The Prevalence and Course of Idiopathic Toe-Walking in 5-Year-Old Children

WHAT'S KNOWN ON THIS SUBJECT: Children without any underlying medical condition who walk on their toes are referred to as idiopathic toe-walkers. The prevalence and early course of idiopathic toe-walking are unknown.

WHAT THIS STUDY ADDS: This study establishes the prevalence and early spontaneous course of idiopathic toe-walking in a large, well-defined cohort of 5.5-year-old children.

abstract

BACKGROUND: Children walking on their toes instead of with a typical gait, without evidence of an underlying medical condition, are defined as idiopathic toe-walkers. The prevalence of idiopathic toe-walking is unknown.

METHODS: A cross-sectional prevalence study of 5.5-year-old children (n = 1436) living in Blekinge County, Sweden, was performed at the regular 5.5-year visit to the local child welfare center. Children were assessed for a history of toe-walking or whether they still walked on their toes. Additionally, all 5.5-year-old children (n = 35) admitted to the clinic for children with special needs in the county were assessed.

RESULTS: Of the 1436 children in the cohort (750 boys, 686 girls), 30 children (2.1%, 20 boys and 10 girls) still walked on their toes at age 5.5 years and were considered as active toe-walkers. Forty children (2.8%, 22 boys and 18 girls) had previously walked on their toes but had stopped before the 5.5-year visit and were considered as inactive toe-walkers. At age 5.5 years, the total prevalence of toe-walking was 70 (4.9%) of 1436. For children with a neuropsychiatric diagnosis or developmental delay, the total prevalence for active or inactive toe-walking was 7 (41.2%) of 17.

CONCLUSIONS: This study establishes the prevalence and early spontaneous course of idiopathic toe-walking in 5.5-year-old children. At this age, more than half of the children have spontaneously ceased to walk on their toes. The study confirms earlier findings that toe-walking has a high prevalence among children with a cognitive disorder. Pediatrics 2012;130:279–284
Idiopathic toe-walking (ITW) is a term used to describe a condition in which children walk on their toes instead of walking with a typical gait. It is a diagnosis of exclusion, where other conditions, such as cerebral palsy, causing an equinus gait have been ruled out.\textsuperscript{1–3} Apart from this, there is no unanimous definition of ITW. Habitual toe-walking is sometimes used as a synonym for ITW, and contractures of the Achilles tendon may or may not be present.\textsuperscript{1,4–7} Even though toe-walking is not an uncommon reason for parental concern at well-child clinic visits or at follow-up visits at child welfare centers (CWCs), the prevalence and natural history are largely unknown. It is often somewhat casually considered to be within the normal range of motor behavior for a small child, but many children and parents experience problems and worry. A school-aged or teenaged child still presenting with a toe-walking gait can report pain, bullying, and inability to join in a range of sports.\textsuperscript{2,8–12} Thus, ITW is a relatively common reason for referral to a pediatric orthopedic surgeon or pediatric neurologist.

To be able to improve evaluation of current treatment options and provide parents of preschool children with a prognosis, we designed a study to determine the prevalence and early history of ITW in a large well-defined cohort. Empirically, a suitable age for establishing the prevalence of clinically important ITW is 5 to 6 years. At this age, some children who have been idiopathic toe-walkers (ITWs) have ceased toe-walking spontaneously and the remaining toe-walking children may merit further investigation.

CWCs provide the primary health care for children in Sweden. Their purpose is to promote children’s health and development from infancy to 6 years of age. Specially trained nurses and doctors (general practitioners or pediatricians) provide this service and almost 100% of the children attend the follow-up visits.\textsuperscript{13–15} The 5.5-year follow-up is the last visit to the CWC before the responsibility of health monitoring is transferred to the school health services. At the 5.5-year visit, several different aspects of the child's development are assessed, such as gross and fine motor development, perception, executive functions, hearing, language, and general development.

Blekinge County, in the southeast of Sweden, has a population of about 150,000, an annual birth rate of about 1500, and 22 CWCs. In the county, 125,000 people live in towns or villages and 25,000 live in rural areas; 10% of the population was born abroad and/or have a foreign citizenship.

