

Bracing for Impact: A Survey Analysis of the Impact of Socioeconomic Factors on Brace Adherence in Clubfoot

Océane Mauffrey¹, Kevin Yu², Malvika Choudhari¹, Ashley Lynn Habig³, Alec Pugh¹, Vinay Narotam⁴

Abstract

Introduction: Clubfoot is a congenital deformity characterized by cavus deformity of the midfoot, adducts of the forefoot, and equinus and varus of the hindfoot. The Ponseti method, a series of casting and bracing protocols, has become the standard of care as a highly effective non-surgical intervention. Poor adherence with stringent brace-wearing protocols has been identified as one of the leading causes of deformity recurrence with the Ponseti method. The present study seeks to uncover the socioeconomic variables which may contribute to brace adherence.

Materials and Methods: This survey study included 219 patients and 56 responded (25.5% RR). The survey assessed zip code, annual income, number of caregivers and siblings, brace adherence, and recurrence. Adherence was measured categorically (Likert) and continuously (0–100%); recurrence was measured categorically (yes/no). A t-test was used to evaluate the relationship between adherence and deformity recurrence. All other variables were analyzed using Chi-squared and Fisher's exact.

Results: Twenty-three patients reported an annual income of \$100,000 or greater ($n = 23$), and most had received at least a college education ($n = 37$), many had graduate's degrees ($n = 20$), most reported two caregivers ($n = 44$), and one sibling ($n = 21$). Thirty-six patients reported brace wearing All of the time, and 21 patients reported their child needing to repeat serial casting or additional surgery, indicating recurrence. No significant relationship was found between brace adherence and deformity recurrence ($P > 0.05$). No significant relationship was found between annual income, number of caregivers, highest level of education, and number of siblings against brace adherence ($P > 0.05$).

Conclusion: These findings contrast with the well-documented risk of recurrence with decreased brace adherence, perhaps due to parental over-reporting of brace wearing. The expected relationship between social variables and brace adherence was also not supported potentially because of a skew in our population towards patients with higher education and income.

Keywords: Clubfoot, Social Determinants of Health, Clinical Outcomes, Brace Compliance

Introduction

Clubfoot is a congenital deformity affecting approximately 1–2/1000 live births characterized by the cavus deformity of the midfoot, adducts of the forefoot, and varus equinus of the hindfoot, hindering normal walking and potentially leading to severe disability if untreated [1]. Historically, treatment for

clubfoot involved extensive and invasive surgical interventions, which often resulted in long-term complications such as recurrence, overcorrection, stiffness, and pain [2].

The Ponseti method, developed in the 1950s by Dr. Ignacio Ponseti at the University of Iowa, revolutionized the conservative treatment of idiopathic clubfoot [2]. This method involves a series of manipulations and castings followed by a percutaneous Achilles tenotomy and bracing to maintain correction [3]. Over the past two decades, the Ponseti method has gained global acceptance due to its demonstrated efficacy, safety, and cost-effectiveness. Studies have shown that with proper application and adherence, the Ponseti method can achieve correction rates as

¹The University of North Carolina, School of Medicine, 321 S. Columbia Street, Chapel Hill, NC 27599, United States of America

²The University of North Carolina, Gillings School of Public Health 135 Dauer Drive, Chapel Hill, NC, 27599, United States of America

³The University of North Carolina, Undergraduate, Chapel Hill, NC, 27599, United State of America

⁴The University of North Carolina, Department of Orthopaedics, 130 Mason Farm Road, Chapel Hill, NC 27514, United States of America

Address of Correspondence

Dr. Océane Mauffrey,
321 S. Columbia Street, Chapel Hill, NC 27599, United States of America
E-mail: Oceane_mauffrey@med.unc.edu

Submitted Date: 11 Jan 2025, Review Date: 08 Mar 2025, Accepted Date: 10 Apr 2025 & Published Date: 30 Jun 2025

Journal of Clinical Orthopaedics | Available on www.jcorth.com | DOI:10.13107/jcorth.2025.v10i01.702

© The Author(s). 2025 Open Access. This article is distributed under the terms of the Creative Commons Attribution 4.0 International License (<https://creativecommons.org/licenses/by-nc/4.0/>), which permits unrestricted use, distribution, and non-commercial reproduction in any medium, provided you give appropriate credit to the original author(s) and the source, provide a link to the Creative Commons license, and indicate if changes were made. The Creative Commons Public Domain Dedication waiver (<http://creativecommons.org/publicdomain/zero/1.0/>) applies to the data made available in this article, unless otherwise stated.

