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Assessing the Impact of Crohn's Disease on Foot Health-Related Quality of Life: A Case–Control Study

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ABSTRACT

Crohn's disease (CD) is primarily characterised by chronic gastrointestinal inflammation; however, its systemic nature frequently leads to musculoskeletal complications. Among these, clinically significant foot pathologies can impair mobility and negatively impact patients' overall quality of life. Despite their relevance, the specific influence of podiatric manifestations on health-related quality of life in individuals with CD remains insufficiently explored, underscoring a critical gap in current disease management. The aim of this study was to assess the extent to which foot-related health issues affect the quality of life in people living with CD compared with a healthy population. This multicenter observational case–control study was conducted across five provinces in southern Spain—Málaga, Granada, Jaén, Sevilla, and Cádiz—between January 2024 and February 2025. The study included 110 participants, evenly divided between individuals diagnosed with CD ($n = 55$) and healthy controls ($n = 55$), matched for age, sex, and body mass index. All participants completed the validated Spanish version of the Foot Health Status Questionnaire (SFHSQ), which assesses four foot-specific domains and four general health domains. Due to the non-normal distribution of the data, non-parametric statistical methods were applied, with the Mann–Whitney U test used to evaluate differences between groups. Participants with CD exhibited significantly lower scores across all domains of the SFHSQ, with the exception of the Footwear domain, which showed no statistically significant difference ($p = 0.406$). Compared with healthy controls, individuals in the CD group reported greater impairments in foot pain, foot function, general foot health, and in broader health-related domains including general health, physical activity, and social capacity ($p < 0.01$ for all). CD significantly compromises foot-related QoL. These results highlight the need to include podiatric evaluations as part of comprehensive, multidisciplinary care approaches aimed at enhancing mobility, functional capacity, and general well-being in affected individuals.

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Summary

- Crohn's disease significantly reduces foot health-related quality of life, with marked impairments in pain, function, and general health compared to healthy controls.
- Routine podiatric evaluation should be integrated into multidisciplinary care to prevent disability and improve overall well-being in Crohn's disease patients.
- Higher vitality scores in Crohn's disease patients suggest adaptive coping mechanisms that require further research.

1 | Introduction

Crohn's disease (CD) is a chronic inflammatory disorder of the gastrointestinal tract that typically involves the ileum and produces deep, transmural inflammation along its walls [1–3]. Its aetiology is multifactorial, involving genetic predisposition, immunological dysregulation, environmental influences, and gut microbiota dysbiosis [4, 5], with contributing factors including tobacco use, prolonged antibiotic therapy, and nonsteroidal anti-inflammatory drug (NSAID) consumption [1, 2, 6].

CD typically presents with two incidence peaks, one in the second and another in the fourth decade of life, although some epidemiological studies suggest a predominance during the third decade. Regarding sex distribution, CD shows a relatively equal prevalence between males and females in adult populations, though this balance differs in paediatric cases [1, 7].

The hallmark clinical manifestations include diarrhoea, abdominal pain, unintended weight loss, and generalised fatigue. Beyond gastrointestinal symptoms, Crohn's disease (CD) often presents with extraintestinal manifestations (EIMs), such as arthropathy or cutaneous and ocular involvement. Although EIMs can potentially affect almost any organ system, musculoskeletal manifestations are the most frequent, observed in 6%–47% of cases and affecting 24% of patients with inflammatory bowel disease [1, 8].

Musculoskeletal EIMs are broadly classified into peripheral and axial arthropathies. Peripheral arthropathy is typically seronegative and non-destructive, affecting 10%–20% of patients. It is subdivided into pauciarticular (Type I), involving fewer than five large joints (e.g., knees, ankles) and correlating with disease activity; and polyarticular (Type II), which affects more than five small joints—most commonly the metacarpophalangeal joints—and is independent of disease activity, sometimes even preceding the diagnosis of CD [9, 10].

