Journal Edition 17 (Issue I)

2026

The Association of Paediatric Chartered Physiotherapists

Est. 1973

Online Journal

https://doi.org/10.59481/197316

https://doi.org/10.59481/197317

INDEX

List of Reviewers for 2026

https://doi.org/10.59481/197317

Social characteristics of children and families involved in Idiopathic Toe-Walking research; A rapid scoping review

Jennifer D Harris[1, 2] - Gregory A Whitley[3,4] - Kate Freeman[5] - Steward C Morrison[6]

1. Chesterfield Royal Hospital NHS Foundation Trust.
2. University of Nottingham, School of Health Sciences, Queen's Medical Centre.
3. Clinical Audit and Research Unit, East Midlands Ambulance Service NHS Trust, Lincoln.
4. Community and Health Research Unit, School of Health and Care Sciences, University of Lincoln.
5. Research Support, University of Nottingham Libraries.
6. School of Life Course & Population Sciences, King's College London, Guy's campus, London.

**Correspondence: Author, Samantha Grace: jenniferharris@nhs.net*

Abstract

Background & justification for review

Idiopathic toe-walking is a common condition affecting children. Persistent toe walking can significantly impact physical and social quality of life. Despite known social determinants for long-term health outcomes, little is currently known about the social characteristics of children and families participating in idiopathic toe-walking research.

Specific objective for review

This rapid scoping review aims to map the social characteristics of children participating in idiopathic toe-walking research.

Search criteria

Characteristics to be examined include age, sex, ethnicity, socioeconomic status and neurodiversity. MEDLINE (Ovid), CINAHL, AMED & Embase were searched for quantitative and qualitative studies exploring outcomes or experiences of idiopathic toe-walking interventions. Studies excluded from inclusion were research syntheses, studies focused on children with underlying neurological, neuromuscular conditions or congenital foot deformity or those involving children aged under 2 or over 18 years Studies published in the last 20 years were included.

Study appraisal & synthesis methods

Single-reviewer study selection and data extraction were completed, with 20% independently reviewed. Studies were not appraised for quality in line with rapid scoping review methodology. Age, sex, ethnicity, socio-economic position, and neurodiversity of participants in idiopathic toe walking research were analysed using descriptive statistics.

Results

We identified 2416 titles and 52 texts were included in the final review. The age and sex of participants were reported in most studies. Mean age of participants ranged from 3-13 years and 58% were male. Neurodiversity was reported in only 37% of studies, ethnicity was reported in 6% and socioeconomic status in only 4% texts.

Limitations

In common with many rapid scoping review methods, this review was planned and carried out in a resource-efficient manner. A focus on papers published in the past 20 years, limiting dual approaches to screening and data extraction, and the inclusion of poster and conference abstracts may have led to important study details being omitted.

Conclusions

Future research would benefit from considering both biological and social factors during data collection and reporting to avoid increasing health disparities and inefficiencies.

https://doi.org/10.59481/197317

INTRODUCTION

Idiopathic toe walking (ITW) gait is a term used to describe children who persist in walking on their toes after the age at which children typically develop a heel-toe pattern (Caserta et al., 2019). It is a diagnosis of exclusion, made when no other neurological or neuromuscular cause for the toe-walking is identified. ITW is a relatively common condition, affecting up to 5% of typically developing children (Engström, Tedroff, 2012).

The mechanisms underlying ITW are unclear (Donne et al., 2023, Bauer, Sienko & Davids, 2022). One leading hypothesis for the cause of persistent toe-walking is that it could relate to sensory-processing challenges. Unfortunately, there is no clear evidence to support this theory at present (Donne et al., 2023). ITW is particularly prevalent in neurodivergent children; studies suggest that between 8 and 68% of autistic children (Shetreat-Klein, Shinnar & Rapin, 2014, Leyden, Fung & Frick, 2019, Barrow, Jaworski & Accardo, 2011) and 20% of children with attention deficit hyperactivity disorder (ADHD) (Soto Insuga et al., 2018) persist in walking on their toes with no other medical cause present.

Despite ongoing debate as to whether neurodivergent toe-walkers are truly "idiopathic" in nature, both neurodivergent and neurotypical children follow similar pathways of care in the United Kingdom (UK) (Gelfer, McNee et al., 2024) . Some children appear to return to a normal heel-toe gait spontaneously before they reach 10 years old (Engström, Tedroff, 2018). However, 19% of neurotypical children and 63% of autistic children persist in toe-walking 10 years after their diagnosis (Leyden, Fung & Frick, 2019), and some will continue to toe-walk into adolescence or adulthood (Santos et al., 2024). Persistent toe walking is associated with pain, physical impairments such as poor balance, trips and falls, and significantly reduced school, play, social, and emotional function compared to children with typical gait (Engelbert et al., 2011, Williams, Haines, 2015, Morrow et al., 2024, Caserta, Morgan et al., 2022, Lindsay et al., 2022). Even after perceived resolution of toe walking, adults who toe-walked in childhood report ongoing pain in the calf region, higher rates of skin pathology on the feet, and have kinematic and kinetic differences in gait (Stott et al., 2004, Williams, Haines, 2015).

Children and families living in the UK frequently seek assessment and treatment for persistent toe walking. They can receive advice and intervention from health professionals in a range of settings, but paediatric physiotherapists will often lead initial (non-surgical) management (Harris et al., 2022). Treatments typically involve combinations of interventions, including stretching, strengthening, and motor-control exercises, orthoses (ankle foot orthoses, carbon-fibre insoles, and resting splints), serial-casting, and some will require orthopaedic surgery (Caserta et al., 2019, van Kuijk et al., 2014). Despite several recent systematic reviews, studies flawed by poor methodological quality and small, non-diverse samples have made it challenging to determine clear evidence-based treatment pathways for both neurotypical and neurodivergent children with ITW gait (van Bemmel et al., 2014, Caserta et al., 2019, van Kuijk et al., 2014, Valagussa et al., 2024). Such challenges have contributed to significant variability in NHS care for children with ITW (Harris et al., 2022). Expert consensus among paediatric physiotherapists and orthopaedic surgeons on UK pathways of care acknowledges the need for flexibility in the delivery of non-surgical interventions, to reflect the individual needs and characteristics of patients (Gelfer et al., 2024). Parents of children with ITW also encourage health professionals (including paediatric physiotherapists) to appreciate every child's unique circumstances when planning their intervention (Williams et al. 2020). Awareness of the characteristics of children

https://doi.org/10.59481/197317

participating in research is, therefore, an important factor when considering the outcomes and experience of intervention.

The likelihood of good health and a long life is closely linked to a variety of social determinants experienced in childhood. These include socioeconomic status and sex (Spencer, 2018, von Rueden et al., 2006). Socio-economic status (SES) is a theoretical construct, typically conceptualised through measures such as household income, education, and area-based indicators (Conway et al., 2019). SES in childhood is most often determined by the occupation, income, and education of the parents and the position society attributes to that individual (usually the family unit) (Sankar et al., 2019). There is clear evidence of growing health inequalities across and within European countries (Marmot et al., 2012) Such factors are also likely to impact the health outcomes and experience of children with ITW gait. Despite calls for researchers and editors of medical journals to take greater responsibility in reporting social characteristics, these are infrequently reported in a range of paediatric and general medical journals (Rees et al., 2023). A better understanding of the characteristics of participants represented in ITW research could help patients, clinicians, and researchers to navigate the individual needs and circumstances affecting children and young people with ITW gait. It will also highlight any groups who may be under-represented or excluded from the current body of literature, which could affect the generalisability of findings and impact individual outcomes (Washington et al., 2023).

A scoping review offers an ideal method to examine key characteristics or factors related to ITW (Munn et al., 2022, Peters, Marnie et al., 2020). Scoping reviews offer the opportunity to synthesise both qualitative and quantitative data, creating a broader oversight of the current body of evidence related to children and young people (population), participating in research studies to examine the outcome or experience of intervention for idiopathic toe walking gait (concept) in any global healthcare setting (context). No current scoping or rapid scoping reviews on this topic were identified in a preliminary search of MEDLINE, the Cochrane Database of Systematic Reviews and JBI Evidence Synthesis, PROSPERO and Open Science Framework. This rapid scoping review aims to map the social characteristics of children, young people and/or their parents in idiopathic toe-walking research.

Objectives

Describe the social characteristics of children and young people participants in idiopathic toe walking research including age, sex, and ethnicity.
Identify if studies report socioeconomic status, or neurodiversity in idiopathic toe walking and explore if participants in idiopathic toe walking research are representative of population norms.

Review question

What are the social characteristics of children and young people participating in idiopathic toe-walking research?

METHODS

This rapid scoping review follows the JBI methodology for scoping reviews (Peters, Godfrey et al., 2020) with adaptations made in ine with rapid review principles (Speckemeier et al., 2022). The protocol for this review (Harris et al., 2024) is published on Open Science Framework and available at: https://osf.io/8p25m/#:~:text=Description:%20This%20rapid%20scoping%20review,of%20ASD%20and%20/%20or%20ADHD.

Search strategy

The search strategy aimed to locate all relevant published studies. Searches took place between 24th and 28th May 2024. An initial limited search

https://doi.org/10.59481/197317

of MEDLINE and CINAHL was undertaken on 17th May 2024 to identify articles on the topic and relevant text and index terms were identified. A full search strategy was developed for MEDLINE (Ovid), CINAHL, AMED & Embase (see exemplar in table 1. The search strategy was reviewed by an Information Specialist/Librarian and piloted before use. Subject headings were adapted following the initial pilot. The search strategy, including all identified keywords and index terms, were adapted for each included database.

For pragmatic purposes, grey literature was excluded from this study and only studies published after 2004 were included (Speckemeier et al., 2022). This offers an overview of published literature in the last twenty years, which is likely to contribute to current evidence-based practice, but within the limits of this study, it allowed for more time-efficient analysis.

