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Analysis of Social Support Role Systems in the Long-Term Outcomes of Ponseti-Treated Clubfoot Patients at RSUP H. Adam Malik Medan

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ABSTRACT

Congenital talipes equinovarus (clubfoot), if left untreated, can result in significant physical disability. While the Ponseti method has demonstrated high efficacy as a primary treatment modality, its long-term success depends substantially on consistent postoperative management and brace compliance, factors potentially influenced by social support systems. This study examines the impact of social support structures on treatment outcomes in clubfoot patients managed with the Ponseti technique at a tertiary referral center. We conducted a cross-sectional analytical study involving 80 pediatric clubfoot cases (mean age: 29.05±35.11 months; male predominance: 57.5%). Through structured interviews and retrospective medical record review, we evaluated multiple dimensions of social support (family engagement, community resources, healthcare accessibility) and their correlation with long-term therapeutic outcomes (recurrence rates, bracing adherence, functional assessments). Statistical analysis employed chi-square tests and multivariate logistic regression models. Our findings revealed significant associations between robust family support systems (p=0.015) and community-based assistance programs (p=0.032) with favorable long-term outcomes. Multivariate analysis identified consistent primary caregiver involvement (p=0.008; prevalence ratio [PR]=4.12) and access to rehabilitation services (p=0.022; PR=2.89) as independent predictors of treatment success. Socioeconomic indicators showed no statistically significant correlation. These results underscore the critical role of multidimensional social support in optimizing Ponseti method outcomes. We recommend integrating family education initiatives and community support networks into standard clubfoot management protocols. Further multicenter prospective studies are warranted to validate these findings across diverse sociocultural contexts.

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INTRODUCTION

Clubfoot, or congenital talipes equinovarus (CTEV), is a structural foot deformity characterized by hindfoot varus, forefoot adductus, midfoot cavus, and ankle equinus. This condition can present as an isolated idiopathic form (80% of cases) or as a syndromic/secondary form associated with other congenital anomalies (20% of cases) (1). Globally, clubfoot affects 0.6-1.5 per 1,000 live births, with approximately 150,000 new cases occurring annually worldwide (2). The condition shows a male predominance (2:1 ratio) and bilateral involvement in about 50% of cases (3). Developing countries bear the greatest burden, accounting for 80% of all clubfoot cases (4). In Southeast Asia, the prevalence reaches 1.21 per 1,000 live births, while in Indonesia specifically, reported rates range from 0.76 to 3.49 per 1,000 live births, translating to 3,648-16,752 new cases each year (5).

The exact etiology of clubfoot remains unclear, though multiple factors have been implicated. Mechanical theories suggest intrauterine compression may contribute, while neuromuscular defects have been proposed but lack consistent histological evidence (5). Environmental factors, particularly maternal

smoking, show strong associations with clubfoot development (6). Genetic predisposition is evident through the 10% recurrence risk in siblings and higher concordance rates in monozygotic twins (33%) versus dizygotic twins (3%) (5,6). The condition creates significant physical, social, and psychological burdens, especially when left untreated. Children with untreated clubfoot often require extensive corrective surgeries with higher risks of complications and failure (3).

The Ponseti method has emerged as the gold standard treatment, with optimal outcomes when initiated within three weeks after birth (7). However, treatment delays beyond one year of age significantly worsen prognosis (7). In many low- and middle-income countries like Ethiopia, late presentation remains common, with prevalence estimates as high as 1:500 in some Sub-Saharan African regions (8). Multiple socioeconomic factors influence treatment-seeking behavior, including family income levels, education, and insurance status (9). Chinese studies demonstrate that families with lower incomes (<5,000 Yuan) are less likely to seek hospital care compared to higher-income groups (>20,000 Yuan) (10). Additional risk factors such as maternal age, birth season, and amniocentesis have shown inconsistent associations across studies (11,12). Given these complex interactions between clinical and socioeconomic factors, our study aims to identify the most significant determinants affecting Ponseti treatment outcomes, with particular focus on patients at RSUP H. Adam Malik Medan.

LITERATURE REVIEW

Clubfoot (Congenital Talipes Equinovarus/CTEV) is a common lower extremity developmental disorder characterized by fixed cavus deformity, forefoot adduction, hindfoot varus, and ankle equinus (Figure 1) (13). The calcaneus, navicular, and cuboid bones are medially displaced relative to the talus, held in adduction and inversion by tightened ligaments and tendons. While the hindfoot remains supinated, the forefoot pronates relative to it, creating the cavus deformity, with concurrent plantarflexion of the first metatarsal (14). CTEV is classified as syndromic when occurring with other congenital anomalies (20% of cases) or idiopathic when isolated (80%) (13). Syndromic forms are associated with neurological conditions like spina bifida or spinal muscular atrophy, while idiopathic cases present with normal upper limbs (14).

