | 5-9 years Mean±SD | 10-19 years Mean±SD | p |
|---|---|---|---|---|
| Foot pain | 93.4±12.7 | 92.3±13.9 | 88.8±19.4 | 0.743 |
| Foot function | 87.2±26.2 | 89.6±23.6 | 82.8±30.6 | 0.590 |
| Footwear | 88.7±23.6 | 88.5±27.1 | 86.1±31.3 | 0.998 |
| General health of the foot | 81.8±34.7 | 80.3±29.8 | 72.6±36.9 | 0.512 |
| | n (%) | n (%) | n (%) | p |
| **Footprint RF** | | | | 0.003 |
| Normal | 4(25) | 21(63.6) | 27(75) | |
| Flat: | 12(75) | 12(36.4) | 9(25) | |
| Flat Grade I | 6(37.5) | 3(9.1) | 5(13.9) | |
| Grade II | 0 | 4(12.1) | 2(5.6) | |
| Grade III | 5(31.3) | 4(12.1) | 1(2.8) | |
| Grade IV | 1(6.3) | 1(3.0) | 1(2.8) | |
| **Footprint LF** | | | | 0.001 |
| Normal | 5(31.3) | 22(64.7) | 30(83.3) | |
| Flat: | 11(68.8) | 12(35.3) | 6(16.7) | |
| Flat Grade I | 5(31.3) | 3(8.8) | 4(11.1) | |
| Grade II | 0 | 4(11.8) | 1(2.8) | |
| Grade III | 5(31.3) | 4(11.8) | 1(2.8) | |
| Grade IV | 1(6.3) | 1(2.9) | 0 | |
| **RPCS RF** | | | | 0.426 |
| Normal | 4(25.0) | 18(52.9%) | 18(47.4) | |
| Pronate | 10(62.5) | 14(41.2) | 16(42.1) | |
| Supine | 2(12.5) | 2(5.9) | 4(10.5) | |
| **RPCS LF** | | | | 0.147 |
| Normal | 6(37.5) | 20(58.8) | 14(37.8) | |
| Pronate | 8(50.0) | 14(41.2) | 18(48.6) | |
| Supine | 2(12.5) | 0 | 5(13.5) | |
| **Patology:** | | | | |
| HV | 0 | 2(5.0) | 7(18.4) | 0.027 |
| HE | 1(4.3) | 0 | 0 | 0.180 |
| HL | 0 | 2(5.0) | 4(10.5) | 0.229 |
| Claw fingers | 0 | 1(2.5) | 6(15.8) | 0.023 |
| Infraductus | 1(4.3) | 1(2.5) | 3(7.9) | 0.541 |
| Supraductus | 1(4.3) | 2(5.0) | 2(5.3) | 0.987 |
| Metatarsus aductus | 3(13.0) | 6(15.0) | 4(10.5) | 0.840 |
| Achilles Tendon Retraction | 10(43.5) | 9(22.5) | 11(28.2) | 0.208 |
| Talo foot | 1(6.7) | 1(2.9) | 1(2.6) | 0.752 |
| Clubfoot | 0 | 1(2.9) | 0 | 0.465 |
| Equine foot | 12(52.2) | 8(20.0) | 9(23.1) | 0.016 |
| **Position of the foot:** | | | | |
| Rearfoot varus | 2(8.7) | 1(2.5) | 4(10.5) | 0.352 |
| Rearfoot valgo | 6(26.1) | 10(25.0) | 4(10.3) | 0.173 |

FHSQ: Foot Health status questionnaire; RF: Right foot; LF: Left foot; HV: Hallux valgus; HE: Hallux extensus; HL: Hallux limitus; RPCS: Relaxed position of the calcaneous in support
*p-values corresponding to the differences between the three age groups