Eligibility criteria

Participants

Studies that included children and young people aged 2-18 years diagnosed with idiopathic toe walking gait were eligible for inclusion. Idiopathic toe walking gait is defined as bilateral toe walking from initiation of walking and is not associated with any known neurological or orthopaedic condition and persists beyond the age of two years (Gelfer, Harris et al., 2024). Neurodiversity (ASD/ADHD) can co-exist with ITW and is not an exclusion to the diagnosis (Gelfer, Harris et al., 2024)

Children and young people with persistent toe walking as a result of neurodevelopmental or neuromuscular conditions (including Cerebral Palsy, Muscular Dystrophy or Charcot Marie Tooth Disease), with Clubfoot (congenital talipes equino-varus) or with skeletal dysplasia were excluded from this study. Research syntheses and repetition of primary data were excluded.

Table 1 Exemplar search strategy

Search strategy MEDLINE (Ovid)	
Limits 2004-present	
1	("idiopathic toe walk*" or "ITW" or "toe walk*" or "ITWp").mp.
2	((habitual* or persist* or tactile or sensory or bilateral or propriocep* or vestibular* idiopathic*) adj3 (walk* or tipto* or "tip to*" or gait* or "toe walk*" or "forefoot")).mp.
3	1 or 2
4	Child/
5	Child, Preschool/
6	Child Development/
7	Adolescent/
8	(toddler* or preschool* or child* or adolescence* or teen* or youth* or paediatric* or juvenile* or "young* person*" or "young* people" or girl* or boy*).mp.
9	4 or 5 or 6 or 7 or 8
10	3 and 9
11	limit 10 to yr="2004 -Current"

Concept

Research studies published in peer-reviewed journals focusing on outcomes or experience of idiopathic toe-walking intervention.

Context

Research carried out in any healthcare setting (worldwide).

Types of Sources

Quantitative studies, including experimental, analytic, observational, and descriptive observational study designs, were considered. Qualitative studies were considered if qualitative data focused on the experience of toe-walking intervention. Conference and poster abstracts published in peer-reviewed journals were included. Evidence syntheses were excluded to avoid duplication of data. Commentaries and opinion papers were not considered for inclusion in this scoping review in line with rapid review processes (Speckemeier et al., 2022).

https://doi.org/10.59481/197317

Epidemiological, psychometric, and clinimetric studies were also excluded.

Study/Source of Evidence selection

Following the search, all identified citations were collated and uploaded into Covidence (Covidence, 2024), and duplicates removed. Following a pilot test, titles and abstracts were screened by JDH for assessment against the inclusion criteria for the review, with 20% of abstracts independently reviewed by GAW. Potentially relevant sources were retrieved in full. The full text of selected citations was assessed in detail against the inclusion criteria by JDH, with 20% independently reviewed by GAW. Reasons for exclusion of sources of evidence in full text that did not meet the inclusion criteria were recorded in the results. Any disagreements arising between the reviewers at each stage of the selection process were resolved through discussion. Screening and extraction were carried out by one person, with a second reviewer consulted for 20% of studies, which is considered an acceptable approach to reduce resources and limit selection bias in rapid review methods (Taylor-Phillips et al., 2017).

Data Extraction

Data extracted included author, title, publication type, year, country, context, timeframe of data collection, intervention(s), and evidence source type. In line with the research question, the social characteristics of participants were collected and examined. These included the number of participants, the type of participant (i.e., children and young people, parents & carers or both), age of participants, sex, ethnicity, socio-economic position, and presence of neurodivergent disorder. Data were extracted using a data extraction tool developed in Covidence (Covidence, 2024). Data were extracted by JDH, with 20% of papers reviewed by GAW for data comparison purposes. Disagreements were resolved by consensus discussion, including SCM.

Analysis

Age, sex, ethnicity, socio-economic position, and neurodiversity of participants in idiopathic toe walking research were analysed using descriptive statistics. Basic frequencies and proportions are presented in tables and supplemented with graphic representation in pie charts, waffle charts, and world maps. Microsoft® Excel® for Microsoft 365 MSO was used for analyses.

RESULTS

Study selection

A summary of evidence identification and inclusion decisions can be found in Figure 1 (PRISMA flow diagram). A total of 2416 studies were identified (Covidence, 2024). Through manual and automated processes, 674 duplicates were removed. Title and abstract screen excluded 1660 papers, and all full texts (n=82, including conference/poster abstracts) were retrieved. Twenty-eight studies were excluded on full-text screen; thus, 30 were included in the final results. Details on reasons for exclusion can be found in Figure 1.

Data were extracted into a digital data extraction tool created on Covidence. The authors of 5 key texts were contacted via email to request further information. Two authors responded, and due to the rapid nature of this study, no further attempts were made.

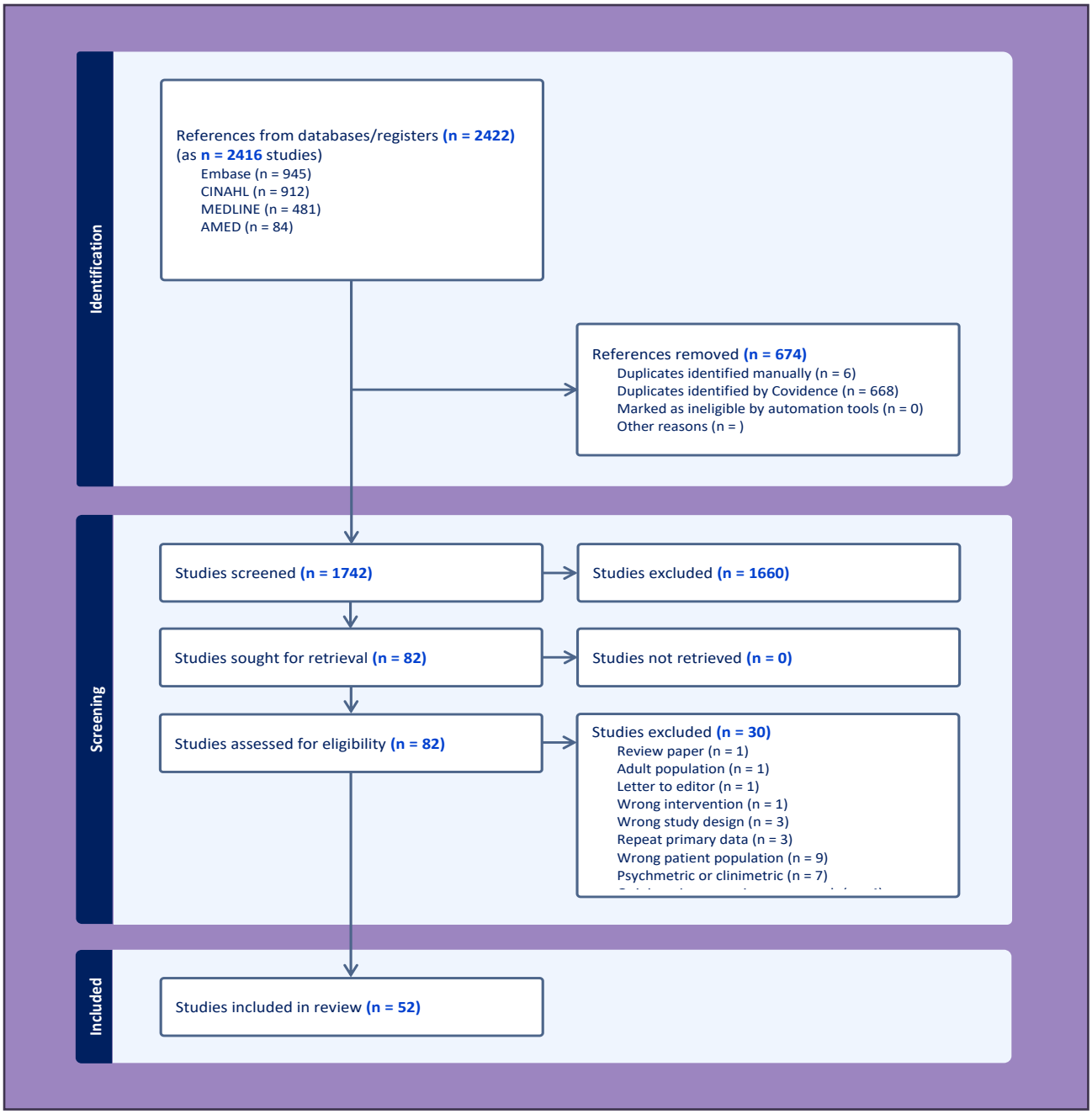
Characteristics of included studies

A summary of the aims and participant numbers in the included studies can be found in Appendix 1. Data from all studies, including study design, research report / abstract, population, and reporting of social characteristics, is summarised in the waffle chart (Figure 2). Descriptive studies were defined as those describing "characteristics or trends", analytic as those "quantifying relationships" and experimental studies as those which included "manipulation of a population to examine its effects" (AJE Team, 2022). Study designs included analytic (n=28), descriptive