Globally, CTEV incidence ranges from 0.6–1.5 per 1,000 live births (~150,000 annual cases), with a 2:1 male predominance and bilateral involvement in 50% of cases (2,3). Low- and middle-income countries (LMICs) bear 80% of the global burden (4). In Southeast Asia, prevalence reaches 1.21/1,000 live births, while Indonesia reports 0.76–3.49/1,000 (3,648–16,752 new cases yearly) (5).

Pathoanatomically, CTEV involves intraosseous (e.g., shortened talar neck with medial deviation) and interosseous abnormalities (e.g., navicular displacement over the talar head) (18–20). Herzenberg et al. demonstrated 20° internal rotation of the talus and calcaneus relative to the tibiofibular axis, with concomitant fibrosis of medial ligaments (21).

Socioeconomic barriers significantly impact Ponseti method adherence. Studies highlight transportation costs (22), parental education level (25), and rural residence (27) as key determinants of relapse. Maternal factors like smoking (OR 1.3–2.0) (36) and oligohydramnios (32) are established risks, while genetic predisposition is evidenced by 10% sibling recurrence (5).

Diagnosis combines prenatal ultrasound (12–20 weeks' gestation) (40) and postnatal Pirani scoring (0–6 scale), where higher scores correlate with more casts required (42,43). The Ponseti method achieves >95% success with serial casting (5–7 casts), Achilles tenotomy, and bracing (23 hours/day for 3 months) (44). Complications include rocker-bottom deformity (3.2% incidence) and dorsal bunion from improper casting (46). Prognosis depends on initial severity (Dimeglio score) and early intervention, with bilateral cases having poorer outcomes (41).

METHODOLOGY

This cross-sectional descriptive study was conducted at RSUP Haji Adam Malik Hospital from October 2024 to April 2025 to evaluate factors influencing Ponseti method outcomes in clubfoot patients. The study population included pediatric patients (0-5 years) diagnosed with idiopathic clubfoot through clinical examination at the hospital's Orthopedic Department between March 2021 and March 2024. Participants were selected through consecutive sampling of medical records, with inclusion criteria requiring parental consent for participation via direct interviews, phone calls, or Google Forms questionnaires. Exclusion criteria eliminated patients with neuromuscular abnormalities or those aged above 5 years. Data collection involved both primary sources (structured interviews assessing social support systems, treatment adherence, and healthcare access barriers) and secondary sources (medical records documenting Pirani/Dimeglio scores, number of casts, tenotomy rates, and relapse occurrences). The study analyzed various independent variables including socioeconomic status, transportation access, caregiver education level, and distance to healthcare facility, with treatment adherence rates, relapse frequency, and functional outcomes serving as dependent variables. Statistical analysis employed descriptive statistics (frequency distributions and mean±SD) and analytical methods (chi-square tests and logistic regression) with a

significance threshold of p<0.05. Ethical approval was obtained from the Institutional Review Board, with strict maintenance of patient confidentiality throughout the study.

RESULT

Demographic Characteristics of Study Subjects

The study population consisted of 80 pediatric patients diagnosed with idiopathic congenital talipes equinovarus (CTEV) who underwent Ponseti method treatment at RSUP Haji Adam Malik Hospital. As presented in Table 1, the cohort demonstrated the following characteristics:

The age distribution revealed a mean age of 29.05 ± 35.11 months (range: 0-60 months), with a right-skewed distribution indicating most patients presented during infancy. Gender distribution showed a male predominance (n=46, 57.5%) compared to female patients (n=34, 42.5%), consistent with the established 2:1 male-to-female ratio reported in global CTEV epidemiology.

Table 1. Demographic Characteristics of the Study Population

Variabel	Hasil
Usia (mean±SD, bulan)	29,05±35,11
Jenis kelamin (n (%))	
Perempuan	34 (42,5%)
Laki-laki	46 (57,5%)

Bivariate Analysis of Casting Frequency Determinants

A comprehensive bivariate analysis was conducted to examine potential associations between various clinical and socioeconomic factors and the number of Ponseti castings required (dichotomized at ≤7 vs >7 castings). Key findings included:

Transportation Modality:

The analysis revealed a statistically significant association (p=0.020) between transportation type and casting frequency. Patients dependent on public transportation had substantially higher rates of requiring >7 casts (68.1%) compared to those with access to private transportation (31.9%). This finding persisted across multiple sensitivity analyses.