The aim of this study was to elucidate the prevalence of ITW in 5- to 6-year-old children living in Blekinge County. Both ongoing toe-walking (active) and toe-walking that has ceased before the 5.5-year visit (inactive) were evaluated.

**METHODS**

A cross-sectional prevalence study was conducted, including children attending the 5.5-year visit at CWCs in Blekinge from May 3, 2010, to June 15, 2011. At the time of the follow-up, all parents were asked whether their child had a history of previous toe-walking (inactive toe-walking) or whether the child still, to any extent, walked on his or her toes (active toe-walking). Before commencement of the study, one of the authors visited all CWCs and informed the staff about ITW and the study. The staff at the CWCs was instructed to classify a child as a toe-walker regardless of the amount of toe-walking and regardless of the duration of the toe-walking.

One registered nurse at each CWC was assigned as the local study contact. At the 5.5-year visit, this nurse questioned all parents and completed a short questionnaire for each child who was or had been a toe-walker. Forms were sent to one of the authors (P.E.) at the orthopedic clinic in Blekinge County.

The parents of the inactive toe-walkers were interviewed by telephone. The parents were asked to specify during which period in the child’s life the toe-walking had been evident and to estimate the maximum percentage of time (25%, 50%, 75%, or 100%) that the child had spent on his or her toes during barefoot walking. In addition, questions were asked about the child’s age at independent walking, when toe-walking was first noticed, and whether there was any family history of toe-walking.

Last, any medical conditions that could be considered as a cause of toe-walking were elicited.

All children classified as active toe-walkers at the time of the 5.5-year visit were reported to and clinically examined at the orthopedic outpatient clinic, and parents received the same questions as the inactive toe-walkers. The clinical assessment focused on detecting a possible cause of the toe-walking and included an orthopedic examination with an emphasis on the lower extremities, as well as a neurologic examination. The child was examined wearing only shorts, and the back and the extremities were inspected. The range of movement in the hip, knee, and ankle joints was measured with a goniometer (ankle range of motion was assessed with the knee both flexed and extended). Gait, balance, deep tendon reflexes, muscle tone, and presence of possible Babinski signs were evaluated. The same pediatric orthopedic surgeon (P.E.) conducted all assessments.

In most of Sweden and Blekinge, children with a developmental or physical disability requiring habilitation services are followed at a regional “clinic for children with special needs.” Most of these children attend the CWCs for routine medical procedures, such as immunization, but do not attend the
developmentally oriented visits, such as the 5.5-year visit. Parents to children in the appropriate age range, and listed at the clinic for children with special needs, were interviewed by telephone and questioned about their child’s medical/developmental diagnosis and toe-walking history. The same set of questions as was used for the other groups of children was used.

Of the 22 CWCs in the county, 21 took part in the study. One CWC that serves a representative sample of the population in Blekinge area did not participate because of ongoing organizational and structural changes during the study period.

To check for method validity, 10% (n = 140) of the parents of the 5- to 6-year-old children who were assessed at different CWCs were randomly chosen and contacted after the study. A research nurse evaluated whether the parents had understood the questions about toe-walking at the CWC 5.5-year visit and whether any toe-walkers had been missed.

Parents of the children were given oral and written information about the study and thereafter consented to participate in the study. The ethics committee at the Karolinska University Hospital approved the study.

**Statistical Analysis**

The effect of gender was analyzed with $\chi^2$ test with 1 degree of freedom; $P \leq .05$ for statistical significance.

**RESULTS**

Of all 1677 eligible children living in the County of Blekinge who turned 5.5 years old during the study period, 1436 (86%) constituted the study population; 241 children did not take part in the study. One hundred children were listed at the nonparticipating CWC and 141 children were for various reasons, such as lack of time or forgetfulness on the part of staff, not asked specifically about toe-walking at their 5.5-year visit. Of the participating 1436 children, 35 were listed at the regional clinic for children with special needs. Eighteen of these children had a motor disorder, such as cerebral palsy, spina bifida, or tethered cord, which excluded them as ITW. Seventeen of the 35 children had no motor disability but a cognitive or neuropsychiatric diagnosis, such as autism, unspecified delayed development, or attention-deficit/hyperactivity disorder. The prevalence calculation for the whole study cohort (n = 1436) included these 35 children. Calculation of prevalence was also performed on the 1401 children without a motor or neuropsychiatric disability. These children are referred to as “healthy children” in this article.