https://doi.org/10.59481/197317

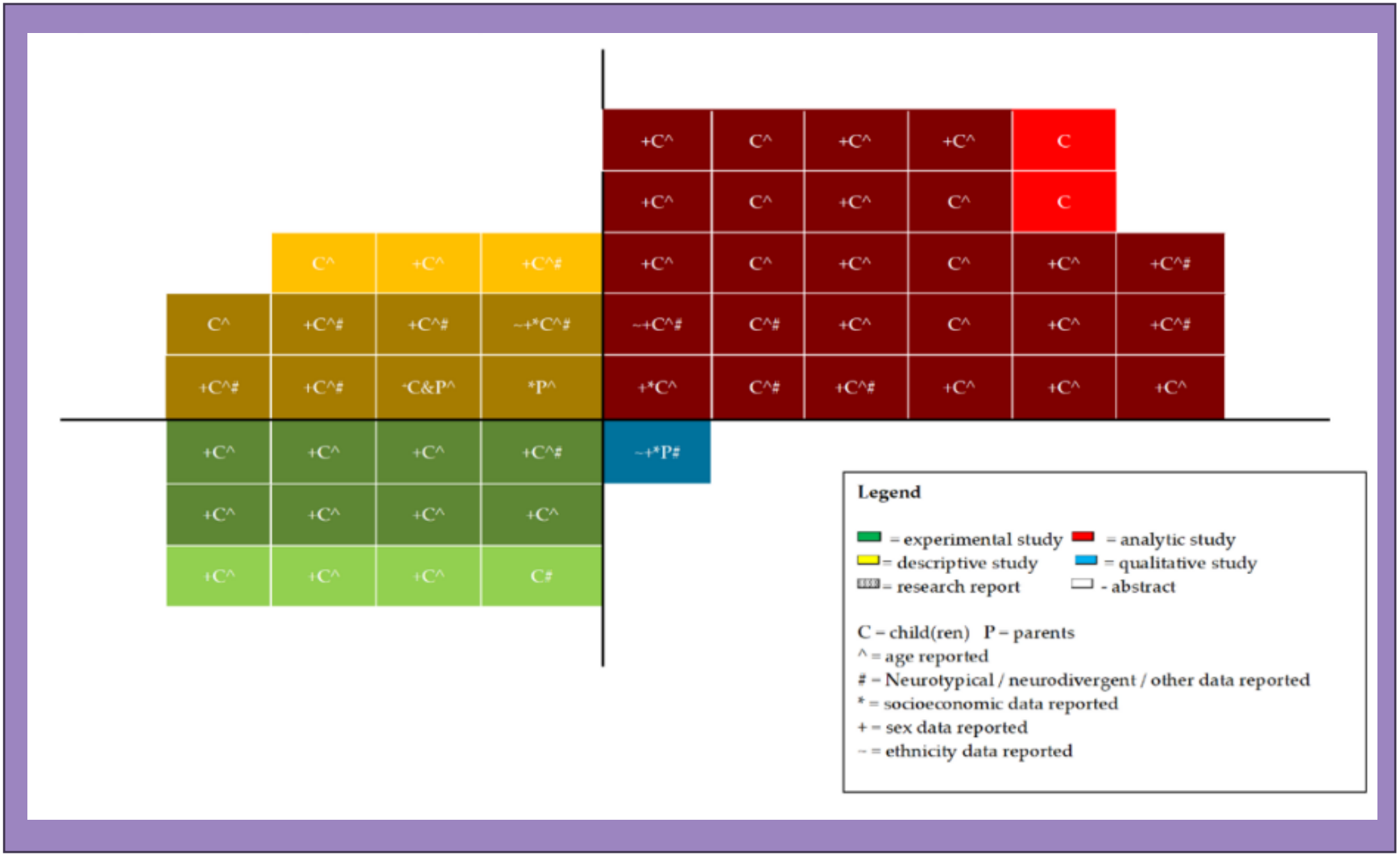
observational (n=11), experimental (n=12), and one qualitative study. Only 4% (n=2) of included studies focused on the experience of parents of children with a diagnosis of ITW (one study included parents and children). Children were the subject of all other studies.

Figure 1 PRISMA flow diagram



https://doi.org/10.59481/197317

Figure 2 Waffle chart summarising social characteristics of included studies



https://doi.org/10.59481/197317

Study type and location

Of the 52 included texts, 43 were research reports and 9 were abstracts (one presentation abstract, two poster abstracts, and six generic conference abstracts). Studies were conducted worldwide but the majority (n=28) took place in the United States. Study locations are presented graphically in Figure 3.

Social characteristics

A total of 1439 subjects participated in the included research studies.

Age was reported in 94% (n=49) of studies conducted with children. The age of children participating in the included ITW studies ranged from 2 to 18 years. The average (mean) age of participants ranged from 3 to 13 years.

The sex of participants was reported in 42 (81%) studies. Males represented 58% (n=386) of participants and females 42% (n= 278). One study (Shirel et al., 2022) reported a single non-binary participant.

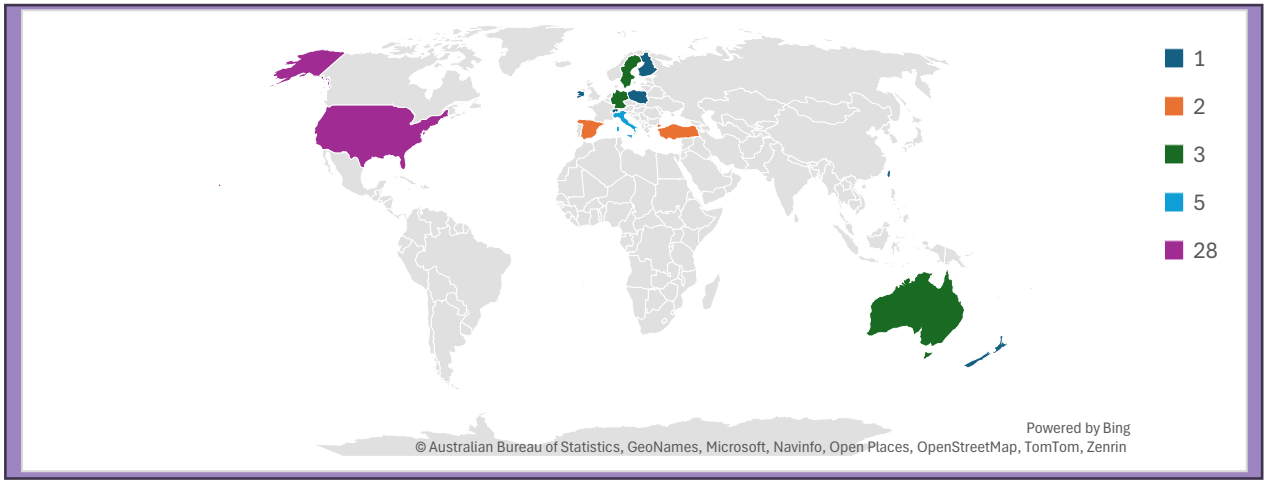
Neurodivergent status and learning differences were reported in 19 studies (37%). Four studies excluded children with a diagnosis of Autistic Spectrum Disorder (ASD) (McMulkin et al., 2006, Bartoletta, Tsao & Bouchard, 2021, Berger et al., 2021b, Satila et al., 2016).

One study excluded children with learning differences (including ADHD and dyslexia) (Zapata et al., 2022b).

Exclusion criteria for two other studies were more ambiguous but included statements such as "signs of … psychiatric disease" (Hirsch, Wagner, 2004) and "any other condition which may cause toe-walking" (Brasiliano et al., 2022). Eleven studies excluded children without a diagnosis of ASD. Despite a relatively high number of studies excluding participants without ASD, those focusing solely on the outcome or experience of children with ASD accounted for only 41 (3%) of total participants across all studies. Of the studies that reported neurodivergent status or other learning differences, 82% of participants were neurotypical, 10% were diagnosed with ASD, 2% with a hyperactivity disorder and 5% with a learning difficulty, developmental delay or speech and language delay.

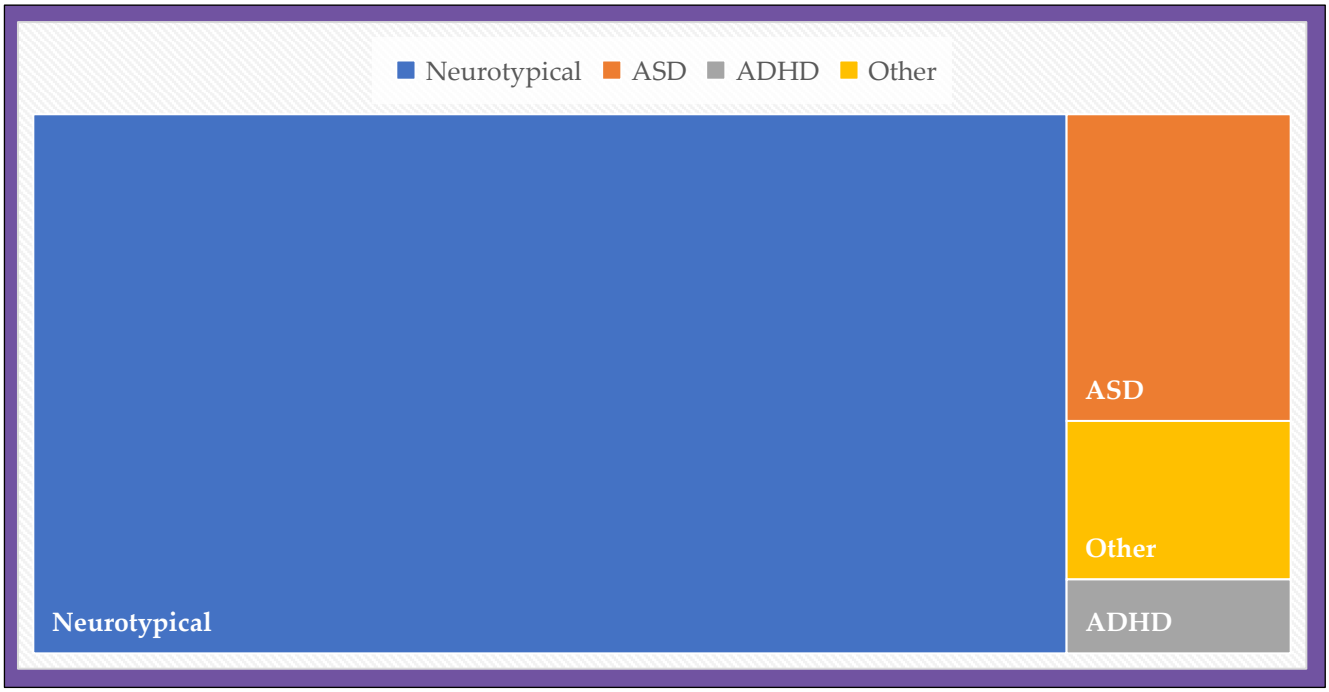
Figure 4 represents the proportion of neurotypical, ASD, ADHD and other learning differences diagnosed in participants within ITW research which were reported in included studies.