Epidemiological data indicate a rising global prevalence of CD over the past decades, both in developed and developing regions. Countries exhibiting the top incidence levels consist of Australia (approximately 29 cases per 100 000 inhabitants), Canada (around 20 per 100 000), New Zealand (close to 16.5 per 100 000), and regions of Northern Europe (about 10.6 per 100 000). In the European context, CD cases have become more prevalent, with

incidence increasing from 1 per 100 000 per year in 1962 to 6.3 per 100 000 in 2010 [2, 3, 11, 12]. In Southern Spain alone, the cumulative incidence is estimated at 16 per 100 000 inhabitants annually, surpassing previously reported national and Western European averages [13].

From an economic perspective, Crohn's disease (CD) represents a considerable burden on European healthcare systems. Before the introduction of biologic therapies, annual treatment costs were approximately £3416 in the United Kingdom and €3171 in Germany, with medications accounting for up to 85% of expenses. Hospital admissions and surgeries comprised more than half of total healthcare costs, with inpatient care up to 10 times more expensive than outpatient services. The EC-IBD multicenter project reported an average yearly cost of €2548 per patient across eight European countries and Israel, ranging from €888 in Norway to €3705 in Denmark, with a notable cost peak in the first year after diagnosis. Overall, CD generates an estimated direct economic impact of €4681–€5596 million annually in Europe, while in Spain, yearly costs per patient range between €1800 and €8600 depending on disease severity and treatment [7, 14].

According to the World Health Organization, health-related quality of life (HRQoL) encompasses physical, mental, and social well-being beyond the absence of disease [15]. Enteropathic arthritis in IBD, particularly Type I, often affects the ankle and foot joints, producing pain, swelling, and stiffness that impair gait and load-bearing. When recurrent, as in Type II arthritis, it may cause biomechanical alterations, enthesitis, and deformities that further limit mobility and HRQoL. Effective management requires multidisciplinary collaboration among rheumatologists, gastroenterologists, and foot health specialists [8–10, 16]. However, the specific contribution of foot health to the overall well-being of individuals with CD remains poorly understood. Given that the feet are essential for mobility, posture, and independence in daily life, evaluating their condition may provide valuable insights into the functional burden and quality of life of patients with CD.

Therefore, this study aims to determine the extent to which foot-related health issues affect quality of life in people living with CD compared to a healthy population.

2 | Material and Methods

2.1 | Sample Design

A case-control observational design was employed. The study involved a total of 110 participants, equally divided into two cohorts: 55 individuals clinically diagnosed with Crohn's disease (CD) and 55 healthy controls. Participants were selected using a consecutive, non-random sampling method between January 2024 and February 2025. Participants with CD were recruited via regional patient organisations affiliated with the Spanish Association for Crohn's Disease and Ulcerative Colitis (ACCU) across five Andalusian provinces (Málaga, Granada, Jaén, Sevilla, and Cádiz). The control group comprised volunteers from primary care centers and family members residing in the same areas.

Participants were eligible if they were 18 years of age or older, able to walk independently, and willing to provide written informed consent prior to enrollment. For the CD group, a confirmed diagnosis established by a gastroenterology specialist was required. All participants were required to be capable of understanding and completing the Spanish Foot Health Status Questionnaire (SFHSQ) independently.

Exclusion criteria included a history of lower-limb surgery or trauma, cognitive impairment that could hinder the understanding or completion of the questionnaire, or, for controls, a diagnosis of any autoimmune or inflammatory disease. Individuals who were unable to independently perform activities of daily living were also excluded to ensure consistency in functional assessment between groups.

The methodological and reporting processes of the present study were guided by the STROBE framework for enhancing transparency in observational study design [17].

2.2 | Sample Size Calculation

To ensure adequate statistical power for group comparisons, the required sample size was estimated using G*Power software (version 3.1.9.3; Heinrich Heine University, Düsseldorf, Germany). The analysis was based on an independent samples *t*-test (two-tailed), assuming a moderate effect size (Cohen's $d=0.5$), a significance level of 0.05, and a power of 70% to detect meaningful differences while minimizing Type I and Type II errors. A balanced design with equal numbers in each group was considered, resulting in a minimum requirement of 78 participants (39 per group). Ultimately, 110 individuals were recruited, exceeding the minimum threshold and thereby enhancing the robustness and reliability of the statistical analyses.

2.3 | Procedure

To explore the potential link between CD and foot health-related quality of life, we collected sociodemographic data including age, sex, anthropometric measurements (weight, height, and body mass index [BMI]), employment status, educational attainment, and marital status.