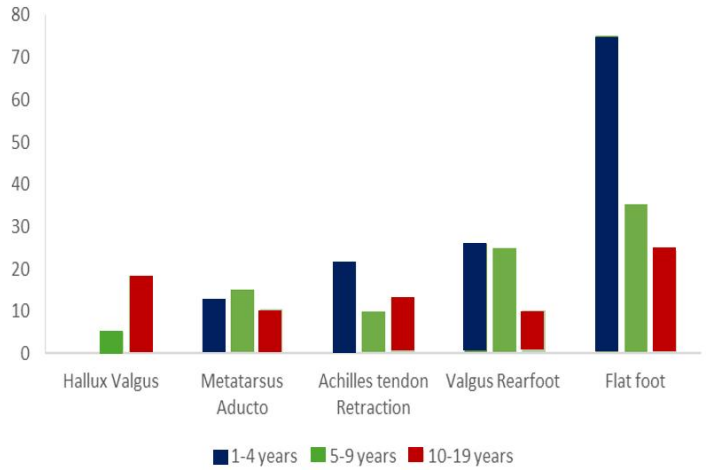


**Figure 1. Distribution of the main podiatric disorders according to age range**

Table IV shows that no significant differences were found between the groups with and without neurological disease in terms of age, sex, or the presence of biomechanical alterations. The FHSQ scores were similar in all dimensions, with no statistically significant differences. In the podiatric findings, most deformities showed a comparable distribution between groups. However, people with neurological disease more frequently presented with:Rearfoot varus, more frequent in the group with neurological disease (15.6% vs. 4.3%; p=0.048), with an OR of 2.4. Achilles tendon retraction, significantly higher in the group with neurological disease (59.4% vs. 15.7%; p<0.001), with an OR of 4 (CI 1.6-9.9).Talo foot, more common in subjects with neurological disease (18.8% vs. 4.3%; p=0.017), with an OR of 5.3. Clubfoot, also more frequent in the group with neurological disease (50% vs. 18.6%; p=0.001), with an OR of 4.5 (CI 1.8–11.5).No relevant differences were observed in the rest of the alterations evaluated.

**Table IV. Comparison of podiatric characteristics and foot health scores according to the presence of neurological disease**

| | Without neurological disease (n=58) | With neurological disease (n=44) | p | OR (CI 95%) |
|---|---|---|---|---|
| Age group, n (%) | | | 0.938 | |
| **1–4 years** | 13 (22.4) | 10 (22.7) | | 1 |
| **5–9 years** | 22 (37.9) | 18 (40.9) | | 1.1 (0.4-3) |
| **10–19 years** | 23 (39.7) | 16 (36.4) | | 0.9 (0.3-2.6) |
| Sex, n (%) | | | 0.780 | |
| **Female** | 24 (41.4) | 17 (38.6) | | 1 |
| **Male** | 34 (58.6) | 27 (61.4) | | 1.1 (0.5-2.5) |
| Biomechanical alterations, n (%) | | | 0.076 | |
| **No** | 54 (93.1) | 44 (100) | | - |
| **Yes** | 4 (6.9) | 0 (0) | | - |
| FHSQ Scores (Mean ± SD) | | | | |
| **Foot pain** | 92.13 ± 15.42 | 89.97 ± 16.85 | 0.547 | 1 (0.9-1) |
| **Foot function** | 86.07 ± 26.62 | 87.17 ± 27.65 | 0.798 | 1 (0.9-1) |
| **Footwear** | 90.95 ± 22.80 | 82.68 ± 33.86 | 0.174 | 1 (0.9-1) |
| **General foot health** | 80.60 ± 32.54 | 73.36 ± 35.02 | 0.232 | 1 (0.9-1) |
| Podological findings, n (%) | | | | |
| **Hallux valgus** | 7 (10.0) | 2 (6.5) | 0.564 | 0.4 (0.1-1.8) |
| **Hallux extensus** | 1 (1.4) | 0 (0) | 0.504 | - |
| **Hallux limitus** | 5 (7.1) | 1 (3.2) | 0.442 | 0.3 (0-2.2) |
| **Claw toes** | 7 (10.0) | 0 (0) | 0.068 | 0.5 (0.1-2.8) |
| **Infraductus toes** | 4 (5.7) | 1 (3.2) | 0.595 | 0.89 (0.1-5.6) |
| **Supraductus toes** | 3 (4.3) | 2 (6.5) | 0.643 | 0.9 (0.1-5.6) |
| **Metatarsus adductus** | 8 (11.4) | 5 (16.1) | 0.515 | 1.2 (0.4-3.8) |
| **Rearfoot varus** | 3 (4.3) | 5 (15.6) | **0.048** | 2.4 (0.5-10.4) |
| **Rearfoot valgus** | 14 (20.0) | 6 (18.8) | 0.883 | 1.8 (0.7-4.9) |
| **Achilles tendon retraction** | 11 (15.7) | 19 (59.4) | **<0.001** | 4 (1.6-9.9) |
| **Talo foot** | 3 (4.3) | 6 (18.8) | **0.017** | 5.3 (1-26.9) |
| **Equinus foot** | 13 (18.6) | 16 (50.0) | **0.001** | 4,5 (1,8-11,5) |
| **Flatfoot** | 23 (34.8) | 11 (50.0) | 0.206 | 1,8 (0,7-4,3) |