Figure 3 World map showing geographical location of studies



https://doi.org/10.59481/197317

Figure 4 Treemap charting representation of neurotypical, neurodivergent and learning differences diagnoses reported in children participating in ITW research



The reporting of participants' socio-economic status and/or ethnicity was particularly low among ITW studies. Only two studies reported data on socioeconomic factors. One (Wilder, Ingram & Hodges, 2022) stated all participants were "middle-income households". The other (Barkocy, Schilz et al., 2021)stated that "4 out of 5 participants were on Medicaid so would likely qualify either due to low socioeconomic status or due to ASD diagnosis". Ethnicity was reported in only three studies (Barkocy, Muir et al., 2021, Bartoletta, Tsao & Bouchard, 2021, Wilder, Ingram & Hodges, 2022). Of the participants in these studies, 61% reported their ethnicity as Caucasian, 14% Hispanic, 6% Black, 5% Asian and the other 14% as "other" or "unknown".

DISCUSSION

The treatment and management of idiopathic toe walking remains a controversial topic among clinicians and academics (Dietz, Khunsree, 2012, Freiman et al., 2022).

However, awareness of the impact this condition can have on the quality of life of children and young people is increasing (Morrow et al., 2024, Caserta, Reedman et al., 2022). As paediatric physiotherapists strive to offer effective and efficient care, individualised to the needs of the patient, it is important to understand who is represented in the existing research evidence.

This study demonstrates poor reporting of social characteristics in ITW research published over the past twenty years. Unfortunately, limited reporting of gender, ethnicity and socio-economic status is a common theme in healthcare research (Routen et al., 2022, Beard et al., 2021, Alegria et al., 2021). Research into other common long-term health conditions, such as type 2 diabetes, highlights that under-representation of minority ethnic and diverse social- economic backgrounds has resulted in important social and biological differences being missed (Campbell et al., 2012, Jhita et al., 2014). Similar issues were encountered during the Covid-19pandemic, which disproportionately affected people of Black and Asian Minority ethnic groups in the United Kingdon and Black and Hispanic in the United States. Many trials failed to report

https://doi.org/10.59481/197317

ethnicity or under-represented these ethnic groups during trial recruitments (Treweek et al., 2020, Flores et al., 2021, Mathur et al., 2021, Morales, Ali, 2021). This impacted health outcomes and was a potential factor in, disproportionate rates of vaccination uptake (Sutton et al., 2022, Mathur et al., 2021).

Buttery et al. (2022), conducted a targeted literature review of ten high-impact medical journals aiming to assess the frequency of reporting of ethnicity (or 'race') and socioeconomic status (SES) indicators in clinical research. They identified that only 35% of the selected articles published in 2021 reported ethnicity and 13% reported data on socio-economic status. Similarly to the studies we reviewed, Buttery et al (2022) found participant sex was the social characteristic reported most frequently. However, even when sex and ethnicity are reported in clinical research, authors fail to distinguish biologically inevitable and social causes for any changes detected in sub-group analyses (Geller et al., 2011). Males represented 58% of the participants in ITW studies included in this review. This figure appears representative of ITW reported in epidemiological studies. Engström and Tedroff (2018) analysed a cohort of over 1400 Swedish children and found 62% of children diagnosed with ITW at 5.5 years were male. This increased to 75% of children who were still toe-walking at 10 years. Leyden and colleagues (2019) analysed the medical files of over 2 million children under 19 years living in the US. They found that 50% of neurotypical children with a diagnosis of ITW were male, but this increased to 67% in those with a concurrent diagnosis of ASD.

Sex and gender affect many facets of society but are of particular importance when considering health research (Miles, 2020). Within the data examined in this study, most reports failed to distinguish between the biological classification of sex (male/female/intersex) and the sociocultural and behavioural concept of gender (boys/girls/non-binary/trans). This distinction was acknowledged in only one study (Shirel et al., 2022). Sex and gender have the potential to impact how an individual selects, responds to, and adheres to healthcare treatments and may affect what future studies to undertake and why (Clayton, Tannenbaum, 2016). As referred to previously in relation to ethnicity, consideration of sex and gender issues within future research will ensure greater accuracy and precision in conclusions, reduce healthcare disparities, and promote diverse inclusion (Goldman, 2024).

There is little agreement on standardised SES measures in childhood (Swift EK et al., 2002, Braveman et al., 2005) and no consistent indicators of SES were reported in the studies included in this review. However, reporting socio-economic data, alongside sex (and gender) and ethnicity, presents an opportunity for authors and readers to consider the generalizability of results to low-status or marginalised groups and to balance biological and social factors influencing outcomes (Geller et al., 2011, Ogedegbe, 2020, Jaehn et al., 2020).

In the studies reporting neurodivergence and/or learning differences, 10% of participants had a diagnosis of ASD, 2% had hyperactivity, and a further 5% had other learning differences. Only 5% (n=484) of Leyden and colleagues (2019) American cohort of idiopathic toe-walking children had a concurrent diagnosis of ASD. In a smaller cohort of children diagnosed with ITW in the UK, 30% were diagnosed with ASD and 6% with ADHD. However, in a five-year follow-up study conducted by Engström & Tedroff (2018) found that ten of the 26 children who still toe-walk at 10 years old had received concurrent diagnoses of neurodevelopmental conditions. Although there is no suggestion of a causal relationship, this finding raises awareness of the relatively late diagnoses of many neurodevelopmental issues compared with the early presentation of childhood gait disorders

https://doi.org/10.59481/197317

(Hrdlicka et al., 2024). With the mean ages of participants undergoing ITW intervention ranging from 3-13 years, there is potential for a proportion of subjects to receive diagnoses of ASD, ADHD or other learning differences after they start intervention for toe-walking. The potential for altered outcomes and/or modification to ITW intervention should, therefore, be considered early in the planning and delivery of non-surgical ITW intervention. In common with many clinical studies involving autistic people (Green, Garg, 2018) , studies focused on autistic children included in this review had small samples and limited rigour. Researchers conducting future studies on ITW would benefit from taking specific steps to involve children with both ASD and ADHD at all stages of research and ensure neurodivergent voices are heard when developing or trialling new ITW interventions (Sonuga-Barke et al., 2024, Beasant et al., 2024)

Studies relating to the experience or outcome of ITW intervention been conducted worldwide over the past 20 years. However, the ethnicity of participants was only reported in a small proportion of our included studies (3/52). Most participants described themselves as Caucasian. Under-representation of minority ethnic groups is an ongoing concern in the field of health research (Smart, Harrison, 2017). Under-representation of these groups could lead to the implementation of interventions with differing responses according to the target population (Routen et al., 2022). The only way to ensure healthcare interventions serve all ethnic groups within a population and represent a range of social characteristics within these subgroups is to ensure researchers recognise and target their recruitment (Routen et al., 2022).

Limitations

This rapid scoping review was planned and carried out in a resource-efficient manner. Restricting this study to papers published in the past 20 years could result in data from important foundational studies or highly influential grey literature being omitted from findings. Findings from studies including subjects younger than two years and older than 18 years could also result in key findings being omitted. The inclusion of conference and poster abstracts limited available data for extraction, and there was limited time available to contact authors for additional data. Limiting the dual approach to title and abstract screening and full-text screening increases the risk of missing important studies. However, this review necessitated agreement on 20% of papers before proceeding to the next stage of review. Single-reviewer data extraction could also increase the risk of bias or error in reporting (Buscemi et al., 2006). This risk is limited by introducing 20% independent review and limiting fields to those considered most important to answer the research question.

CONCLUSION

This study has mapped the social characteristics of participants in idiopathic toe-walking research published in the last twenty years. We identified low reporting rates for key characteristics, including ethnicity, socioeconomic status and neurodivergence/learning differences. Lack of diversity amongst research participants affects the generalizability of results to the wider population, increases health disparities, and could lead to cost inefficiencies (Swartz et al., 2019, Committee on Improving the Representation of Women and Underrepresented Minorities in Clinical Trials and Research, Committee on Women in Science, Engineering, and Medicine, 2022). The age, sex (and gender), ethnicity, socio-economic status and neurodivergent status of individuals all have the potential to impact outcomes and experiences of healthcare and to pose important questions for paediatric physiotherapists, researchers and policy-makers. Although poor reporting of factors made it challenging to determine if gaps in representation exist, future research would

https://doi.org/10.59481/197317

benefit from taking specific steps to support the recruitment and retention of such groups and to encourage diverse patient and public involvement throughout the research process. Understanding the social characteristics of participants in idiopathic toe-walking research will facilitate greater inclusivity and representation in future research and highlight essential gaps in our understanding.

Acknowledgements: The authors would like to acknowledge the contribution of Ms Aneesa Lindau, Deputy Library & Knowledge Service Manager at Chesterfield Royal Hospital for her contribution in advising initial search strategies for this study. We would also like to acknowledge the Focus On Orthopaedic Treatment of Toe-walking in the United Kingdom (FOOTT-UK) collaborators for their contribution in inspiring the research question.

Ethical and R&D Approval: There are no human participants in this article and informed consent is not required.

Funding: Jennifer Harris, East Midlands Pre-doctoral bridging fellow, is funded by Health Education England (HEE) / National Institute of Health & Care Research (NIHR) for this research project. The views expressed in this publication are those of the author(s) and not necessarily those of the NIHR, or the UK Department of Health and Social Care.

Conflict of Interest: There are no conflicts of interest to declare.