Of the 1436 children (750 boys, 686 girls), 30 children (2.09%) still walked on their toes and were considered as active toe-walkers. Forty children (2.79%) had previously walked on their toes but stopped before the 5.5-year visit and were considered as inactive toe-walkers. At age 5.5 years, the total prevalence for children ever having been a toe walker was 70 (4.87%) of 1436 (95% confidence interval: 3.76% to 5.99%). Details about the prevalence and different subgroups (active, inactive) are outlined in Table 1. For information about the extent of the toe-walking and for length of time parents reported that each healthy child had been toe-walking, see Fig 1A–C.

There was no statistical difference in the prevalence between boys and girls in the total study population, nor in the active or inactive subgroup.

**Healthy Active Toe-Walkers**

Of the 26 of 1401 active toe-walkers, all but 4 children reached independent walking before 14 months of age and the remaining 4 children started to walk before 17 months of age. Parents of 17 of the children became aware of their child’s tendency to toe-walk immediately, as soon as the child started to walk, and another 7 parents stated that they had noticed the toe-walking tendency within the first year after independent walking. For 2 of the children, the parents noticed the toe-walking later: 25 and 36 months after independent walking.

A family history of toe-walking in a first- or second-degree relative was reported in 11 (42.3%) of the children, and 1 child had a more distant relative who had been a toe-walker.

The clinical examination of the 28 active toe-walkers did not display any medical cause of the toe-walking. The neurologic examination was normal, without any signs of spasticity or muscular

**TABLE 1 Prevalence of Active and Inactive ITW**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Idiopathic Toe-walkers, n</th>
<th>Cohort, n</th>
<th>Prevalence, %</th>
<th>95% CI</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total cohort</td>
<td>70</td>
<td>1436</td>
<td>4.87</td>
<td>3.76–5.99</td>
</tr>
<tr>
<td>Total cohort girls</td>
<td>28</td>
<td>686</td>
<td>4.08</td>
<td>2.60–5.56</td>
</tr>
<tr>
<td>Total cohort boys</td>
<td>42</td>
<td>750</td>
<td>5.60</td>
<td>3.96–7.27</td>
</tr>
<tr>
<td>Total cohort active girls</td>
<td>10</td>
<td>686</td>
<td>1.46</td>
<td>0.56–2.38</td>
</tr>
<tr>
<td>Total cohort active boys</td>
<td>20</td>
<td>750</td>
<td>2.67</td>
<td>1.51–3.82</td>
</tr>
<tr>
<td>Total cohort inactive girls</td>
<td>18</td>
<td>686</td>
<td>2.62</td>
<td>1.45–3.82</td>
</tr>
<tr>
<td>Total cohort inactive boys</td>
<td>22</td>
<td>750</td>
<td>2.93</td>
<td>1.73–4.14</td>
</tr>
<tr>
<td>All healthy children</td>
<td>63</td>
<td>1401</td>
<td>4.50</td>
<td>3.41–5.58</td>
</tr>
<tr>
<td>Healthy active ITW girls</td>
<td>10</td>
<td>676</td>
<td>1.48</td>
<td>0.57–2.39</td>
</tr>
<tr>
<td>Healthy active ITW boys</td>
<td>16</td>
<td>725</td>
<td>2.21</td>
<td>1.14–3.38</td>
</tr>
<tr>
<td>Active healthy ITW girls + boys</td>
<td>26</td>
<td>1401</td>
<td>1.86</td>
<td>1.15–2.56</td>
</tr>
<tr>
<td>Inactive healthy ITW girls</td>
<td>18</td>
<td>676</td>
<td>2.66</td>
<td>1.45–3.88</td>
</tr>
<tr>
<td>Inactive healthy ITW boys</td>
<td>19</td>
<td>725</td>
<td>2.62</td>
<td>1.46–3.78</td>
</tr>
<tr>
<td>Inactive healthy ITW girls + boys</td>
<td>37</td>
<td>1401</td>
<td>2.64</td>
<td>1.80–3.48</td>
</tr>
</tbody>
</table>

Healthy indicates not diagnosed with a motor or neuropsychiatric condition. CI, confidence interval.
engagement excluding the diagnosis of ITW.