FHSQ: Foot Health status questionnaire.

## Discussion

The aim of this study was to identify the most common podiatric pathologies in pediatric and adolescent populations with functional diversity in Morocco. To our knowledge, this is the first study to analyze foot-related health and quality of life in a similar population in this country. The results show a relatively high prevalence of foot abnormalities, with one in four children having a flat foot and a moderately impaired perception of their general foot health. Differences were found between age groups, with Achilles tendon retraction being more common in children aged 1-4 years, and hallux valgus and claw toe prevalence exceeding 15% in the 10-19-year age group. On the other hand, no relevant differences were found between sexes.

### Podiatric pathologies

The causes of podiatric pathologies in childhood can be motivated, among others, by genetic factors, by a bad position of the baby in the uterus or by the type of footprint or the type of foot. In this study, we found that Achilles tendon retraction was one of the most frequent alterations, appearing in any age group, although with a higher incidence among children aged 1 to 9 years (31.7% vs. 13. 2%). The type of plantar footprint may motivate this since the incidence of flat feet was higher in younger children, motivated by the development of the plantar arch, which does not end until four years of age; hence, the younger patients have a higher incidence of flat feet and therefore a higher incidence of Achilles tendon retraction [18].

We have also found the existence of Hallux Valgus and claw toes in the adolescent population (18.4% and 15.8% respectively). Previous studies have shown that depending on the type of foot, certain alterations or pathologies are more frequent. Thus, according to Viladot. [19] the Egyptian foot is the one most exposed to injury, since it is overloaded with footwear and predisposes to the appearance of Hallux abductus valgus and Hallux rigidus. Thus, Pico et al. observed that mallet toes and claw toes were more frequent in Egyptian feet [20].These results are consistent with those obtained, since most of the population studied had an Egyptian foot and hence the presence of Hallux Valgus and claw toes has a higher incidence. Another cause of the presence of Hallux Valgus is having an associated metatarsal abduct [21] in this sense, the incidence in adolescents was only 10.5% and lower than in younger ages. Other frequent pathologies have been the clubfoot and the metatarsal adduct. The causes of the first are multifactorial, it may be due to a poor positioning in the uterus or due to neurogenic factors such as spina bifida. In any case, this type of pathology is usually more frequent in men than in women [22], which correspond to the results we have obtained where the incidence in boys versus girls was 9.8% vs. 8.1%. As for the metatarsal adduct, it is very common in newborns and seems to be caused by the pressure and positioning of the fetus in the uterus [23] being of great importance early diagnosis and treatment for its correction. In our sample. It is observed that the highest incidence of this pathology is in the age range between 5 and 9 years (15%). which may be due to the lack of adequate treatment since the study was carried out in a disadvantaged population both socially and economically.