Table 1: Demographic characteristics of clubfoot patients at the University of North Carolina Medical Center treated with the Ponseti method between 2013–2022 (n=56)

Variable	Value (%)
Caregivers – n (%)	
1	4 (7.14)
2	44 (78.57)
3	5 (8.93)
More than 3	3 (5.36)
Education – n (%)	
High school graduate, diploma or the equivalent (for example: GED)	7 (12.50)
Some college credit, no degree	5 (8.93)
Associate's degree	5 (8.93)
Bachelor's degree	17 (30.36)
Master's degree	17 (30.36)
Professional degree	2 (3.57)
Doctorate degree	3 (5.36)
County – n (%)	
Wake	11 (19.64)
Onslow	6 (10.71)
Guilford	4 (7.14)
Orange	4 (7.14)
Others (n<3)	28 (50.01)
Missing data	3 (5.36)
Siblings – n (%)	
Only child	12 (21.43)
1	21 (37.50)
2	13 (23.21)
3	4 (7.14)
More than 3	6 (10.71)
Annual family income – n (%)	
<\$20,000	5 (8.93)
\$20,001–\$40,000	5 (8.93)
\$40,001–\$60,000	6 (10.71)
\$60,001–\$80,000	12 (21.43)
\$80	5 (8.92)
>\$100,001	23 (41.07)
Brace usage consistency – n (%)	
Rarely	1 (1.79)
Some of the time	2 (3.57)
Most of the time	17 (30.36)
All of the time	36 (64.29)
Adherence – n (%)	
<75 of the time	7 (12.50)
76–85 of the time	3 (5.36)
86–95 of the time	19 (33.93)
96–100 of the time	27 (48.21)
Recurrence – n (%)	
No	34 (60.71)
Yes	22 (39.29)

high as 92% [2].

The success of the Ponseti method is, however, heavily dependent on adherence with the bracing protocol post-correction. Bracing protocols are often very intensive, ranging up to 23 h a day in the early years [3]. The literature has demonstrated brace non-adherence as one of the leading factors contributing to deformity recurrence. Understanding these barriers to adherence is crucial, particularly in resource-limited settings where the incidence of

Table 3: Statistical analyses of adherence, income, education, access to caregivers, and county effects on recurrence in clubfoot patients at a single institution treated with the Ponseti method between 2013–2022 (n=56)

Variable	Chi-square value	P-value
Adherence (categorical)	1.819	0.611
Income	3.165	0.675
Education	7.258	0.298
Caregivers	5.328	0.149
Number of siblings	4.024	0.403

Table 2: Statistical analyses of income, access to caregivers, education, and number of siblings effects on brace adherence in clubfoot patients at a single institution treated with the Ponseti method between 2013–2022 (n=56)

Variable	Chi-square value	P-value
Income	21.143	0.132
Caregivers	5.034	0.831
Education	29.665	0.041
Number of siblings	12.317	0.421
County	54.505	0.768

untreated or improperly treated clubfoot remains high [4]. Within the United States, though healthcare resources exist, the lack of universal healthcare may further divide quality and access to care based on socioeconomic factors. This study aims to evaluate the socioeconomic factors contributing to brace adherence in patients treated with the Ponseti method at a single institution.

Methods

Participants

This study surveyed 219 guardians of patients diagnosed with clubfoot and treated with the Ponseti method by two providers at a single institution. All participants provided consent to participate in the survey. Fifty-six patients completed the survey (response rate 25.5%).