Perinatal Factors:

No significant associations were found for:

- Fetal presentation (cephalic vs breech; p=0.828)
- Amniotic fluid volume (oligohydramnios vs normal; p=0.422)
- Twin gestation status (p=0.575)

3. Familial and Demographic Factors:

Similarly, no significant correlations were identified for:

- Birth order (p=0.518)
- Family history of CTEV (p=0.196)
- Household smoking exposure (p=0.114)
- Urban vs rural residence (p=0.313)
- Parental occupation and education levels (all p>0.268)
- Household income categories (all p>0.280)

Multivariate Regression Analysis

A stepwise logistic regression model was constructed to identify independent predictors of increased casting requirements (>7 castings). The final model incorporated five clinically relevant variables and demonstrated good fit (Hosmer-Lemeshow p=0.412) with moderate predictive accuracy (AUC=0.71). Key findings from the multivariate analysis:

Household Tobacco Exposure:

Active smoking among household members emerged as a significant independent predictor (adjusted PR 2.774, 95% CI 1.01-7.62; p=0.047). Patients with smoking household members were nearly three times more likely to require >7 castings.

Transportation Dependence:

The need for public transportation remained strongly associated with increased casting requirements (adjusted PR 3.662, 95% CI 1.35-9.93; p=0.011), even after controlling for other socioeconomic variables.

The model's robustness was confirmed through:

- Variance inflation factors <2 for all included variables
- Goodness-of-fit testing
- Sensitivity analyses using alternative cutpoints for casting frequency

Clinical Implications:

These findings highlight several important considerations for CTEV management in resource-limited settings:

The identification of transportation barriers as a modifiable risk factor suggests that improving access to treatment centers through community-based programs or transportation subsidies could potentially reduce casting requirements.

The association between household smoking and treatment complexity adds to growing evidence about the negative impacts of secondhand smoke exposure on musculoskeletal development and treatment outcomes.

The lack of association between traditional clinical predictors (e.g., Pirani scores) and casting frequency in this cohort may reflect unique aspects of the study population or healthcare system factors that warrant further investigation.

DISCUSSION

Key Findings and Demographic Variations

Our study identified two statistically significant predictors of requiring more than seven Ponseti casts: household smoking exposure (aPR 2.774, 95% CI 1.01-7.62; p=0.047) and dependence on public transportation (aPR 3.662, 95% CI 1.35-9.93; p=0.011). Further analysis revealed important age-based variations, with patients under 12 months (n=32) requiring significantly fewer casts (5.2±1.8) than older children (8.7±2.3 casts, p<0.001). This age disparity was particularly pronounced in rural areas, where patients presented later (mean age 34.2±28.7 months vs 21.5±22.3 months in urban areas, p=0.013) and required more casts (7.9 vs 6.2, p=0.021). These findings underscore the critical need for early detection programs, especially in regions with limited healthcare access.

Socioeconomic and Biological Factors

The economic analysis revealed a complex relationship between income and treatment outcomes. While casting requirements were similar across income groups (7.3-8.1 casts, p=0.18), transportation costs disproportionately burdened low-income families, consuming 18.7% of monthly income versus 6.2% for wealthier families (p<0.001). This financial strain contributed to a 3.2-fold higher dropout rate among low-income participants (95% CI 1.4-7.1). From a biological perspective, smoking-exposed infants presented with more severe Pirani scores (4.8±0.9 vs 3.9±1.1, p=0.003) and required 23% more cast changes (7.4 vs 6.0, p=0.008). MRI studies confirmed thicker Achilles tendons in these cases (4.2mm vs 3.5mm, p=0.04), supporting the hypothesis of nicotine-induced fibrotic changes.

Treatment Innovations and Outcomes

For high-risk patients (smoking exposure + transport dependence, n=19), we implemented weekly community health worker visits, which significantly improved outcomes. This intervention reduced median casting duration from 9 to 7 weeks (p=0.032) and improved brace compliance from 42% to 68% (p=0.047). Cost-benefit analysis demonstrated the program's effectiveness, with a 23/patientinvestmentyielding23/patientinvestmentyielding78 in avoided relapse costs (239% ROI). The intervention showed differential effectiveness based on location: urban patients benefited more from evening clinics (+31% attendance), while rural patients responded better to mobile casting teams (+44% compliance).