Foot-related quality of life

In our study, the lowest FHSQ scores were found in older patients (10-19 years), probably due to foot development. After the age of 12 years, the foot reaches its final length, becoming less flexible, which can lead to more pain, worse function and poorer quality of life. Beyond the age of ten, there is a danger of decompensation of the deformity, as well as increased stiffness. Only a minority of children develop any pain (<2%) [24].

In terms of gender, we see that, in general, males have worse scores in each of the domains of the questionnaire and this is probably due to the fact that, in the study sample, males are the oldest in age.

### Study biases

The results of the study should be interpreted taking into account possible biases. First of all, there may be selection biases resulting from the inclusion criteria established, the way the sample was selected and the local nature of the study. Patients attending the "Complexe Regionale des Personnes en Situation d'Handicap", in relation to other pediatric and adolescent populations with functional diversity, come from families with more favorable socioeconomic circumstances. The population living in the more rural areas in a situation of social exclusion or of scarce resources, associated with greater comorbidity, cannot travel to the urban areas where the hospitals are located. Likewise, the poor podiatric culture may be different between the two areas, which may lead to differences in attendance at podiatric centers. The absence of similar studies in analogous pediatric populations corresponding to the same geographic region also makes it difficult to assess the external validity of the results. On the other hand, there may be information biases derived from the way in which the data were obtained, since a single observer clinically diagnosed the pathologies. We have tried to minimize these biases, as far as possible, by using validated questionnaires, calibrated instruments, training the observers and repeating the measurements in case of doubt.

Finally, the existence of possible confounding biases cannot be ruled out in relation to the analysis of differences by age or sex. However, the small sample size of the study does not allow multivariate analysis to adjust for the effect of third variables. Future studies in larger populations with a similar profile will be necessary to contrast the results obtained.

## Conclusion

This study presents the first epidemiological data on the prevalence of podiatric pathologies among pediatric and adolescent populations with functional diversity in Morocco. In addition to a high prevalence of flat feet, the most frequent podiatric conditions identified were Achilles tendon retraction and metatarsus adductus.

Both Achilles tendon retraction and metatarsus adductus were predominant across all age groups, while Hallux Valgus became more prevalent among older adolescents and females.

Participants reported generally a favorable foot health–related quality of life according to the FHSQ questionnaire, with the highest scores in the pain and footwear domains and the lowest in general foot health. Perceived foot-related quality of life slightly decreased in older adolescents and males, who showed lower scores across FHSQ domains.

These findings suggest that specific podiatric deformities, particularly Achilles tendon retraction and metatarsus adductus, may influence foot health–related quality of life in pediatric and adolescent populations with functional diversity, highlighting the importance of early screening and intervention.

### Implications for Rehabilitation

- Regular foot health assessment should be integrated into rehabilitation programs for children and adolescents with disabilities, as podiatric conditions such as flatfoot, hallux valgus, and toe deformities are frequent and may impact mobility and comfort.
- Early detection of foot deformities allows timely orthotic or therapeutic interventions that can prevent functional deterioration and improve participation in daily activities.
- Multidisciplinary collaboration among podiatrists, physiotherapists, and rehabilitation specialists is essential to address biomechanical alterations and optimize overall functional outcomes.
- The use of standardized assessment tools such as the Foot Posture Index and Foot Health Status Questionnaire may help monitor progress and guide individualized care plans.

### Study Contributions

- Provides the first epidemiological evidence on podiatric pathology in Moroccan pediatric and adolescent populations with functional diversity.
- Highlights the association between neurological impairment and specific foot deformities, such as Achilles tendon retraction and metatarsus adductus.
- Demonstrates that foot health–related quality of life remains generally good, but tends to decline with age and among males.
- Emphasizes the need for early podiatric evaluation and targeted preventive strategies to improve mobility and quality of life in this population.

**Acknowledgments:** The authors would like to thank the staff and families at the Complexe Régional des Personnes en Situation de Handicap in Azrou, Morocco, for their collaboration and support during the development of this study.