REFERENCES

1. AJE Team, (2022) *What are Analytical Study Designs?* Available at: https://www.aje.com/arc/what-are-analytical-study-designs/.
2. Alegria M, Sud S, Steinberg BE, Gai N and Siddiqui A (2021) Reporting of Participant Race, Sex, and Socioeconomic Status in Randomized Clinical Trials in General Medical Journals, 2015 vs 2019. *JAMA Network Open* 4(5): e2111516.
3. Alvarado MI, Owens H, Brand O, Lieto S, Lehman L and McCaigue IS (2021) Taming Idiopathic Toe Walking: Examining the Toe Tamer® for Children Who Idiopathically Toe-Walk®...American Occupational Therapy Association (AOTA) INSPIRE 2021 (Virtual), April 6-30, 2021. *American Journal of Occupational Therapy* 75: 1.
4. Barkocy M, Dexter J and Petranovich C (2017) Kinematic Gait Changes Following Serial Casting and Bracing to Treat Toe Walking in a Child With Autism. *Pediatric Physical Therapy : The Official Publication of the Section on Pediatrics of the American Physical Therapy Association* 29(3): 270–274.
5. Barkocy M, Schilz J, Heimerl S, Chee M, Valdez M and Redmond K (2021) The Effectiveness of Serial Casting and Ankle Foot Orthoses in Treating Toe Walking in Children With Autism Spectrum Disorder. *Pediatric Physical Therapy : The Official Publication of the Section on Pediatrics of the American Physical Therapy Association* 33(2): 83–90.
6. Barkocy M, Muir N, Le Cras S, Brausch S, Hoffman N, Bouck J, et al. (2021) Parent Perspectives Regarding Care Delivery for Children With Idiopathic Toe Walking to Inform an American Physical Therapy Association Clinical Practice Guideline. *Pediatric Physical Therapy : The Official Publication of the Section on Pediatrics of the American Physical Therapy Association* 33(4): 260–266.
7. Barrow WJ, Jaworski M and Accardo PJ (2011) Persistent toe walking in autism. *Journal of Child Neurology* 26(5): 619–621.
8. Bartoletta J, Tsao E and Bouchard M (2021) A Retrospective Analysis of Nonoperative Treatment Techniques for Idiopathic Toe Walking in Children: Outcomes and Predictors of Success. *PM & R : The Journal of Injury, Function, and Rehabilitation* 13(10): 1127–1135.
9. Bauer JP, Sienko S and Davids JR (2022) Idiopathic Toe Walking: An Update on Natural History, Diagnosis, and Treatment. *Journal of the American Academy of Orthopaedic Surgeons*.
10. Beard E, Dixon S, Rai T and Hayward G (2021) Ethnicity and socioeconomic status: missing in research means missing in clinical guidance. *BJGP Open* 5(3): BJGPO.2021.0034. doi: 10.3399/BJGPO.2021.0034. Print 2021 Jun.
11. Beasant L, Realpe A, Douglas S, Kenny L, Rai D and Mills N (2024) Autistic adults' views on the design and processes within randomised controlled trials: The APRiCoT study. *Autism* 28(6): 1540–1550.

https://doi.org/10.59481/197317

12. Benedetti MG, Fusaro I, Volini S, Gasparre G and Berti L (2013) Clinical and instrumental evaluation of botulinum toxin effects on the "idiopathic toe walking": A pilot study. *Gait and Posture* 38: S60–S61.
13. Berger N, Bauer M, Hapfelmeier A, Salzmann M and Prodinger PM (2021a) Orthotic treatment of idiopathic toe walking with a lower leg orthosis with circular subtalar blocking. *BMC Musculoskeletal Disorders* 22(1): 520.
14. Berger N, Bauer M, Hapfelmeier A, Salzmann M and Prodinger PM (2021b) Orthotic treatment of idiopathic toe walking with a lower leg orthosis with circular subtalar blocking. *BMC Musculoskeletal Disorders* 22(1): 520.
15. Bonnefoy-Mazure A, Franco-Carvalho M, Leroquais C, De Coulon G, Lascombes P and Armand S (2023) Idiopathic toe walkers: Conservative or surgical treatments? *Gait and Posture* 106: S28–S29.
16. Boyd L, Soangra R, Mukhar L, Kling R and Grant Beuttler M (2023) Stepping Beyond Efficacy: Understanding the User Experience of Wearables for Children with Idiopathic Toe Walking in the Natural Setting. *Human Factors in Healthcare* 3: 100044.
17. Brasiliano P, Alvini M, Di Stanislao E, Vannozzi G, Di Rosa G and Camomilla V (2022) Effects of wearing a foot orthosis on ankle function in children with idiopathic toe walking during gait. *Heliyon* 8(10): e11021.
18. Brasiliano P, Mascia G, Di Feo P, Di Stanislao E, Alvini M, Vannozzi G, et al. (2023) Impact of Gait Events Identification through Wearable Inertial Sensors on Clinical Gait Analysis of Children with Idiopathic Toe Walking. *Micromachines* 14(2).
19. Braveman PA, Cubbins C, Egeter S, Chdeya S, Marchi K, Metzler M, et al. (2005) Socioeconomic Status in Health Research: One Size Does Not Fit All. *Journal of the American Medical Association* 294: 2879–2888.
20. Brierty A, Walsh J, Jeffries P, Graham D, Horan S and Carty C (2018) Clinical outcomes following Zone 2 calf lengthening surgery in children with equinus deformity. *Developmental Medicine and Child Neurology* 60: 21.
21. Brunt D, Woo R, Kim HD, Ko MS, Senesac C and Li S (2004) Effect of botulinum toxin type A on gait of children who are idiopathic toe-walkers. *Journal of Surgical Orthopaedic Advances* 13(3): 149–55.
22. Buscemi N, Hartling L, Vandermeer B, Tjosvold L and Klassen TP (2006) Single data extraction generated more errors than double data extraction in systematic reviews. *Journal of Clinical Epidemiology* 59(7): 697–703.
23. Buttery SC, Philip KEJ, Alghamdi SM, Williams PJ, Quint JK and Hopkinson NS (2022) Reporting of data on participant ethnicity and socioeconomic status in high-impact medical journals: a targeted literature review. *BMJ Open* 12(8): e064276–064276.
24. Campbell JA, Walker RJ, Smalls BL and Egede LE (2012) Glucose control in diabetes: the impact of racial differences on monitoring and outcomes. *Endocrine* 42(3): 471–482.
25. Caserta AJ, Pacey V, Fahey MC, Gray K, Engelbert R and Williams CM (2019) Interventions for idiopathic toe walking. *Cochrane Database of Systematic Reviews*(10).
26. Caserta A, Reedman S, Morgan P and Williams CM (2022) Physical activity and quality of life in children with idiopathic toe walking: a cross sectional study. *BMC Pediatrics* 22(1): 544–w.
27. Caserta A, Morgan P, McKay MJ, Baldwin JN, Burns J and Williams C (2022) Children with idiopathic toe walking display differences in lower limb joint ranges and strength compared to peers: a case control study. *Journal of Foot & Ankle Research* 15(1): 70.
28. Clark E, Sweeney JK, Yocum A and McCoy SW (2010) Effects of motor control intervention for children with idiopathic toe walking: a 5-case series. *Pediatric Physical Therapy : The Official Publication of the Section on Pediatrics of the American Physical Therapy Association* 22(4): 417–26.
29. Clayton JA and Tannenbaum C (2016) Reporting Sex, Gender, or Both in Clinical Research? *JAMA* 316(18): 1863–1864.
30. Committee on Improving the Representation of Women and Underrepresented Minorities in Clinical Trials and Research, and Committee on Women in Science, Engineering, and Medicine, (2022) Why Diverse Representation in Clinical Research Matters and the Current State of Representation within the Clinical Research Ecosystem. In: Bibbins-Domingo K and Helman A (eds) *Improving Representation in Clinical Trials and Research: Building Research Equity for Women and Underrepresented Groups.* Washington DC: National Academies Press, 23–46.
31. Covidence (2024) *Covidence Systematic Review Software.* Melbourne, Australia: Veritas Health Innovation.
32. Dietz F and Khunsree S (2012) Idiopathic Toe Walking: To Treat or not to Treat, that is the Question. *The Iowa Orthopaedic Journal* 32: 184–188.
33. Donne JH, Powell JA, Fahey MC, Beare R, Kolic J and Williams CM (2023) Some children with idiopathic toe walking display sensory processing difficulties but not all: A systematic review. *Acta Paediatrica (Oslo, Norway : 1992)* 112(8): 1620–1632.