Podiatric and general health were assessed using the Spanish Foot Health Status Questionnaire (SFHSQ) [18, 19], a self-reported tool designed to assess foot-related health-related quality of life. The instrument has demonstrated strong psychometric properties and is divided into three main sections. The first comprises 13 items across four specific domains: foot pain, functionality, footwear, and perceived overall foot health. This section shows strong internal consistency (Cronbach's alpha ranging from 0.89 to 0.95) and excellent reproducibility, with intraclass correlation coefficients between 0.74 and 0.92. A second section measures broader health dimensions using four subscales: general health, physical activity, social function, and vitality. The final segment includes items on socioeconomic background, comorbidities, healthcare usage, satisfaction levels,

and clinical history. Previous research has identified the SFHSQ as a highly suitable tool for evaluating HRQoL outcomes in individuals with chronic heel disorders [20].

The SFHSQ does not produce an overall summary score but instead generates individual results for each domain. Data were entered into version 1.03 of the SFHSQ software, which converts responses into domain scores ranging from 0 to 100. A score of 0 indicates the poorest possible health status, while 100 represents the best possible foot health. The software also provides visual representations of the domain-specific results.

2.4 | Ethical Considerations

This study was approved by the Ethics Committee for Experimental Research at the University of Málaga (reference 137-2023-H). All procedures were conducted in accordance with the ethical standards of the Declaration of Helsinki [21].

2.5 | Statistical Analysis

Descriptive statistics were calculated for all sociodemographic and SFHSQ variables. Continuous data are presented as mean, standard deviation, and range. The normality of the data was assessed using the Kolmogorov–Smirnov test, with a p value >0.05 indicating a normal distribution.

As this assumption was not met for the majority of variables, group comparisons (CD vs. control) for continuous data were performed using the non-parametric Mann–Whitney U test. This included all sociodemographic variables (age, height, weight, BMI) and all SFHSQ domains, with the exception of the footwear domain, which showed a normal distribution.

All statistical analyses were performed using SPSS Statistics software (version 29.0.1.0; IBM Corp., Armonk, NY, USA).

3 | Results

The analysis revealed that the distribution of all examined variables—including age, weight, height, and BMI—deviated from normality ($p<0.05$). The study sample ($n=110$) was evenly divided into two groups: 55 participants clinically diagnosed with CD and 55 healthy controls. Both groups were matched based on sex, age, and BMI to ensure comparability.

As detailed in Table 1, no statistically significant differences were found between the groups ($p>0.05$). Table 1 presents the complete summary of demographic and anthropometric data for the full sample.

The Mann–Whitney U test revealed that the CD cohort scored significantly lower than the control group across almost all domains of the Spanish Foot Health Status Questionnaire (SFHSQ) ($p<0.001$ for all). The single exception was the Footwear domain, where no significant difference was observed ($p=0.406$) (Table 2).

TABLE 1 | Descriptive data.

		Total (<i>n</i> = 110) mean ± SD (Min–Max)	CD (<i>n</i> = 55) mean ± SD (Min–Max)	Control (<i>n</i> = 55) mean ± SD (Min–Max)	<i>p</i>
Age (years)		46.94 ± 13.78 (18–76)	47.24 ± 14.02 (18–76)	46.64 ± 14.02 (23–67)	0.905 ^a
Weight (kg)		72.51 ± 15.25 (42.0–115.0)	72.31 ± 16.41 (48.0–115.0)	72.71 ± 14.15 (42.00–104.00)	0.702 ^a
Height (m)		1.67 ± 0.08 (1.48–1.90)	1.66 ± 0.08 (1.50–1.85)	1.67 ± 0.09 (1.48–1.90)	0.299 ^a
BMI (Kg/m ²)		25.89 ± 4.75 (16.40–38.87)	26.09 ± 5.01 (18.06–38.87)	25.69 ± 4.52 (16.40–38.67)	0.758 ^a
Sex (%)	Male	38 (34.5%)	19 (17.3%)	19 (17.3%)	1 ^b
	Female	72 (65.5%)	36 (32.7%)	36 (32.7%)	
Time since CD diagnosis (years)		N/A	14.52 ± 13.96 (0.25–55.0)	N/A	—

Note: In all analyses, $p < 0.05$ (95% confidence interval) was considered statistically significant.