**Declaration of Conflicting Interests:**The authors declare that there is no conflict of interest regarding the publication of this article.

**Funding Statement:** This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

**Ethical Approval and Informed Consent:**The study was approved by the Ethics Committee of Valencia, Spain (code UCV/2019/2020/090). Written informed consent was obtained from all participants' legal guardians.

**Data Availability Statement:** The datasets generated and analyzed during the current study are available from the corresponding author upon reasonable request.

## References

1. Garrow AP, Silman AJ, Macfarlane GJ. The Cheshire Foot Pain and Disability Survey: a population survey assessing prevalence and associations. Pain. 2004 Jul;110(1-2):378-84. doi: 10.1016/j.pain.2004.04.019..
2. Farndon L, Barnes A, Littlewood K, Harle J, Beecroft C, Burnside J, Wheeler T, Morris S, Walters SJ. Clinical audit of core podiatry treatment in the NHS. J Foot Ankle Res. 2009 Mar 13;2:7. doi: 10.1186/1757-1146-2-7. PMID: 19284645.
3. Nix S, Smith M, Vicenzino B. Prevalence of hallux valgus in the general population: a systematic review and meta-analysis. J Foot Ankle Res. 2010 Sep 27;3:21. doi: 10.1186/1757-1146-3-21.
4. Gupta AK, Daigle D, Foley KA. The prevalence of culture-confirmed toenail onychomycosis in at-risk patient populations. J Eur Acad Dermatol Venereol. 2015 Jun; 29(6):1039-44. doi: 10.1111/jdv.12873. Epub 2014 Nov 21. Review. PubMed PMID: 25413984.
5. de Berker D. Childhood nail diseases. Dermatol Clin. 2006 Jul;24(3):355-63. doi: 10.1016/j.det.2006.03.003. PMID: 16798433.
6. VanderHave KL, Hensinger RN, King BW. Flexible cavovarus foot in pediatric and adolescent populations. Foot Ankle Clin. 2013 Dec;18(4):715-26. doi: 10.1016/j.fcl.2013.08.006. Epub 2013 Oct 5. Review. PubMed PMID: 24215835.
7. Sankar WN, Weiss J, Skaggs DL. Orthopaedic conditions in the newborn. J Am Acad Orthop Surg. 2009 Feb;17(2):112-22. doi: 10.5435/00124635-200902000-00007. PMID: 19202124.
8. Spahn G, Schiele R, Hell AK, Klinger HM, Jung R, Langlotz A. Die Prävalenz von Beschwerden und Deformierungen des Fusses bei Adoleszenten -- Ergebnisse einer Querschnittuntersuchung [The prevalence of pain and deformities in the feet of adolescents. Results of a cross-sectional study]. Z Orthop Ihre Grenzgeb. 2004 Jul-Aug;142(4):389-96. German. doi: 10.1055/s-2004-822844. PMID: 15346298.
9. Meara JG, Leather AJM, Hagander L, Alkire BC, Alonso N, Ameh EA, Bickler SW , ·Conteh L, Dare AJ , Mérisier ED , El-Halabi S, Farmer PE, Gawande A,

Gillies Rowan, Greenberg S, Grimes C E , Gruen Russell L , Ismail EA , Kamara TB et al. Global Surgery 2030: Evidence and solutions for achieving health, welfare, and economic development. Vol. 386, The Lancet. Lancet Publishing Group; 2015;386(9993):569-624.