Protocol

This study was Institutional Review Board-approved. The survey was administered via email through Redcap to the 219 eligible clubfoot patient guardians. A cover letter explained the purpose of the study and stated that participation was voluntary. Participants had a 2-week window to complete the online survey. Two reminder emails were sent during that period to maximize the response rate. All survey responses were anonymized.

Data analysis

Statistical analysis was performed using STATA/SE software (version: 18.0 StataCorp, College Station, Texas). Chi-squared and Fisher's Exact tests were run to analyze relationships between the number of caregivers, highest degree of education, average annual income, number of siblings, and brace adherence. A t-test was also used to analyze the relationship between brace adherence and deformity recurrence requiring additional intervention. P < 0.05 was considered significant.

Results

Fifty-six patients completed the survey in its entirety (response rate 25.5%). Over 41% of survey respondents reported an annual income of \$100,001 or over (n = 23). Most survey respondents had completed a bachelor's degree (31.48%, n = 17) or higher (Master's 20.37%, n = 11; Doctorate 18.52%, n = 10). Most respondents had two caregivers in the home (82.14%, n = 46),

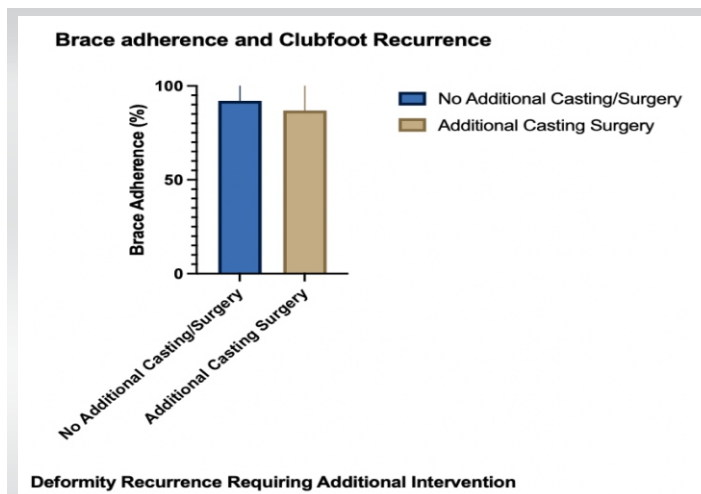


Figure 1: The effect of brace adherence on clubfoot recurrence. The group with clubfoot recurrence requiring additional intervention reported a mean brace adherence of 87.18% compared to 92.32% in the group with no clubfoot recurrence (t-test score=1.340, P=0.177).

and most clubfoot patients were reported to have 1 (42.86%, n = 24) or 2 (39.29%, n = 22) siblings (Table 1).

No significant relationships were found between income (P = 0.132), caregivers (P = 0.831), education (P = 0.041), or number of siblings (P = 0.421) and brace adherence (Table 2).

In addition, no significant relationships were found between income (P = 0.675), caregivers (P = 0.149), education (P = 0.298), or the number of siblings (P = 0.403) and the need for additional treatment or intervention. Notably, no relationship was found between brace adherence and the need for additional treatments or interventions (P = 0.611) (Table 3).

The group with clubfoot recurrence requiring additional intervention reported lower brace adherence rates 87.18% than the group with no clubfoot recurrence 92.32%, but the difference did not reach statistical significance (P = 0.177) (Fig. 1).

Discussion

The Ponseti method has established itself as the standard of care treatment of idiopathic clubfoot, demonstrating high efficacy and safety across diverse populations. Several prospective trials have demonstrated its efficacy over surgical interventions in maximizing Pirani score changes, improving ankle dorsiflexion, and reducing complications and adverse events [5-7]. Numerous studies have reinforced the importance of strict adherence to the bracing protocol post-correction to prevent relapse [8]. For instance, the study by Abdelgawad et al. followed 137 patients with clubfoot treated with the Ponseti method over 2 years and reported a recurrence rate of 66% in the non-brace adherent patients compared to a recurrence rate of only 14% in the brace adherent patients, highlighting the critical role of adherence in maintaining correction achieved through initial treatment [9]. Similarly, a study on 53 clubfoot patients followed for 2 years found a significant correlation between brace non-adherence and

clubfoot relapse after initial correction [10]. Interestingly, this study also analyzed patient demographic data to reveal any factors contributing to non-adherence and found no correlation with parental education level, insurance, or self-identified culture. Several other studies have sought to uncover the specific factors that contribute to brace non-adherence. Some have demonstrated a significant effect of the number and age of patient siblings [11, 12] unilateral versus bilateral clubfoot [11], cultural factors [13], and parental education level on brace adherence [4, 14].