https://doi.org/10.59481/197317

34. Engelbert R, Gorter JW, Uiterwaal C, van de Putte E and Helders P (2011) Idiopathic toe-walking in children, adolescents and young adults: a matter of local or generalised stiffness? *BMC Musculoskeletal Disorders* 12: 61–61.
35. Engstrom P, Bartonek A, Tedroff K, Haglund-Akerlind Y, Orefelt C and Gutierrez-Farewik EM (2013) Botulinum toxin a does not improve cast treatment for idiopathic toe-walking - A prospective randomized trial. *Gait and Posture* 38: S2–S3.
36. Engstrom P, Gutierrez-Farewik E, Bartonek A, Tedroff K, Orefelt C and Haglund-Akerlind Y (2010) Does botulinum toxin A improve the walking pattern in children with idiopathic toe-walking? *Journal of Children's Orthopaedics* 4(4): 301–8.
37. Engström P and Tedroff K (2018) Idiopathic Toe-Walking: Prevalence and Natural History from Birth to Ten Years of Age. *The Journal of Bone and Joint Surgery. American Volume* 100(8): 640–647.
38. Engström P and Tedroff K (2012) The prevalence and course of idiopathic toe-walking in 5-year-old children. *Pediatrics* 130(2): 279–284.
39. Fanchiang HD, Geil M, Wu J, Chen Y and Wang YT (2015) The Effects of Vibration on the Gait Pattern and Vibration Perception Threshold of Children With Idiopathic Toe Walking. *Journal of Child Neurology* 30(8): 1010–6.
40. Filippetti M, Picelli A, Di Censo R, Vantin S, Randazzo PN, Sandrini G, et al. (2022) IncobotulinumtoxinA Injection for Treating Children with Idiopathic Toe Walking: A Retrospective Efficacy and Safety Study. *Toxins* 14(11).
41. Flores LE, Frontera WR, Andrasik MP, del Rio C, Mondríguez-González A, Price SA, et al. (2021) Assessment of the Inclusion of Racial/Ethnic Minority, Female, and Older Individuals in Vaccine Clinical Trials. *JAMA Network Open* 4(2): e2037640.
42. Freiman HD, Mensah C, Codrington J and Frick SL (2022) Idiopathic Toe-Walking in Children and Adolescents: Diagnosis, Natural History, and Treatment Options. *JBJS Reviews* 10(2).
43. Gelfer Y, Harris J, McNee A, Douglas C, Dewhurst S, Trees A, et al. (2024) *Idiopathic Toe Walkers Consensus Statement* . Available at: https://www.bscos.org.uk/public/consensus-projects/consensus-project/itw#:~:text=Idiopathic%20Toe%20Walkers%20consensus%20statement%20%2D%20February%202024&text=3.,paediatrician%2F%20paediatric%20neurologist%20when%20appropriate.
44. Gelfer Y, McNee AE, Harris JD, Mavrotas J, Deriu L, Cashman J, et al. (2024) The management of idiopathic toe walking. *The Bone & Joint Journal* 106-B(10): 1190–1196.
45. Geller SE, Koch A, Pellettieri B and Carnes M (2011) Inclusion, analysis, and reporting of sex and race/ethnicity in clinical trials: have we made progress? *Journal of Women's Health (2002)* 20(3): 315–320.
46. Goldman I (2024) *Enhancing Accuracy, Inclusion and Scientific Integrity through Sex- and Gender-Based Guidelines.* Available at: https://www.elsevier.com/en-gb/connect/enhancing-accuracy-inclusion-and-scientific-integrity-through-sex-and-gender-based-guidelines.
47. Grant-Beuttler M, Beuttler R, Shiraishi M, Gwerder M, Asher J, Jeng C, et al. (2023) Smart technology intervention to retrain gait in children with idiopathic toe walking. *Gait and Posture* 106: S68–S69.
48. Green J and Garg S (2018) Annual Research Review: The state of autism intervention science: progress, target psychological and biological mechanisms and future prospects. *Journal of Child Psychology and Psychiatry* 59(4): 424–443.
49. Harris JD, Whitley GA, Freeman K and Morrison SC (2024) *Social Characteristics in Idiopathic Toe-Walking Research: A Rapid Scoping Review.*
50. Harris J, Gelfer Y, Cashman J, Eyre-Brook A, Kothari A, HJ, et al. (2022) Current Management of Idiopathic Toe-Walking Gait in Children and Young People in the UK: A Cross- Sectional Survey to Reflect Physiotherapists' and Surgeons' Perspective. *Journal of Surgery* 7(16).
51. Hemo Y, Macdessi SJ, Pierce RA, Aiona MD and Sussman MD (2006) Outcome of patients after Achilles tendon lengthening for treatment of idiopathic toe walking. *Journal of Pediatric Orthopedics* 26(3): 336–40.
52. Herrin K and Geil M (2016) A comparison of orthoses in the treatment of idiopathic toe walking: A randomized controlled trial. *Prosthetics and Orthotics International* 40(2): 262–9.
53. Hirsch G and Wagner B (2004) The natural history of idiopathic toe-walking: a long-term follow-up of fourteen conservatively treated children. *Acta Paediatrica (Oslo, Norway : 1992)* 93(2): 196–9.
54. Hodges AC, Wilder DA and Ertel H (2018) The use of a multiple schedule to decrease toe walking in a child with autism. *Behavioral Interventions* 33(4): 440–447.
55. Hoffman NA, Dallum JR, Hinshon S and Finch MD (2022) Carbon Fiber Two-Pull Solid Ankle-Foot Orthoses versus Serial Casting in the Treatment of

https://doi.org/10.59481/197317

Idiopathic Toe Walking with Ankle Equinus Contracture. *Journal of Prosthetics & Orthotics (JPO)* 34(3): 140–151.

56. Hrdlicka M, Urbanek T, Rotreklova A, Kultova A, Valek O and Dudova I (2024) Predictors of age at diagnosis in autism spectrum disorders: the use of multiple regression analyses and a classification tree on a clinical sample. *European Child & Adolescent Psychiatry* 33(4): 1171–1177.
57. Ioannidis JPA, Powe NR and Yancy C (2021) Recalibrating the Use of Race in Medical Research. *JAMA* 325(7): 623–624.
58. Jadhav S, Deshpande S and Gormley M (2017) Treatment of pediatric idiopathic toe walking with and without botulinum toxin and ankle foot orthosis. *Developmental Medicine and Child Neurology* 59: 81.
59. Jaehn P, Rehling J, Klawunn R, Merz S, Holmberg C, Bolte G, et al. (2020) Practice of reporting social characteristics when describing representativeness of epidemiological cohort studies – A rationale for an intersectional perspective. *SSM - Population Health* 11: 100617.
60. Jahn J, Vasavada AN and McMulkin ML (2009) Calf muscle-tendon lengths before and after Tendo-Achilles lengthenings and gastrocnemius lengthenings for equinus in cerebral palsy and idiopathic toe walking. *Gait & Posture* 29(4): 612–7.
61. Jhita T, Petrou S, Gumber A, Szczepura A, Raymond NT and Bellary S (2014) Ethnic differences in health related quality of life for patients with type 2 diabetes. *Health and Quality of Life Outcomes* 12(1): 83.
62. Lara SL and Caballero IM (2016) Efectos a medio y largo plazo sobre la marcha de un programa de ejercicio domiciliario y ortesis de uso nocturno en niños con equinísimo idiopático. *Fisioterapia* 38(5): 243–250.
63. Leyden J, Fung L and Frick S (2019) Autism and toe-walking: are they related? Trends and treatment patterns between 2005 and 2016. *Journal of Children's Orthopaedics* 13(4): 340–345.
64. Lindsay SE, Bauer J, Bouton D, Do P, Woodmark C, Sienko S, et al. (2022) Patient-Reported Outcome Measurement Information System (PROMIS) Scores in Pediatric Idiopathic Toe Walkers. *Journal of Pediatric Orthopaedics* 42(8).
65. Manfredi F, Riefoli F, Coviello M and Dibello D (2022) The Management of Toe Walking in Children with Autism Spectrum Disorder: "Cast and Go". *Children (Basel, Switzerland)* 9(10): 1477. doi: 10.3390/children9101477.
66. Marcus A, Sinnott B, Bradley S and Grey I (2010) Treatment of idiopathic toe-walking in children with autism using GaitSpot Auditory Speakers and simplified habit reversal. *Research in Autism Spectrum Disorders* 4(2): 260–267.
67. Marmot M, Allen J, Bell R, Bloomer E and Goldblatt P (2012) WHO European review of social determinants of health and the health divide. *The Lancet* 380(9846): 1011–1029.
68. Mathur R, Rentsch CT, Morton CE, Hulme WJ, Schultze A, MacKenna B, et al. (2021) Ethnic differences in SARS-CoV-2 infection and COVID-19-related hospitalisation, intensive care unit admission, and death in 17 million adults in England: an observational cohort study using the OpenSAFELY platform. *The Lancet* 397(10286): 1711–1724.
69. McMulkin ML, Baird GO, Caskey PM and Ferguson RL (2006) Comprehensive outcomes of surgically treated idiopathic toe walkers. *Journal of Pediatric Orthopedics* 26(5): 606–11.
70. McMulkin ML, Gordon AB, Tompkins BJ, Caskey PM and Baird GO (2016) Long term gait outcomes of surgically treated idiopathic toe walkers. *Gait & Posture* 44(9416830): 216–20.
71. Michalitsis J, Murphy AT, Rawicki B, Haines TP and Williams C (2019) Full length foot orthoses have an immediate treatment effect and modify gait of children with idiopathic toe walking. *Gait & Posture* 68(9416830): 227–231.
72. Miles J (2020) *The Importance of Sex and Gender Reporting.* Available at: https://www.elsevier.com/connect/the-importance-of-sex-and-gender-reporting.
73. Morales DR and Ali SN (2021) COVID-19 and disparities affecting ethnic minorities. *Lancet (London, England)* 397(10286): 1684–1685.
74. Morrow E, Harris J, Gelfer Y, Cashman J, Kothari A and FOOTT-UK Collaborators (2024) Health-related Quality of Life in Idiopathic Toe Walkers: A Multicenter Prospective Cross-sectional Study. *Journal of Pediatric Orthopedics*.
75. Munn Z, Pollock D, Khalil H, Alexander L, Mclnerney P, Godfrey CM, et al. (2022) What are scoping reviews? Providing a formal definition of scoping reviews as a type of evidence synthesis. *JBI Evidence Synthesis* 20(4): 950–952.
76. Ogedegbe G (2020) Responsibility of Medical Journals in Addressing Racism in Health Care. *JAMA Network Open* 3(8): e2016531.
77. Persicke A, Jackson M and Adams A (2014) Brief Report: An Evaluation of TAGteach Components to Decrease Toe-Walking in a 4-Year-Old Child with Autism...Teaching with Acoustical Guidance. *Journal of Autism & Developmental Disorders* 44(4): 965–968.
78. Peters M, ., Godfrey C, McInerney P, Munn Z, Tricco AC and Khalil H (2020) Chapter 11: Scoping