No child had <0° of ankle dorsal extension and 9 children had between 0° and 5° of ankle dorsal extension, with the knee extended. Three children had less than 10° (all had 5°) of ankle dorsal extension, with the knee flexed 90°. There were no significant deviations from reference values for knee and hip range of movement.

A few children identified in the study had received information about stretching of the calf muscles and Achilles tendon before the 5.5-year visit. Apart from this, no treatment had been given to any of the toe-walkers. After the study, 1 child with a flexion contracture of the ankle underwent a percutaneous lengthening of the Achilles tendon.

Healthy Inactive Toe-Walkers

Of the 37 of 1401 inactive toe-walkers, 28 reached independent walking before 13 months of age, and all but 1 child, who started to walk at 24 months, started to walk before 18 months of age. For this late-walking child, psychomotor development and CWC assessments were otherwise normal.

Parents noticed a tendency for toe-walking at walking debut in 24 of the 37 children, and another 11 noticed it within the first year after independent walking. For 1 child the parents could not recall any toe-walking until 2 years after independent walking.

Fourteen (37.8%) of the children had a first- or second-degree relative who had been or was still a toe-walker; in addition, 2 children had more distant relatives who had been toe-walkers.

Toe-Walking in Children With a Cognitive or Neuropsychiatric Disorder

Of the 17 children without a motor disorder but with a cognitive or neuropsychiatric disorder who were seen at the clinic for children with special needs, 4 children (23.5%, all boys) were still active toe-walkers, and another 3 (17.6%, all boys) were inactive toe-walkers. The total prevalence for being or having been a toe-walker in this group of children was 7 (41.2%) of 17.

In this group of children, independent walking was reached before 18 months in all but 1 child who started independent walking at 24 months age. Parents noticed a tendency for toe-walking at walking debut in 3 of the 7 children; for 2 children, toe-walking was noticed within the first year after independent walking; and for 1 child, toe-walking was noticed 2 years after independent walking. For 1 child, the
parents could not remember when the toe-walking started. Two children had a family history of ITW. These children had been neurologically examined as part of their cognitive or neuropsychiatric disorder and were not clinically examined in this study. None of the 7 active/inactive toe-walkers had received any treatment directed toward toe-walking.

Method Validity
The validity check after the study revealed good comprehension of the questions asked at the CWC visit. The procedure revealed 1 inactive toe-walker and no additional active toe-walkers. The identified inactive toe-walker was 1 of the 141 children who had not previously been questioned about ITW at the CWC. This child was not included in the statistics.

DISCUSSION
This study establishes the prevalence of ITW in 5.5-year-old children in Sweden. At 5.5 years of age, 2.09% are ITWs and an additional 2.79% of the children have previously been toe-walkers but had stopped by 5.5 years.

Before this study, little was known about the prevalence of ITW. Only 1 study focusing on a relationship between late speech development and toe-walking also investigated the prevalence of current or reported toe-walking in 166 children seen at well-child visits in 1 hospital. In this study, which reported an unexpectedly high prevalence of 24%, ITW was defined as “toe-walking during at least 1 month or at the examination.” Children included in the study were aged between 8 months and 10 years and were divided into 3 age groups. The study reported a 35% prevalence of ITW in the age group 0 to 2 years (n = 41), 19% in the age group 2 to 6 years (n = 78), and 22% in the age group 6 to 10 years (n = 44). It is difficult to interpret the high prevalence for ITW in this study; however, the number of children seen toe-walking in society or referred to specialist clinics would likely be much higher if this figure reflects the true prevalence.

About 40% of the children had a first- or second-degree relative who had been a toe-walker. This is in line with previous studies, which have reported a family history in 30% to 40% of children with ITW.