The data on socioeconomic factors influencing brace adherence is mixed, but there is ample evidence that brace adherence is required to achieve sustained deformity correction [15-17]. Among the 56 patients who completed our survey, we observed no significant relationships between socioeconomic factors such as income, caregivers, education level or number of siblings, and brace-wearing consistency. More importantly, our data showed no significant correlation between brace adherence and the need for additional treatments or interventions, in contrast to the existing literature.

One likely explanation for this discrepancy is the potential for overreporting of brace usage by parents. The literature suggests a strong relationship between decreased brace adherence and clubfoot recurrence [15-17]. The lack of a similar finding in our study suggests that parents may be overestimating their child's brace usage, thereby skewing our results. A randomized control trial conducted in 2015 assigned 67 clubfoot patients to a brace with a working sensor, a brace with no sensor, and a brace with a non-working sensor [18]. Actual versus caregiver-reported wear rates were recorded and compared. There was no significant discrepancy in wear times between the three groups, but there was a sizeable difference in caregiver-reported wear times and actual wear times in the functioning sensor group. This difference was most stark 3 months into treatment with caregivers reporting a 94.8% wear time on average, and the sensor only finding a 77.1% wear time [18]. Another similar cross-sectional study of 48 clubfoot patients found patients wore their braces an average of 62% of the time recommended by physicians and 77% of the time reported by guardians. Both studies highlight the likelihood of overreporting, skewing our survey results [19].

An additional limitation is the population surveyed. Although this study was conducted in a public institution, Chapel Hill is a relatively affluent city with a strong university presence. A significant portion of the population surveyed reported the highest annual income level of \$100,001 or above. Moreover, the majority of respondents had a bachelor's degree or higher. The small sample size of respondents from lower socioeconomic backgrounds makes accurate statistical analysis of these populations challenging.

Conclusion

While our study did not find the expected correlations between brace adherence and clinical outcomes, it underscores the

importance of considering potential biases in self-reported data and the impact of demographic factors on study results. Orthopedic providers should extrapolate from this study that it may be difficult to gauge patient adherence to brace-wearing protocols from patients and their guardians alone. In addition, though the present study found no impact of socioeconomic markers on brace adherence or clubfoot recurrence, orthopedists should consider these variables when creating a treatment plan to optimize patient outcomes. Future research should aim to

incorporate objective measures of brace use to validate self-reported adherence and explore the nuanced ways in which socioeconomic status might influence treatment adherence in diverse populations. This approach will help to ensure that the Ponseti method continues to achieve its full potential in preventing clubfoot relapse and improving patient outcomes across different settings.

Declaration of patient consent: The authors certify that they have obtained all appropriate patient consent forms. In the form, the patient has given his consent for his images and other clinical information to be reported in the Journal. The patient understands that his name and initials will not be published, and due efforts will be made to conceal his identity, but anonymity cannot be guaranteed.