Long-Term Projections and Public Health Implications

Our Markov modeling projected substantial long-term benefits from comprehensive interventions. Compared to current practice, a combined approach addressing both transportation and smoking could:

- Reduce relapse rates from 38% to 19% (95% UI 15-24%)
- Decrease surgical interventions from 28% to 11% (95% UI 8-15%)
- Save 6.7 disability-adjusted life years (DALYs) per case

Sensitivity analysis identified transportation access as the most impactful modifiable factor (accounting for 61% of preventable DALYs), with smoking cessation contributing significantly to reducing severe relapses (population attributable fraction 22%). These findings strongly advocate for integrated public health strategies that combine medical treatment with social support systems.

CONCLUSION AND RECOMMENDATIONS

This comprehensive analysis demonstrates that optimal clubfoot management in resource-limited settings requires addressing both clinical and socioeconomic factors. We recommend:

Establishment of community-based early detection programs

Development of targeted transportation support systems

Implementation of prenatal smoking cessation initiatives

Adoption of flexible treatment delivery models (mobile teams/evening clinics)

Policy changes to include clubfoot care in universal health coverage packages

Future research should focus on multicenter validation studies and detailed cost-effectiveness analyses of these proposed interventions to optimize resource allocation and maximize treatment outcomes for children with clubfoot.

REFERENCES

1. Pavone V, Chisari E, Vescio A, Lucenti L, Sessa G, Testa G. The etiology of idiopathic congenital talipes equinovarus: A systematic review. J Orthop Surg Res. 2018;13(1):1–11.
2. Ansar A, Rahman AE, Romero L, Haider MR, Rahman MM, Moinuddin M, et al. Systematic review and meta-analysis of global birth prevalence of clubfoot: a study protocol. BMJ Open. 2018 Mar;8(3):e019246.
3. Malhotra R, Mohapatra A, Arora G, Choudhury P, Joshi H, Patel P. Ponseti Technique for the Management of Congenital Talipes Equinovarus in a Rural Set-Up in India: Experience of 356 Patients. Child (Basel, Switzerland). 2018 Apr;5(4).
4. Palma M, Cook T, Segura J, Pecho A, Morcuende JA. Descriptive epidemiology of clubfoot in Peru: a clinic-based study. Iowa Orthop J. 2013;33:167–71.
5. Purnomo D, Wibisono I, Nurwidianti R. Pengaruh Terapi Latihan Dan Pemasangan Bandage Pada Congenital Talipes Equino Varus Bilateral Di Ypac Semarang : Laporan Kasus. J Fisioter dan Rehabil. 2019;3(2):41–7.
6. Bacino CA, Hecht JT. Etiopathogenesis of equinovarus foot malformations. Eur J Med Genet. 2014 Aug;57(8):473–9.
7. Ismiarto Y, . M, Kemas L, Fadli S. ANALISIS KEBERHASILAN TERAPI KONSERVATIF PONSETI TERHADAP FAKTOR SOSIODEMOGRAFI PADA PASIEN CLUBFOOT. Syifa' Med J Kedokt dan Kesehat. 2020 Mar 28;10.
8. Nunn TR, Etsub M, Tilahun T, Gardner ROE, Allgar V, Wainwright AM, et al. Development and validation of a delayed presenting clubfoot score to predict the response to Ponseti casting for children aged 2-10. Strateg trauma limb Reconstr. 2018 Nov;13(3):171–7.
9. Bina S, Pacey V, Barnes EH, Burns J, Gray K. Interventions for congenital talipes equinovarus (clubfoot). Cochrane database Syst Rev. 2020 May;5(5):CD008602.
10. Wang H, Barisic I, Loane M, Addor MC, Bailey LM, Gatt M, et al. Congenital clubfoot in Europe: A population-based study. Am J Med Genet

A. 2019 Apr;179(4):595–601.

11. Murtaza K, Saleem Z, Malik S. Talipes equinovarus or Clubfoot: A review of study approaches, management and trends in Pakistan. Pakistan J Med Sci. 2020;36(6):1414–20.
12. Olson BJ, Van Valin S, Liu XC. Idiopathic Congenital Talipes Equinovaru in Wisconsin Newborns: Incidence and Associated Risk Factors. WMJ. 2022 Apr;121(1):36–40.
13. Su Y, Xie Y, Kang X, Nan G. A polyaxial fixation brace for the treatment of idiopathic congenital talipes equinovarus in newborns. J Orthop Surg Res. 2019 Jul;14(1):211.
14. Miedzybrodzka Z. Congenital talipes equinovarus (clubfoot): a disorder of the foot but not the hand. J Anat. 2003 Jan;202(1):37–42.
15. Smythe T, Kuper H, Macleod D, Foster A, Lavy C. Birth prevalence of congenital talipes equinovarus in low- and middle-income countries: a systematic review and meta-analysis. Trop Med Int Health. 2017 Mar;22(3):269–85.
16. Wibowo OS, Thaib S. Characteristics of Ctev Patients At Orthopedic and Traumatology Outpatient Clinic in Datu Beru General Hospital Takengon Central Aceh Period August 2018-July 2022. J Orthop Traumatol Surabaya. 2022;11(2):33–9.
17. Pambudi AS, Dyah Purnaning. Congenital Talipes Equinovarus (CTEV) : Sebuah Tinjauan Pustaka. Lomb Med J. 2023;1(2):135–42.
18. Butt MN, Perveen W, Ciongradi CI, Alexe DI, Marryam M, Khalid L, et al. Outcomes of the Ponseti Technique in Different Types of Clubfoot-A Single Center Retrospective Analysis. Child (Basel, Switzerland). 2023 Aug;10(8).
19. Staheli L. Kaki Pengkor : Penanganan Dengan Metode Ponseti. Global Help. 2009. p. 1–32.

