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Teething and Tooth Eruption in Infants: A Cohort Study

Melissa Wake, MBChB, MD; Kylie Hesketh, BBS(Hons); and James Lucas, BSc, MDSc

ABSTRACT. *Objective.* Many symptoms are attributed to teething in infants. There is little evidence to support these beliefs, despite their implications for clinical management. We investigated relationships between tooth eruption, fever, and teething symptoms.

Methods. Prospective cohort study.

Participants. Twenty-one children 6 to 24 months old attending 3 suburban long-day care centers ≥ 3 days/week.

Measures. 1) Daily temperature recording and examination of alveolar ridges for tooth eruption (dental therapist). 2) Daily questionnaires—symptoms over preceding 24 hours (staff and parents independently). 3) Final questionnaire—beliefs/experiences related to teething (parents).

Definitions. *Eruption day*—the first day a tooth could be seen or felt. *Non-toothdays*—more than 28 days clear of any eruption day. *Toothdays*—the 5 days preceding eruption days.

Results. Data were collected for 236 toothdays and 895 non-toothdays pertaining to 90 teeth. Child temperatures were similar on toothdays and non-toothdays (36.21 vs 36.18, paired *t* test). Logistic regression adjusted for age did not show an association between toothdays and temperature (odds ratio [OR] = 1.35, 95% confidence interval [CI] = 0.80, 2.27 for high fever; OR = 1.34, 95% CI = 0.48, 3.77 for low fever). Logistic regression models allowing for within-child cluster effects and age were fitted to daily staff and parent reports of mood, wellness/illness, drooling/dribbling, sleep, diarrhea, strong diapers, red cheeks, and rashes/flushing. Only parent-reported (but not staff-reported) loose stools were significantly associated with tooth eruption (OR = 1.86, 95% CI = 1.26, 2.73). When the toothday definition was varied to 10 days preceding or 5 days surrounding tooth eruption, this single significant association was no longer apparent (OR = 1.42, 95% CI = 0.98, 2.05 and OR = 1.47, 95% CI = 0.97, 2.21, respectively). All parents retrospectively reported that their own children had suffered a range of teething symptoms.

Conclusions. This study did not confirm the expected strong associations between tooth eruption and a range of teething symptoms in children 6 to 30 months old, although we cannot rule out the possibility that weak associations may exist (Type II error). These findings contrast with strong parent and professional beliefs to the contrary. Such beliefs may preclude optimal management of common patterns of illness and behavior in

young children. *Pediatrics* 2000;106:1374–1379; *teething, infants, symptoms, tooth eruption, illness.*

ABBREVIATIONS. OR, odds ratio; CI, confidence interval.

Many symptoms are attributed to teething in infancy. Some, such as irritability, drooling, mouthing, and sleep disturbance, may seem trivial but are significant for the child and parents; a few, such as fever, diarrhea, strong urine, and susceptibility to infections, may have far more serious implications.¹ Surveys of parents,² pediatricians,^{3–5} and other child health professionals⁵ reveal that beliefs in teething symptoms are common and stable over time, and are similar across all groups studied. In contrast, academic publications^{6–12} tend to take the view that teething causes few, if any, symptoms and that no serious illness should ever be ascribed to tooth eruption. Very little research exists to support either view. What is the truth about teething?

Tooth eruption is the process by which a tooth moves from its site of development within the jaws to its final functional position in the oral cavity.¹³ Although the tooth itself seems to play no active role in the process, the dental follicle, which is a rich source of eicosanoids, cytokines, and growth factors,¹⁴ seems to be crucial. It is thus quite plausible that teething may lead to local symptoms which are inflammatory or irritative in nature. Supporting this, in one prospective study, mothers of 224 infants reported 74% and 100% to suffer at least one local disturbance during the eruption of the front and back teeth, respectively.¹⁵ In another, teething infants were reported to show significantly more mouthing, sucking, and drooling than nonteething infants.¹⁶ Mothers reported significant relief in a double-blind randomized controlled trial of a teething solution containing lignocaine, benzyl alcohol, and myrrh tincture against placebo, the inference being that the infants were indeed symptomatic at the time of treatment, although relief was independent of the stage of eruption and evident only for males.¹⁷