Conflict of Interest: NIL; **Source of Support:** NIL

References

- Shabtai L, Specht SC, Herzenberg JE. Worldwide spread of the Ponseti method for clubfoot. *World J Orthop* 2014;5:585-90.
- Rieger MA, Dobbs MB. Clubfoot. *Clin Podiatr Med Surg* 2022;39:1-14.
- Cady R, Hennessey TA, Schwend RM. Diagnosis and treatment of idiopathic congenital clubfoot. *Pediatrics* 2022;149:e2021055555.
- Dobbs MB, Rudzki JR, Purcell DB, Walton T, Porter KR, Gurnett CA. Factors predictive of outcome after use of the Ponseti method for the treatment of idiopathic clubfeet. *J Bone Joint Surg Am* 2004;86:22-7.
- Švehlík M, Floh U, Steinwender G, Sperl M, Novak M, Kraus T. Ponseti method is superior to surgical treatment in clubfoot - long-term, randomized, prospective trial. *Gait Posture* 2017;58:346-51.
- Wang YY, Su YC, Tu YK, Fang CJ, Hong CK, Huang MT, et al. Determining the optimal treatment for idiopathic clubfoot: A network meta-analysis of randomized controlled trials. *J Bone Joint Surg Am* 2024;106:356-67.
- Recordon JA, Halanski MA, Boocock MG, McNair PJ, Stott NS, Crawford HA. A prospective, median 15-year comparison of Ponseti casting and surgical treatment of clubfoot. *J Bone Joint Surg* 2021;103:1986-95.
- Ganesan B, Luximon A, Al-Jumaily A, Balasankar SK, Naik GR. Ponseti method in the management of clubfoot under 2 years of age: A systematic review. *PLoS One* 2017;12:e0178299.
- Abdelgawad AA, Lehman WB, Van Bosse HJ, Scher DM, Sala DA. Treatment of idiopathic clubfoot using the Ponseti method: Minimum 2-year follow-up. *J Pediatr Orthop B* 2007;16:98-105.
- Ramírez N, Flynn JM, Fernández S, Seda W, Macchiavelli RE. Orthosis noncompliance after the Ponseti method for the treatment of idiopathic clubfeet: A relevant problem that needs reevaluation. *J Pediatr Orthop* 2011;31:710-5.
- Jawadi AH, Al-Abbasi EM, Tamim HA. Factors predicting brace noncompliance among idiopathic clubfoot patients treated with the Ponseti method. *J Taibah Univ Med Sci* 2015;10:444-8.
- Bozkurt C, Sipahioglu S. Effects of younger siblings on the brace compliance and recurrence in children with clubfoot during Ponseti treatment. *Acta Orthop Traumatol Turc* 2021;55:102-6.
- Zionts LE, Dietz FR. Bracing following correction of idiopathic clubfoot using the Ponseti method. *J Am Acad Orthop Surg* 2010;18:486-93.
- Avilucea FR, Szalay EA, Bosch PP, Sweet KR, Schwend RM. Effect of cultural factors on outcome of Ponseti treatment of clubfeet in rural America. *J Bone Joint Surg Am* 2009;91:530-40.
- Haft GF, Walker CG, Crawford HA. Early clubfoot recurrence after use of the Ponseti method in a New Zealand population. *J Bone Joint Surg Am* 2007;89:487-93.
- Hu W, Ke B, Niansu X, Li S, Li C, Lai X, et al. Factors associated with the relapse in Ponseti treated congenital clubfoot. *BMC Musculoskelet Disord* 2022;23:88.
- Van Schelven H, Moerman S, Van Der Steen M, Besselaar AT, Greve C. Prognostic factors for recurrent idiopathic clubfoot deformity: A systematic literature review and meta-analysis. *Acta Orthop* 2021;92:1-9.
- Morgenstein A, Davis R, Talwalkar V, Iwinski H Jr., Walker J, Milbrandt TA. A randomized clinical trial comparing reported and measured wear rates in clubfoot bracing using a novel pressure sensor. *J Pediatr Orthop* 2015;35:185-91.
- Sangiorgio SN, Ho NC, Morgan RD, Ebramzadeh E, Zionts LE. The objective measurement of brace-use adherence in the treatment of idiopathic clubfoot. *J Bone Joint Surg* 2016;98:1598-605.

Conflict of Interest: NIL
Source of Support: NIL

How to Cite this Article

Mauffrey O, Yu K, Choudhari M, Habig AL, Pugh A, Narotam V. Bracing for Impact: A Survey Analysis of the Impact of Socioeconomic Factors on Brace Adherence in Clubfoot. *Journal of Clinical Orthopaedics* January-June 2025;10(1):04-07.