Abbreviations: BMI, body mass index; CD, Crohn's disease; N/A, Not applicable; SD, standard deviation.

^aThe Mann–Whitney *U* test was applied.

^bFrequencies (percentages) and chi-square (χ^2) test were employed.

TABLE 2 | Relationship between SFHSQ domains in CD patients and healthy subjects.

Outcome measurements		Total group mean ± SD (Min–Max) <i>n</i> = 110	CD group mean ± SD (Min–Max) <i>n</i> = 55	Control group mean ± SD (Min– Max) <i>n</i> = 55	<i>p</i>
SFHSQ domains	Foot pain	72.54 ± 25.99 (0–100)	62.67 ± 25.84 (0–100)	82.42 ± 22.30 (16.87–100)	< 0.01 ^a
	Foot function	76.25 ± 28.78 (0–100)	66.36 ± 30.72 (6.25–100)	86.13 ± 23.00 (0–100)	< 0.01 ^a
	Footwear	44.09 ± 28.78 (0–100)	41.21 ± 33.19 (0–100)	46.96 ± 35.40 (0–100)	0.406 ^a
	General foot health	58.06 ± 28.63 (0–100)	47.22 ± 28.63 (0–100)	68.90 ± 24.41 (25.00–100)	< 0.01 ^a
	General health	52.81 ± 30.32 (0–100)	33.72 ± 24.49 (0–90)	72.36 ± 21.85 (20.00–100)	< 0.01 ^a
	Physical activity	80.35 ± 22.12 (5.55–100)	69.39 ± 21.80 (5.55–100)	91.31 ± 16.38 (11.11–100)	< 0.01 ^a
	Social capacity	67.04 ± 29.89 (0–100)	52.72 ± 29.72 (0–100)	81.36 ± 22.42 (0–100)	< 0.01 ^a
	Vigour	52.67 ± 23.68 (6.25–100)	63.40 ± 23.70 (6.25–100)	41.93 ± 18.30 (6.25–100)	< 0.01 ^a

Abbreviations: CD, Crohn's disease; Frequency, percentage (%) were employed; SD, standard deviation; SFHSQ, Spanish Foot Health Status Questionnaire.

^aThe Mann–Whitney *U* test was employed.

These results indicate that CD has a substantial negative impact on foot health-related quality of life, while perceptions related to footwear remain unaffected.

4 | Discussion

This study sought to examine variations in health-related quality of life (HRQoL) associated with foot health among individuals diagnosed with Crohn's disease (CD) compared with a healthy control group within a southern Spanish population.

The current findings reveal that individuals with CD experience significantly reduced podiatric HRQoL in comparison with their healthy counterparts. In particular, significant disparities were observed in the domains of foot pain, foot function, overall foot health, general health, physical activity, and social capacity ($p < 0.01$), with consistently lower scores reported in participants diagnosed with CD.

These findings reinforce the notion that systemic manifestations of the disease—particularly extraintestinal ones—can adversely affect foot condition and compromise overall physical performance. This aligns with evidence from previous research on other chronic disorders involving joint structures, including haemophilia, multiple sclerosis, and ankylosing spondylitis, where the SFHSQ has also been applied as a valid analytical tool [22, 23].

Interestingly, the vitality domain scored higher in the CD group. This result, although unexpected, may reflect adaptive psychological responses or resilience mechanisms developed through chronic disease coping strategies. Individuals with long-standing CD often acquire behavioural and emotional adjustments that help them maintain a subjective sense of vitality despite physical limitations. Alternatively, this could indicate compensatory health behaviours—such as physical activity adapted to disease tolerance or stronger social support networks—that mitigate the perceived impact of fatigue. In the present study, no association was found between vitality scores and the time since diagnosis; however, future research should examine whether this domain is influenced

by disease activity or remission status. Longitudinal studies are warranted to clarify whether this finding represents resilience, adaptation, or a reporting bias linked to disease perception.