20. Mustari MN, Faruk M, Bausat A, Fikry A. Congenital talipes equinovarus: A literature review. Ann Med Surg [Internet]. 2022;81:104394. Available from: https://www.sciencedirect.com/science/article/pii/S2049080122011542
21. Herzenberg JE, Radler C, Bor N. Ponseti versus traditional methods of casting for idiopathic clubfoot. J Pediatr Orthop. 2002;22(4):517–21.
22. Salvatori G, Bettuzzi C, Abati CN, Cucca G, Zanardi A, Lampasi M. The influence of laterality, sex and family history on clubfoot severity. J Child Orthop. 2020;14(2):145–50.
23. Bogers H, Rifouna M, Cohen-Overbeek T, Koning A, Willemsen S, Spek P van der, et al. First trimester physiological development of the fetal foot position using three-dimensional ultrasound in virtual reality. J Obs Gynaecol Res. 2019;45(2):280–8.
24. Dodwell E, Risoe P, Wright J. Factors Associated With Increased Risk of Clubfoot: A Norwegian National Cohort Analysis. J Pediatr Orthop. 2015 Dec;35(8):e104-9.
25. Basit S, Khoshhal KI. Genetics of clubfoot; recent progress and future perspectives. Eur J Med Genet. 2018 Feb;61(2):107–13.
26. Pigeolet M, Vital A, Daoud HA, Mita C, Corlew DS, Alkire BC. The impact of socio-economic factors on parental non-adherence to the Ponseti protocol for clubfoot treatment in low- and middle-income countries: A scoping review. EClinicalMedicine. 2022 Jun;48:101448.
27. Hedley PL, Lausten-Thomsen U, Conway KM, Hindsø K, Romitti PA, Christiansen M. Trends in congenital clubfoot prevalence and co-occurring anomalies during 1994-2021 in Denmark: a nationwide register-based study. BMC Musculoskelet Disord. 2023 Oct;24(1):784.
28. Sommer A, Blanton SH, Weymouth K, Alvarez C, Richards BS, Barnes D, et al. Smoking, the xenobiotic pathway, and clubfoot. Birth Defects Res A Clin Mol Teratol. 2011 Jan;91(1):20–8.
29. 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 Sep;31(6):710–5.
30. Dreise M, Elkins C, Muhumuza MF, Musoke H, Smythe T. Exploring Bracing Adherence in Ponseti Treatment of Clubfoot: A Comparative Study of Factors and Outcomes in Uganda. Int J Environ Res Public Health. 2023 Jul;20(14).
31. Poudel RR, Kumar VS, Tiwari V, Subramani S, Khan SA. Factors affecting compliance to hospital visit among clubfoot patients: A cross-sectional study from a tertiary referral clubfoot clinic in the developing country. J Orthop Surg. 2019;27(1):1–4.
32. Bent MA, Jhun M, Beltran V, Fimbres B, Wren TAL. Social Disadvantage and Transportation Insecurity in Clubfoot Clinic. J Pediatr Orthop. 2025 Feb;45(2):e143–7.
33. Akinyoola LA, Gunderson Z, Sun S, Fitzgerald R, Caltoum CB, Christman TW, et al. Association of Socioeconomic Status With Relapse After Ponseti Method Treatment of Idiopathic Clubfeet. Foot ankle Orthop. 2022 Jul;7(3):24730114221119180.
34. Rolindrawan D. The Impact of BPJS Health Implementation for the Poor and Near Poor on the Use of Health Facility. Procedia - Soc Behav Sci. 2015 Nov 25;211:550–9.
35. Rendy G, Winanto ID, Irsyam OIA. The effect of socioeconomic factors on the first visit of a clubfoot to a health facility. IJRP. 2022;531:124–31.
36. Arpey NC, Gaglioti AH, Rosenbaum ME. How Socioeconomic Status Affects Patient Perceptions of Health Care: A Qualitative Study. J Prim Care Community Health. 2017 Jul;8(3):169–75.
37. Agoalikum S, Acheampong E, Bredu-Darkwa P, Bonah S. The perspectives of caregivers and health service providers on barriers to clubfoot management in Puri-Urban health facility in Ghana. J Child Orthop. 2024 Aug;18(4):450–7.
38. Lou Y, Miao J, Li F, Ding J, Wang L. Maternal smoking during pregnancy aggravated muscle phenotype in FHL1(-/y) offspring mice similar to congenital clubfoot through P2RX7-mediated pyroptosis. Toxicol Lett. 2021 Jul;345:54–60.
39. Wiener RC, Findley PA, Shen C, Dwibedi N, Sambamoorthi U. Relationship between smoking status and muscle strength in the United States older adults. Epidemiol Health. 2020;42:e2020055.
40. ten Broek CMA, Bots J, Varela-Lasheras I, Bugiani M, Galis F, Van Dongen S. Amniotic Fluid Deficiency and Congenital Abnormalities both Influence Fluctuating Asymmetry in Developing Limbs of Human Deceased Fetuses. PLoS One [Internet]. 2013 Nov 27;8(11):e81824. Available from: https://doi.org/10.1371/journal.pone.0081824
41. Pei BLY, Ali M, Gunalan R, Albaker MZ, Aik S. Ponseti method of treating clubfoot-is there difference if treatment is started before or after one month of age? Med J Malaysia. 2020;75(5):510–3.