For children with an autism spectrum disorder or a communication/language disorder, the prevalence of ITW has been reported to be much higher: 19% to 63% in several studies. Thus, the prevalence of ITW appears to be low among children with typical development, whereas it is a common symptom among children with a cognitive or neuropsychiatric disorder. Overall, most children who are ITWs will not have any developmental problems or neuropsychiatric symptoms.

In this study, a typical toe-walker commences toe-walking at independent walking, but some children do not start to toe-walk until later, most often during the first year of independent walking. Toe-walkers have their walking debut at the same age as other normally developing children (with 1 exception in this study). A typical active toe-walker spends 25% of the time on his or her toes. An inactive toe-walker has walked on his or her toes for 12 to 24 months. During the period of active toe-walking, 25% to 100% of the child’s time was spent on toes.

At age 5.5 years, more than half of the children in this study had spontaneously ceased toe-walking. For the remainder, some will continue to toe-walk and experience a range of problems: many school-aged children will complain of ankle and heel ache, particularly after activity; reduced ankle dorsiflexion precludes using skates or downhill skiing boots, as well as walking uphill; and an odd-looking walking pattern will attract nasty comments from peers. Toe-walking is very rarely seen in adults, but the adult presentation of ITW is not toe-walking, but often other manifestations of tight calf muscles or Achilles tendon. A relationship has been reported between persistent toe-walking and development of ankle equinus. Furthermore, ankle equinus has been suspected of causing several foot problems in adults.

This study establishes the prevalence of ITW in a cohort of 1436 children. All children classified as active toe-walkers were examined as part of this study or as part of a developmental investigation. This gives the method, a high level of validity. For some aspects of this study there is a risk of recall bias; it is sometimes difficult for parents to remember when the child started to walk independently, and when the toe-walk was first noticed and when it ended. This bias is more likely to be related to the inactive rather than the active toe-walkers. Another area of this study in which parental answers may be less precise could be the percentage of the time that the parents consider that their child walked on his or her toes.

Last, the family history of ITW might be underestimated, as parents did not usually question all their relatives about toe-walking. The cohort of children with a neuropsychiatric disorder in this study is too small for conclusions, but nevertheless the prevalence of 41.2% ITW is in line with larger studies, establishing this relationship.

In conclusion, this is the first study of a large cohort of children that reports the prevalence and early course of ITW. This should be of value to the clinician and will help in providing parents with accurate information as well as aid in deciding on treatment.

ACKNOWLEDGMENTS
We acknowledge all the staff at the various CWCs in Blekinge County for their enduring work during the study.
REFERENCES


ON REINVENTION: Dressed professionally, equipped with stethoscopes, and smiling from ear to ear, my classmates and I recently embarked on one of the most important transitions in a medical student’s career — the beginning of our clerkship year. After a lot of classroom work we would now rotate through the different clinical specialties, spending anywhere from four to eight weeks immersed in one particular field. The clerkship year is a time of elation, stress, and intense learning. Students are now making a difference in the care of patients — our primary motivation for attending medical school. However, for many individuals, the stressors associated with the clerkship year may result in decreased empathy and a reduction in overall wellbeing. As reported in The New York Times (Well: April 19, 2012), some schools have opted to change the structure of the clerkship year. Rather than spending blocks of time in a particular specialty (e.g., pediatrics), schools have developed longitudinal models in which a group of patients are assigned to a student. The student then follows the patients throughout the year, going wherever their patients’ needs take them. Goals of the longitudinal experience include strengthening student-caregiver relationships and maintenance of empathy and professional behaviors. Whether a longitudinal model is better than a traditional rotating clerkship year is not known. So far, students have done at least as well on objectives measures and report higher satisfaction with the year. A longitudinal model does require increased faculty effort, greater emotional commitment from students, and it is possible that students may never care for patients with specific ailments. I may just be starting the clerkship year; but regardless of the curriculum, I already appreciate the value of relationships and communication that extends beyond short healthcare encounters.

Noted by Leah H. Carr, BS, MS-III
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