https://doi.org/10.59481/197317

Reviews (2020 version). In: Aromataris E and Munn Z (eds) *JBI Manual for Evidence Synthesis.* : JB!.
79. Peters MDJ, Marnie C, Tricco AC, Pollock D, Munn Z, Alexander L, et al. (2020) Updated methodological guidance for the conduct of scoping reviews. *JBI Evidence Synthesis* 18(10): 2119–2126.
80. Pollind M, Soangra R, Grant-Beuttler M and Aminian A (2019) CUSTOMIZED WEARABLE SENSOR-BASED INSOLES FOR GAIT RE-TRAINING IN IDIOPATHIC TOE WALKERS. *Biomedical Sciences Instrumentation* 55(2): 192–198.
81. Pomarino D, Fregien B, Nazarkin A.Ya., Rostasy K and Emelina AA (2022) Surgical Outcomes in Patients with Toe Walking after Percutaneous Myofasciotomy: Cohort Study. *Voprosy Sovremennoi Pediatrii - Current Pediatrics* 21(2): 125–130.
82. Rahnama L, Soulis K and Geil M (2021) Effects of Non-Restrictive Sensory Insoles in Treatment of Idiopathic Toe Walking: A Single Case, Longitudinal Follow-up Study. *Prosthetics and Orthotics International* 45(6): 190.
83. Rees CA, Stewart AM, Portillo EN, Mehta S, Avakame E, Jackson J, et al. (2023) Reporting of Important Social Determinants of Health in Pediatric Clinical Trials. *American Journal of Preventive Medicine* 64(6): 918–926.
84. Romero MDMG, Sobrino GL, Fragua RV, Requero PT, Caballero JMC, Sanchez CR, et al. (2021) Idiopathic toe gait: Efficacy of botulinum toxin. Description of a series of 134 patients. *Toxicon* 190: S62–S63.
85. Routen A, Bodicoat D, Willis A, Treweek S, Paget S and Khunti K (2022) Tackling the lack of diversity in health research. *British Journal of General Practice* 72(722): 444–447.
86. Santos LD'L, Oliveira Generoso T, Angeli LRAd, Blumetti FC and Barcelos FM (2024) Idiopathic toe walking: What's New? An Integrative Review: An Integrative Review. *Journal of the Foot & Ankle (Online)* 18(1): 21–30.
87. Saraswat P, Carson LT, Shull ER, Hyer LC and Westberry DE (2023) Does use of ankle foot orthoses affect the dynamic motor control index during walking in cerebral palsy and idiopathic toe walking populations? *Gait & Posture* 102(9416830): 100–105.
88. Satila H, Beilmann A, Olsen P, Helander H, Eskelinen M and Huhtala H (2016) Does Botulinum Toxin A Treatment Enhance the Walking Pattern in Idiopathic Toe-Walking? *Neuropediatrics* 47(3): 162–8.
89. Shaw T and Soto-Garcia M (2021) Chiropractic management of toe-walking in an eight-year-old male diagnosed with autism spectrum disorder utilizing a functional approach: A case study. *Journal of Bodywork and Movement Therapies* 26(9700068): 538–541.
90. Shetreat-Klein M, Shinnar S and Rapin I (2014) Abnormalities of joint mobility and gait in children with autism spectrum disorders. *Brain and Development* 36(2): 91–96.
91. Shirel T, Krach L, Sylvanus T, Cho K and Authement A (2022) Efficacy of Serial Casting Protocols in Idiopathic Toe Walking. *Developmental Medicine and Child Neurology* 64: 34–35.
92. Sidman K and Silva R (2018) *Impact of using Heel Wedges to Reduce Idiopathic Toe Walking in a Child with Autism...AOTA Annual Conference & Expo, April 19 to April 22, 2018, Salt Lake City, Utah.* North Bethesda, Maryland: American Occupational Therapy Association.
93. Smart A and Harrison E (2017) The under-representation of minority ethnic groups in UK medical research. *Ethnicity & Health* 22(1): 65–82.
94. Sonuga-Barke E, Chandler S, Lukito S, Kakoulidou M, Moore G, Cooper N, et al. (2024) Participatory translational science of neurodivergence: model for attention-deficit/hyperactivity disorder and autism research. *The British Journal of Psychiatry* 224(4): 127–131.
95. Soto Insuga V, Moreno Vinués B, Losada del Pozo R, Rodrigo Moreno M, Martínez González M, Cutillas Ruiz R, et al. (2018) Do children with attention deficit and hyperactivity disorder (ADHD) have a different gait pattern? Relationship between idiopathic toe-walking and ADHD. *Anales De Pediatría (English Edition)* 88(4): 191–195.
96. Speckemeier C, Niemann A, Wasem J, Buchberger B and Neusser S (2022) Methodological guidance for rapid reviews in healthcare: A scoping review. *Research Synthesis Methods* 13(4): 394–404.
97. Spencer N (2018) The social determinants of child health. *Paediatrics and Child Health* 28(3): 138–143.
98. Stott NS, Walt SE, Lobb GA, Reynolds N and Nicol RO (2004) Treatment for idiopathic toe-walking: results at skeletal maturity. *Journal of Pediatric Orthopedics* 24(1): 63–69.
99. Stott NS (2004) Erratum: Treatment for idiopathic toe-walking. Results at skeletal maturity (Journal of Pediatric Orthopaedics (2004) 24 (63-69)). *Journal of Pediatric Orthopaedics* 24(3): 343.
100. Sutton NR, Robinson-Lane SG, Yeow RY, Chubb HA, Kim T and Chopra V (2022) Racial and ethnic variation in COVID-19 care, treatment, and outcomes: A retrospective cohort study from the MiCOVID-19 registry. *PloS One* 17(11): e0276806.
101. Swartz TH, Palermo AS, Masur SK and Aberg JA (2019) The Science and Value of Diversity: Closing

https://doi.org/10.59481/197317

the Gaps in Our Understanding of Inclusion and Diversity. *The Journal of Infectious Diseases* 220(220 Suppl 2): S33–S41.

102. Swift EK e&, Washington (DC): National Academies Press (US), 2002. 2, and Available from: https://www.ncbi.nlm.nih.gov/books/NBK221050/ (2002) *Institute of Medicine (US) Committee on Guidance for Designing a National Healthcare Disparities Report.* Washington (DC).
103. Szopa A, Domagalska-Szopa M, Gallert-Kopyto W, Kiebzak W and Plinta R (2016) Effect of a nonsurgical treatment program on the gait pattern of idiopathic toe walking: a case report. *Therapeutics and Clinical Risk Management* 12(101253281): 139–46.
104. Taylor-Phillips S, Geppert J, Stinton C, Freeman K, Johnson S, Fraser H, et al. (2017) Comparison of a full systematic review versus rapid review approaches to assess a newborn screening test for tyrosinemia type 1. *Research Synthesis Methods* 8(4): 475–484.
105. Thielemann F, Rockstroh G, Mehrholz J and Druschel C (2019) Serial ankle casts for patients with idiopathic toe walking: effects on functional gait parameters. *Journal of Children's Orthopaedics* 13(2): 147–154.
106. Treweek S, Forouhi NG, Narayan KMV and Khunti K (2020) COVID-19 and ethnicity: who will research results apply to? *The Lancet* 395(10242): 1955–1957.
107. Tuncer D, Caliskan M and Akalan E (2015) Functional bandaging in children with idiopathic toe walking. *Fizyoterapi Rehabilitasyon* 26(3): P27.
108. Tuncer D, Akalan EE, Caliskan MM, Temelli Y and Yigit P (2021) Functional Bandaging in Children with Idiopathic Toe Walking. *Journal of the American Podiatric Medical Association*.
109. Valagussa G, Piscitelli D, Baruffini S, Panzeri V, Perin C, Mazzucchelli M, et al. (2024) Little Evidence for Conservative Toe Walking Interventions in Autism Spectrum Disorders: a Systematic Review. *Review Journal of Autism and Developmental Disorders* 11(1): 107–120.
110. van Bemmel AF, van de Graaf VA, van den Bekerom MPJ and Vergroesen DA (2014) Outcome after conservative and operative treatment of children with idiopathic toe walking: a systematic review of literature. *Musculoskeletal Surgery* 98(2): 87–93.
111. van Kuijk AAA, Kosters R, Vugts M and Geurts ACH (2014) Treatment for idiopathic toe walking: a systematic review of the literature. *Journal of Rehabilitation Medicine* 46(10): 945–957.
112. von Rueden U, Gosch A, Rajmil L, Bisegger C and Ravens-Sieberer U (2006) Socioeconomic determinants of health related quality of life in childhood and adolescence: results from a European study. *Journal of Epidemiology and Community Health* 60(2): 130–135.
113. Washington V, Franklin JB, Huang ES, Mega JL and Abernethy AP (2023) Diversity, Equity, and Inclusion in Clinical Research: A Path Toward Precision Health for Everyone. *Clinical Pharmacology & Therapeutics* 113(3): 575–584.
114. Westberry DE, Carpenter AM, Brandt A, Barre A, Hilton SB, Saraswat P, et al. (2021) Surgical Outcomes for Severe Idiopathic Toe Walkers. *Journal of Pediatric Orthopedics* 41(2): e116–e124.
115. Wilder DA, Ingram G and Hodges AC (2022) Evaluation of shoe inserts to reduce toe walking in young children with autism. *Behavioral Interventions* 37(3): 754–765.
116. Wilder DA, Ertel H, Hodges AC, Thomas R and Luong N (2020) The use of auditory feedback and edible reinforcement to decrease toe walking among children with autism. *Journal of Applied Behavior Analysis* 53(1): 554–562.
117. Williams C and Haines T (2015) Idiopathic toe walking may impact on quality of life. *Journal of Foot and Ankle Research* 8(Suppl 2): O40.
118. Williams C, Robson K, Pacey V and Gray K (2020) American and Australian family experiences while receiving a diagnosis or having treatment for idiopathic toe walking: a qualitative study. *BMJ Open* 10(9): e035965.
119. Zapata K, Trevino M, Reyes F, Jo C and Sharma C (2022) Quality Improvement of Serial Casting for Idiopathic Toe Walking. *Developmental Medicine and Child Neurology* 64: 82.
120. Zapata KA, Trevino ME, Reyes FI, Jo C and Sharma C (2022) Adherence to serial casting protocols for idiopathic toe walking: A quality improvement initiative. *Journal of Pediatric Rehabilitation Medicine* 15(3): 469–476.