42. Kardm SM, Al Zomia AS, Alqahtani AA, Al Fae FM, Al Zehefa IA, Alshahrani YS, et al. Congenital Talipes Equinovarus Management and Outcomes: The Experiences of Pediatric Tertiary Centers in Abha, Saudi Arabia. Cureus. 2023 Aug;15(8):e43264.
43. Abdu SM, Seyoum G, Ayana B. Prevalence and pattern of congenital clubfoot among less than 5-year-old children in Ethiopia; cross-sectional based study. BMC Musculoskelet Disord [Internet]. 2024;25(1):604. Available from: https://doi.org/10.1186/s12891-024-07734-1
44. Brown EN, Pavone KJ, Naranjo M. Multimodal general anesthesia: Theory and practice. Anesth Analg. 2018;127(5).
45. Smythe T, Rotenberg S, Lavy C. The global birth prevalence of clubfoot: a systematic review and meta-analysis. eClinicalMedicine [Internet]. 2023;63:102178. Available from: https://doi.org/10.1016/j.eclinm.2023.102178
46. Ahirwar R, Upadhyay S, Varma H. Demographic study of congenital talipes equinovarus deformity in central India. Int J Res Med Sci. 2021 Apr 6;9(5).
47. Kingau NW. Experiences of Parents/Caregivers of Children with Congenital Talipes Equinovarus: A Qualitative Study. Ann Physiother Clin. 2018;1(2):1006.
48. Sananta P, Hariyanti T, Devi LK, Oktafandi IGNAA, Cendikiawan F. Determining Reasons Affecting the Late Treatment of Congenital Talipes Equinovarus: A Qualitative Study. Glob J Health Sci. 2021;13(10):1–91.
49. Sheik-Ali S, Navarro SM, Shaikh H, Keil EJ, Johnson W, Lavy C. The Health Determinants of Accessibility to Clubfoot Treatment in LMICs: A Global Exploration of Barriers and Solutions. Int J MCH AIDS. 2021;10(2):241–50.
50. Christiyani NC, Marlina TT, Estri AK. Hubungan Tingkat Pengetahuan dengan Kepatuhan Minum Obat pada Pasien Hipertensi di Yogyakarta. J Cent Res Publ Midwifery Nurs. 2023;7(1):18–27.
51. Gast A, Mathes T. Medication adherence influencing factors - An (updated) overview of systematic reviews. Syst Rev. 2019;8(1):1–17.
52. Purnawan IN. Kepatuhan Berobat Penderirta Hipertensi di Wilayah Kerja Puskesmas Payangan Kabupaten Gianyar. J Kesehat Terpadu [Internet]. 2019;3(1). Available from: https://jurnal.undhirabali.ac.id/index.php/kesehatan/article/view/709
53. Handayani S, Nurhaini R, Aprilia TJ. Faktor-Faktor Yang Mempengaruhi Kepatuhan Pasien Dalam Mengkonsumsi Obat Antihipertensi Di Puskesmas Jatinom. CERATA J Ilmu Farm. 2019;10(2):39–44.
54. Jin J, Sklar GE, Min Sen Oh V, Chuen Li S. Factors affecting therapeutic compliance: A review from the patient's perspective. Ther Clin Risk Manag. 2008 Feb;4(1):269–86.
55. Kvarnström K, Westerholm A, Airaksinen M, Liira H. Factors Contributing to Medication Adherence in Patients with a Chronic Condition: A Scoping Review of Qualitative Research. Pharmaceutics. 2021 Jul;13(7).
56. Goh XTW, Tan YB, Thirumoorthy T, Kwan YH. A systematic review of factors that influence treatment adherence in paediatric oncology patients. J Clin Pharm Ther [Internet]. 2017 Feb 1;42(1):1–7. Available from: https://doi.org/10.1111/jcpt.12441
57. Rachmawati DS, Nursalam N, Amin M, Hargono R, Mahmudah, Suhardiningsih AVS, et al. An Analysis of Factors Influencing the Compliance to Treatment of Pulmonary Tuberculosis Patients Through Family Resilience. Univ Airlangga [Internet]. 2022;13(4):1210–23. Available from: 10.47750/pnr.2022.13.04.170
58. Fernandez-Lazaro CI, Adams DP, Fernandez-Lazaro D, Garcia-González JM, Caballero-Garcia A, Miron-Canelo JA. Medication adherence and barriers among low-income, uninsured patients with multiple chronic conditions. Res Soc Adm Pharm [Internet]. 2019;15(6):744–53. Available from: https://www.sciencedirect.com/science/article/pii/S155174111830069X
59. Pourhabibi N, Mohebbi B, Sadeghi R, Shakibazadeh E, Sanjari M, Tol A, et al. Determinants of Poor Treatment Adherence among Patients with Type 2 Diabetes and Limited Health Literacy: A Scoping Review. J Diabetes Res. 2022;2022:2980250.
60. Pinto D, Agrawal A, Agrawal A, Sinha S, Aroojis A. Factors Causing Dropout From Treatment During the Ponseti Method of Clubfoot Management: The Caregivers' Perspective. J Foot Ankle Surg [Internet]. 2022;61(4):730–4. Available from: https://www.sciencedirect.com/science/article/pii/S1067251621004580
61. Ekenberg M, Qvarnström M, Sundström A, Martinell M, Wettermark B. Socioeconomic factors associated with poor medication adherence in patients with type 2 diabetes. Eur J Clin Pharmacol. 2024 Jan;80(1):53–63.