10. Aiyer A, Hennrikus W. Foot pain in the child and adolescent. Pediatr Clin North Am. 2014 Dec; 61(6):1185-205. doi: 10.1016/j.pcl.2014.08.005. Epub 2014 Sep 12. Review. PubMed PMID: 25439019.
11. Rezel-Potts E., Bowen C., Dunn KM,Jones CI. , Gulliford MC ,Morrison SC. . Foot and ankle problems in children and young people: a population-based cohort study. Eur J Pediatr 183, 3299–3307 (2024). https://doi.org/10.1007/s00431-024-05590-8
12. Halim I, El Kadioui F, Soussi Abdallaoui M. Les onychomycoses à Casablanca (Maroc) [Onychomycosis in Casablanca (Morocco)]. J Mycol Med. 2013 Mar;23(1):9-14. French. doi: 10.1016/j.mycmed.2012.10.002. Epub 2012 Dec 31. PMID: 23287730.
13. Martínez-Leal R, Salvador-Carulla L, Gutiérrez-Colosía MR, Nadal M, Novell-Alsina R, Martorell A, Aguilera-Inés F. Health among persons with intellectual disability in Spain: The European POMONA-II study. Rev Neurol. 2011;53(7):406-14
14. Jiménez Buñuales M.ª Teresa, González Diego Paulino, Martín Moreno José M.ª. La clasificación internacional del funcionamiento de la discapacidad y de la salud (CIF) 2001. Rev. Esp. Salud Publica [Internet]. 2002 Ago [citado 2019 Jun 16] ; 76( 4 ): 271- 279.
15. Dananberg HJ. Gait style as an etiology to chronic postural pain. Part I. Functional hallux limitus. J Am Podiatr Med Assoc. 1993 Aug;83(8):433-41. doi: 10.7547/87507315-83-8-433. PMID: 8366431.
16. Redmond AC, Crane YZ, Menz HB. Normative values for the Foot Posture Index. J Foot Ankle Res. 2008; 1(1):6. Published 2008 Jul 31. Doi: 10.1186/1757-1146-1-6.
17. Riskowski JL, Hagedorn TJ, Hannan MT. Measures of foot function, foot health, and foot pain: American Academy of Orthopedic Surgeons Lower Limb Outcomes Assessment: Foot and Ankle Module (AAOS-FAM), Bristol Foot Score (BFS), Revised Foot Function Index (FFI-R), Foot Health Status Questionnaire (FHSQ), Manchester Foot Pain and Disability Index (MFPDI), Podiatric Health Questionnaire (PHQ), and Rowan Foot Pain Assessment (ROFPAQ). Arthritis Care Res (Hoboken). 2011; 63 Suppl 11(0 11):S229–S239. doi:10.1002/acr.20554.
18. Echarri J.J., Forriol F., Desarrollo de la morfología de la huella plantar en niños congoleños y su relación con el uso de calzado. Revista Española de Cirugía Ortopédica y Traumatología, Volume 47, Issue 6,2003, Pages 395-399,ISSN 1888-4415. https://doi.org/10.1016/S1888-4415(03)76143-8.
19. Viladot A. Patología del antepié. Barcelona. Springer. 2001. Available from: https://books.google.com
20. Pérez-Pico AM; Castaño-Justo B, Mayordomo-Acevedo R. Digital formula is conditioned by deformities and footwear character- istics in older people. A comparison between general population and population with psychiatric disorders. Eur J Anat, 22 (1): 51-58 (2018).
21. Ferrari J, Malone-Lee J. A radiographic study of the relationship between metatarsus adductus and hallux valgus. J Foot Ankle Surg. 2003 Jan-Feb;42(1):9-14. doi: 10.1053/jfas.2003.50006. PMID: 12567361.
22. Moya S. Malformaciones congénitas del pie y pie plano. Rev Chil Pediatr. 2000;71(3):243-245. http://dx.doi.org/10.4067/S0370-41062000000300011
23. Behrman RE, Kliegman RM, Jenson HB, editors. Nelson Textbook of Pediatrics. 17th ed. Philadelphia: Saunders; 2004. Available from: Google Books
24. Hell AK, Döderlein L, Eberhardt O, Hösl M, von Kalle T, Mecher F, Simon A, Stinus H, Wilken B, Wirth T. S2-Leitlinie: der kindliche Knick-Senk-Fuß [S2-Guideline: Pediatric Flat Foot]. Z Orthop Unfall. 2018 Jun;156(3):306-315. German. doi: 10.1055/s-0044-101066. Epub 2018 Apr 9. PMID: 29631308.