https://doi.org/10.59481/197317

Appendix 1: Summary of included studies

Study ID	Report/abstract	Country	Aim of study	Study design	Total Participants
Alvarado (2021)	Abstract	United States	Does the Toe Tamer protocol have a significant effect on decreasing the heel-to-floor distance of children 4-7 y/o who idiopathically toe-walk?	Experimental	1
Barkocy (2017)	Report	United States	To evaluate the effectiveness of serial casting in a child with autism spectrum disorder (ASD) exhibiting a toe-walking gait pattern with equinus contractures.	Descriptive	1
Barkocy (2021)	Report	United States	To determine the effect of a 2-step intervention, SC and AFOs, on walking kinematics and functional outcomes in Ch-ASD who toe walk.	Analytical	5
Barkocy (2021)	Report	United States	To (1) explore and characterize PT ITW care experiences from the parent perspective to inform development of a CPG and (2) identify strengths and gaps in care perceived by this key stakeholder group to optimize PT care for children with ITW.	Descriptive	98
Bartoletta (2021)	Report	United States	To examine the outcomes of commonly used nonoperative treatment techniques in a large cohort of children with ITW to better understand outcomes and rates of recurrence to inform management of this condition	Analytic	204
Benedetti (2013)	Abstract	Italy	To evaluate the effectiveness of the treatment with Botulinum Toxin A of calf muscles in children with Idiopathic Toe Walking	Experimental	9
Berger (2021a)	Report	Germany	To provide a retrospective evaluation of the treatment of ITW with the circular lower leg orthosis at our clinic.	Analytic	22
Bonnefoy-Mazure (2023)	Abstract	Switzerland	The aims of this study were: 1) to observe gait parameters evolution for a group of patients with surgery and conservative treatment; 2) to compare these parameters for a group of matched patients with surgery and without; 3) to compare these parameters with a group of asymptomatic children	Analytic	29
Boyd (2023)	Report	United States	To understand Smart Stepper (a new wearable system) from a human-factors perspective. Specifically, we were interested in understanding if Smart Stepper would work in a real-life context and if families would be willing to adopt the intervention as a practice. Areas we focused on were Acceptability, Implementation, Demand, Practicality, and Limited efficacy.	Analytic	8
Brasiliano (2022)	Report	Italy	To evaluate the effectiveness of the orthosis in restoring a physiological heel-to-toe gait pattern, by performing instrumented 3D gait analysis of children with ITW walking barefoot and while wearing it.	Experimental	21

https://doi.org/10.59481/197317

Study ID	Report/abstract	Country	Aim of study	Study design	Total Participants
Brasiliano (2023)	Report	Italy	To evaluate the accuracy and precision of a selection of MIMU-based algorithms for foot strike estimation in children with ITW.	Experimental	6
Brierty (2018)	Report	Australia	To investigate the effect of zone two calf-lengthening on post-operative gait in two clinical populations (ITW and CP).	Analytic	17
Brunt (2004)	Report	United States	To determine the effects of botulinum toxin type A treatment on ankle muscle activity during gait of children who are idiopathic toe walkers	Analytic	5
Clark (2010)	Report	United States	To (1) to develop a physical therapy motor control intervention protocol and (2) to evaluate the effects of this protocol on gait, motor skill development; and ankle mobility in 5 children aged 21/2 to 6 years with ITW.	Analytic	5
Engstrom (2010)	Report	Sweden	To investigate whether BTX treatment improves the walking pattern in children with ITW as examined with 3-D gait analysis and, secondarily, to classify the severity of the toe-walking pattern	Experimental	15
Engstrom (2013)	Report	Sweden	To evaluate whether botulinum toxin A improves the results of treatment of idiopathic toe-walking with below-the-knee walking casts.	Experimental	47
Fanchiang (2015)	Report	Taiwan	To test the following hypotheses: (1) Typically developing children and/or children with idiopathic toe walking will show different velocity, cadence, step length, step width, and heel rise timing after a bout of vibration intervention. (2) Children with idiopathic toe walking will show hyper-sensitivity to vibration. (3) A dose of whole-body vibration will desensitize the perception to vibration	Analytical	30
Filippetti (2022)	Report	Italy	To explore the efficacy and the tolerability of incobotulinumtoxinA for the treatment of children with ITW	Analytic	28
Grant-Beuttler (2023)	Abstract	United States	To determine if immediate and summary feedback in the natural environment retrain heel strike in children with ITW?	Analytical	14
Hemo (2006)	Report	United States	To objectively compare outcomes between the AFO and FO with an attached rigid carbon fibre footplate in children with ITW.	Experimental	18
Herrin (2016)	Report	United States	Aim of study	Study design	Total Participants
Study ID	Report/abstract	Country			

https://doi.org/10.59481/197317

Hirsch(2004)	Report	Sweden	To report the outcome of ITW in children treated with non-surgical methods	Descriptive	14
Hodges (2018)	Report	United States	To evaluate the use of a wristband as a discriminative stimulus. In the presence of the wrist- band, appropriate walking was praised, and toe walking was reprimanded	Analytic	1
Hoffman (2022)	Report	United States	To investigate whether CTP-AFOs would be comparable with serial casting in standardized outcome measures for range of motion, gait and motor skills amongst children with ITW and ankle equinus contracture	Experimental	35
Jadhav (2017)	Abstract	United States	To evaluate the efficacy of treating ITW using botulinum toxin A (BtxA) injections into the gastrocnemii in conjunction with serial casting and ankle-foot orthosis (AFOs) versus serial casting and AFOs use alone	Analytic	84
Jahn (2009)	Report	United States	To determine if muscle-tendon lengths increase following surgeries., if they were significantly different post-operatively, whether there were differences in outcomes between the surgery types or the diagnoses?	Analytic	38
Lara (2016)	Report	Spain	To verify the impact of a home exercise programme associated with the use of a noctornal orthosisin the management of idiopathic toe walking	Analytic	88
Manfredi (2022)	Report	Italy	To assess the clinical effectiveness of our protocol in ASD patients affected by ITW at long-term follow-up with ankle angle restore and non-pathological walking	Analytic	22
Marcus (2010)	Report	Ireland	To evaluate the effectiveness of a simplified habit reversal training with the use of GaitSpot speakers and differential reinforcement of incompatible behaviour to reduce the frequency of ITW and to train the participants to walk with an appropriate heel-to-toe gait	Analytic	3
McMulkin (2006)	Report	United States	To comprehensively assess the quantitative outcome of idiopathic toe walkers that have been treated surgically with gastrocnemius/soleus lengthening procedures	Analytic	14
McMulkin (2016)	Report	United States	To assess longer term kinematic and kinetic outcomes of children with idiopathic toe walking who were treated surgically to address gastrocnemius/soleus contractures	Analytic	8
Study ID	Report/abstract	Country	Aim of study	Study design	Total Participants
Michalitsis (2019)	Report	Australia	To determine the difference between barefoot, preferred footwear and combined treatment of footwear and orthoses on heel contact, spatiotemporal parameters of gait in children diagnosed with ITW	Experimental	15

https://doi.org/10.59481/197317

Persicke (2014)	Report	United States	To evaluate the use of an acoustical conditioned reinforcer (TAG) in addition to minimal correction procedures to decrease toe-walking for a young child with autism.	Analytic	1
Pollind (2019)	Report	United States	To determine the feasibility of customized wearable sensor-based insoles for gait re-training in idiopathic toe walking adolescents	Analytic	5
Pomarino (2022)	Report	Germany	To study the results of percutaneous myofasciotomy in patients with idiopathic toe walking with severe foot deformity and no effect of conservative therapy.	Analytic	50
Rahnama (2021)	Abstract	United States	To determine the long-term effects of a sensory-stimulating insole on walking in a child with ITW	Descriptive	1
Romero (2021)	Abstract	Spain	To investigate the safety and efficacy of botulinum toxin treatment in a large series of patients.	Experimental	134
Saraswat (2023)	Report	United States	To assess the change in walk-DMC index secondary to AFO use among CP and ITW patient	Analytic	45
Satila (2016)	Report	Finland	To evaluate the hypothesis that a combination of conservative treatment (night splints, firm shoes, physiotherapy, and home stretch program) and repeated BTX-A injections are more effective in decreasing toe-walking than conservative treatment alone at 24 months follow-up	Experimental	30
Shaw (2021)	Report	United States	To discuss the treatment of idiopathic toe-walking utilizing cognitive-motor dual-tasking and primitive reflex integration exercises.	Descriptive	1
Shirel (2022)	Report	United States	To determine ROM changes with cast change intervals of one vs. two weeks, and the rate of ITW recurrence.	Analytic	86
Sidman (2018)	Abstract	United States	To investigate the impact of using heel wedge inserts to decrease toe walking in a child with autism with insidious toe walking in a school setting	Descriptive	1
Stott (2004)	Report	New Zealand	To document the results at skeletal maturity of treatment of idiopathic toe-walking in a non-consecutive cohort of subjects treated by one pediatric orthopaedic surgeon.	Analytic	13
Study ID	Report/abstract	Country	Aim of study	Study design	Total Participants
Szopa (2016)	Report	Poland	To determine if the combination of increased ankle dorsiflexion and inhibited hyperactivity of the foot reflexes (toe-grasping reflex of the foot and support reflex of the legs) can be use full in the treatment of young children with severe ITW by	Descriptive	1

https://doi.org/10.59481/197317

			providing a persistent stretch to the gastrocnemius and soleus contractures and improving the gait pattern		
Thielemann (2019)	Report	Germany	To demonstrate improvement in the plantar heel force; and secondly, to describe changes in kinematics and kinetics during gait that occur after serial casting.	Analytic	20
Tuncer (2015)	Abstract	Turkey	To examine the acute effects of Kinesio-tapingÂ® (KT) in a child with ITW	Descriptive	1
Tuncer (2021)	Report	Turkey	To evaluate the acute effects of dorsiflexion-assisted functional bandaging applied in children with ITW to achieve heel strike at initial contact, gain heel contact at loading response, prevent premature heel-off at midstance, and investigate whether this application helps to improve gait quality, providing an alternative conservative intervention for children with ITW.	Analytic	29
Westberry (2021)	Report	United States	To review the outcomes of surgical treatment (plantar flexor lengthening) in a population of patients with severe ITW who had failed prior conservative management. In addition, we sought to determine differences in outcomes based on the type of plantar flexor lengthening that was performed	Analytic	26
Wilder (2020)	Report	United States	To replicate and extend previous research on the use of auditory feedback to decrease toe walking exhibited by 3 children with autism	Descriptive	3
Wilder (2022)	Report	United States	To verify that toe walking exhibited by two young children with autism was maintained by automatic reinforcement.	Descriptive	2
Williams (2020)	Report	USA and Australia	To understand parent journeys while navigating diagnosis, assessment or treatment of their children with idiopathic toe walking (ITW).	Qualitative	10
Zapata (2022a)	Report	United States	To assessing adherence to the current clinical serial casting protocols and the ultimate goal of deciding whether to change Scottish Rite for Children's protocols and/or to further educate PTs regarding serial casting findings.	Analytic	60

How to cite this article:
J.D. Harris, G. Whitley, K. Freeman, S.C. Morrison Social characteristics of children and families involved in Idiopathic Toe-Walking research: a rapid scoping review. The Association of Paediatric Chartered Physiotherapists Journal 17 2026;00: 3 –25 https://doi.org/10.59481/197317