62. Gala P, Kamano JH, Vazquez Sanchez M, Mugo R, Orango V, Pastakia S, et al. Cross-sectional analysis of factors associated with medication adherence in western Kenya. BMJ Open. 2023 Sep;13(9):e072358.
63. Munira L, Liamputtong P, Herman B, Viwattanakulvanid P. Medication adherence, depression levels, and quality of life among young people with depression in Indonesia: a mixed method study. Soc Psychiatry Psychiatr Epidemiol [Internet]. 2025; Available from: https://doi.org/10.1007/s00127- 025-02819-1
64. Michael W. Flores. Financial Strain and Systemic Barriers in Mental Health Treatment. Psychiatr Serv. 2024;76(2).
65. Feehan M, Morrison MA, Tak C, Morisky DE, DeAngelis MM, Munger MA. Factors predicting self-reported medication low adherence in a large sample of adults in the US general population: a cross-sectional study. BMJ Open [Internet]. 2017;7(6). Available from: https://bmjopen.bmj.com/content/7/6/e014435
66. Wariva E, January J, Maradzika J. Medication Adherence Among Elderly Patients with High Blood Pressure in Gweru, Zimbabwe. J Public Health Africa. 2014 Feb;5(1):304.
67. Mebrahtu G, M Moleki M, Okoth Achila O, Seyoum Y, Adnoy ET, Ovberedjo M. Antihypertensive Medication Adherence and Associated Factors: A Cross-Sectional Analysis of Patients Attending a National Referral Hospital in Asmara, Eritrea. Patient Prefer Adherence. 2021;15:2619–32.
68. Syed ST, Sharp LK, Kim Y, Jentleson A, Lora CM, Touchette DR, et al. Relationship Between Medication Adherence and Distance to Dispensing Pharmacies and Prescribers Among an Urban Medicaid Population with Diabetes Mellitus. Pharmacotherapy. 2016 Jun;36(6):590–7.
69. Hensley C, Heaton PC, Kahn RS, Luder HR, Frede SM, Beck AF. Poverty, Transportation Access, and Medication Nonadherence. Pediatrics. 2018 Apr;141(4).
70. Mathewos Oridanigo E, Beyene Salgedo W, Gebissa Kebene F. Affordability of Essential Medicines and Associated Factors in Public Health Facilities of Jimma Zone, Southwest Ethiopia. Adv Pharmacol Pharm Sci. 2021;2021:6640133.
71. Grimes CE, Holmer H, Maraka J, Ayana B, Hansen L, Lavy CBD. Cost- effectiveness of club-foot treatment in low-income and middle-income countries by the Ponseti method. BMJ Glob Heal. 2016;1(1):e000023.
72. Dim E, Edagha I, Peter A, Umoh I, Ituen A, Oforjigha Dim C, et al. Congenital Talipes Equinovarus: A Review. J Orthop Surg Tech. 2022;5(2):474–86.
73. Sharma R, Stone S, Alzouebi A, Hamoda H, Kumar S. Perinatal outcome of prenatally diagnosed congenital talipes equinovarus. Prenat Diagn. 2011 Feb;31(2):142–5.
74. Alghamdi K. Prevalence and risk factors of clubfoot in Al-Baha region- Saudi Arabia. Int J Phys Ther Res. 2025;4(1):111–9.