Several studies have highlighted that, beyond its intestinal involvement, CD can lead to musculoskeletal EIMs that affect patients' functionality, including peripheral and axial joint symptoms that may directly impact the foot [8–10, 24]. Such impairments in foot structure and functionality can hinder mobility and, consequently, diminish overall quality of life.

In the context of spondyloarthropathies, foot involvement represents a clinically significant manifestation, particularly in peripheral forms and juvenile-onset cases. Studies have shown that up to 50% of patients with spondyloarthritis exhibit foot involvement, either as an initial symptom or during the early stages of the disease. This presentation typically includes heel pain, Achilles tenosynovitis, metatarsalgia, dactylitis, and forefoot deformities, all of which are associated with substantial functional impairment, altered gait, and difficulty wearing footwear [25].

Additionally, individuals with axial spondyloarthritis often present with disturbances in posture, stability, and walking patterns, which notably affect variables such as walking velocity, stride length, and the duration of double-limb support [26]. Both animal and human studies have indicated that tarsitis and plantar enthesitis reflect not only local inflammation but also pathological ossification and bone fusion processes, potentially resulting in ankylosing tarsitis. These findings suggest that the foot is not only a peripherally affected site but may also serve as an early marker and a relevant therapeutic target in spondyloarthritis [27].

Nonetheless, there remains a scarcity of scientific studies addressing how CD affects foot-related quality of life and broader health outcomes. Within this framework, the current study provides evidence that individuals with CD exhibit a marked decline in both dimensions compared with healthy controls.

Comparable situations have been described in other chronic diseases such as ankylosing spondylitis, where, according to Cortes-Rodríguez et al., axial involvement and peripheral joint impairment also limit ambulation and reduce functional autonomy. Similarly, in the case of haemophilia, Karin Fijnvandraat et al. report that recurrent hemarthroses in the foot joints lead to structural damage, chronic pain, and a progressive decline in functional capacity [28].

Although the underlying pathophysiological mechanisms differ among these conditions, the functional and psychosocial impact appears convergent, compromising quality of life from a multidimensional perspective that includes pain, physical limitations, and emotional well-being. Therefore, it is essential to incorporate targeted foot care as an integral component of multidisciplinary management for chronic diseases with articular involvement, including CD.

Regarding the Footwear domain, no significant differences were found between the groups, and both obtained relatively low scores. This suggests that the perceived issues in this area are not directly related to Crohn's disease but may instead reflect cultural or lifestyle factors common to the studied population. Similar findings

have been reported in studies on other chronic diseases conducted in southern Spain, supporting the idea that footwear perceptions are more closely associated with shared habits than with disease-related limitations [22, 29]. Overall, these results indicate that the observed differences in this domain likely stem from sociocultural rather than pathological factors.

A key limitation of this study was the relatively small number of individuals diagnosed with CD, which may limit the generalizability of the findings. Additionally, the study did not incorporate standardised measures of disease activity, such as the Crohn's Disease Activity Index (CDAI) [30], thereby restricting the ability to establish direct associations between intestinal disease severity and its potential effects on foot function and overall health-related quality of life. Addressing these limitations in future research would enhance the robustness of the findings and improve the reliability of conclusions drawn from the instruments used to assess foot-specific quality of life in this population.

5 | Conclusions

The findings demonstrate that individuals with Crohn's disease exhibit significantly reduced scores across multiple domains of foot-related health-related quality of life, particularly those associated with foot pain, function, general health, physical activity, and social capacity. These results underscore that musculoskeletal and podiatric manifestations constitute an important yet often unrecognized component of extraintestinal involvement in Crohn's disease. Integrating routine foot health evaluations into multidisciplinary management may facilitate early identification of functional impairments, support disability prevention, and enhance overall quality of life in affected individuals.

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Ethics Statement

All procedures followed the principles of the Helsinki Declaration for good clinical practice and were previously approved by the Ethics Board for Experimental Research at the University of Málaga, located in Málaga, Spain, under the reference number 137-2023-H. The Ethics Committee for Health gave a favourable opinion on the implementation of the doctoral project and showed itself available to provide support to achieve the proposed research objectives.

Conflicts of Interest

The authors declare no conflicts of interest.

Data Availability Statement

The dataset supporting the conclusions of this article is available with the corresponding upon reasonable request.

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