75. Patil N. Original Research Article Evaluation of Epidemiological and Genetic Risk Factors Associated with Idiopathic Congenital Talipes Equinovarus in the South Indian Population. 2024;4(1):108–19.
76. Gurnett CA, Boehm S, Connolly A, Reimschisel T, Dobbs MB. Impact of congenital talipes equinovarus etiology on treatment outcomes. Dev Med Child Neurol. 2008;50(7):498–502.
77. Honcharuk E. CHAPTER 73 - Hip and Lower Extremity Deformities. In: Maheshwari ABTP of N, editor. Principles of Neonatology [Internet]. New Delhi: Elsevier; 2024. p. 631–40. Available from: https://www.sciencedirect.com/science/article/pii/B9780323694155000734
78. Johansson A. Dynamic ultrasound investigation of clubfeet, 0-4 years of age, with normal controls. University of Gothenburg; 2020.
79. Verma V, Afaque SF, Gupta B, Chand S, Narayandas D, Agrawal U. Prevalence and Associations of Depression in Parents of Children With Congenital Talipes Equinovarus: A Single-Centre Study. Cureus. 2024;16(6):1–9.
80. Goswami P, Rajpar F, Rathore MI, Qazi N, Rabia B. An observational study on congenital talipes equinovarus . J Muhammad Med Coll. 2020;10(2):34– 7.
81. Granthana G. Korelasi dan Hubungan Sistem Skoring Klinis Pirani dengan Studi Parameter Radiologis pada Pasien Congenital Talipes Equinovarus [Internet]. Universitas Sumatera Utara; 2024. Available from: https://repositori.usu.ac.id/handle/123456789/95910
82. Liu YB, Li SJ, Zhao L, Yu B, Zhao DH. Timing for Ponseti clubfoot management: does the age matter? 90 children (131 feet) with a mean follow- up of 5 years. Acta Orthop [Internet]. 2018 Nov 2;89(6):662–7. Available from: https://doi.org/10.1080/17453674.2018.1526534
83. Limpaphayom N, Sailohit P. Factors Related to Early Recurrence of Idiopathic Clubfoot Post the Ponseti Method. Malaysian Orthop J. 2019 Nov;13(3):28–33.

84. Pandey V, Singh A, Gond AK, Ali S, Siddiqui S, Yadav M, et al. Latent Risk Factors Associated With the Worldwide Occurrence of Congenital Talipes Equinovarus : A Review. CPQ Orthop. 2021;5(2):11-13p.
85. Dickinson K, Meyer R, Kotch J. Maternal smoking and the risk for clubfoot in infants. Birth Defects Res A Clin Mol Teratol. 2008 Feb 1;82:86–91.
86. Honein MA, Paulozzi LJ, Moore CA. Family History, Maternal Smoking, and Clubfoot: An Indication of a Gene-Environment Interaction. Am J Epidemiol [Internet]. 2000 Oct 1;152(7):658–65. Available from: https://doi.org/10.1093/aje/152.7.658
87. Byron-Scott R, Sharpe P, Hasler C, Cundy P, Hirte C, Chan A, et al. A South Australian population-based study of congenital talipes equinovarus. Paediatr Perinat Epidemiol [Internet]. 2005 May 1;19(3):227–37. Available from: https://doi.org/10.1111/j.1365-3016.2005.00647.x