Three prospective studies have addressed possible relationships between teething and more general symptoms. In one, mothers recorded both tooth eruption and its effects. A wide range of general disturbances were reported, including fever, infection, sleep disturbance, and diarrhea.¹⁸ In another, a physician recorded tooth eruption and noted increased daytime restlessness only.¹⁶ A third reported a rise in mean daily temperature of 0.5°C in the 3

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days preceding eruption of the first tooth, with 43% of participants having a fever $>37.5^{\circ}\text{C}$ and 33% having a fever $>38^{\circ}\text{C}$ on the day of eruption, but no increase in diarrhea, otitis media, or cough.¹⁹

Each of these studies provides partial support for teething as a cause of at least some ill effects, with support stronger for local and weaker for systemic effects, but overall, the quality of evidence is poor. Each suffers from the possibility of observer bias sufficient to invalidate all reported positive findings, especially those noting the strongest relationship between teething and adverse effects. We aimed to conduct a prospective cohort study which would accurately determine the relationship between tooth eruption and a range of teething symptoms, although avoiding the problems of earlier studies, specifically, minimizing observer bias.

METHODS

Setting

The study was conducted in 3 long-day child care centers in Melbourne, Australia. This convenience sample was considered acceptable because no literature has suggested that teething symptoms are influenced by either demographic variables or child care setting.

Participants

Eligible participants comprised all children between 6 months and 2 years old at commencement of the study, attending these centers 3 or more days per week, for whom informed parent consent was obtained. Parents and day care staff were told that the study concerned health and minor illness (including the effects of conditions such as teething) in young children attending long-day care.

Data Collection

Before commencement, a 1-week pilot study was conducted in one of the centers to establish standardized acceptable working procedures, including examination techniques, recognition of tooth eruption phases, and standardization of record keeping. Parents completed a written questionnaire at enrollment providing sociodemographic details.

Two nearly identical questionnaires (available from the authors on request) were developed that could be completed in less than a minute by staff and parents, respectively. They inquired about the child's mood (5-point faces scale), wellness/illness, drooling/dribbling, sleep, stools (all 5-point visual analog scales), wet diapers, and rashes/flushing (both dichotomous scales) over the preceding 24 hours. Each of these is often considered to be associated with teething.^{2,3,5,15,18} Every weekday morning for 7 months between May and December (fall through early summer) 1997, parents confidentially completed a questionnaire as they were signing their child into the center. Each afternoon, staff completed a similar questionnaire for every participating child present that day. During midmorning, the dental therapist visited each day care center. This timing was chosen to minimize within-child diurnal variation, to avoid times when either staff or parents would be completing questionnaires, and to maximize the number of children present. The dental therapist examined each of the primary dentition sites for stage of tooth eruption and recorded each child's temperature using an infrared tympanic thermometer (the FirstTemp Genius Model 3000A). Genius tympanic thermometers are more accurate than axillary thermometers in young children when compared with reference standards of pulmonary artery temperatures under controlled conditions.²⁰ Discussion of findings with day care staff was avoided except that staff were notified if the child's temperature exceeded 38°C . All questionnaires and dental recording sheets were placed immediately into locked study post boxes, so that each data source was effectively isolated from the other 2 sources, and none could be biased by reviewing their opinion from the preceding day(s).

At the end of the study, parents completed a questionnaire

inquiring about their beliefs and experiences related to teething. This retrospective timing allowed comparison over the same study period of parents' subjective teething experiences with our prospective, more objective findings. The questionnaire has previously been used in a community-based survey of parents.²

Definitions

An *eruption day* was defined as the first day that the edge of an incisor or cusp of a molar crown could be seen or felt emerging through the gum. This became the point of reference for all analyses. In 28 instances, an eruption day was recorded followed by a period when no tooth was recorded at that position; in these cases the eruption day was defined as the first day a new tooth was visible and remained consistently visible thereafter. When a tooth was first observed after a period of absence (eg, weekend), the eruption day was interpolated to the midpoint of the period of absence; if that period exceeded 6 days, data were discarded for that tooth. With little published information to suggest over what time period an erupting tooth might cause symptoms, we defined *non-toothdays* stringently as those days which were more than 28 calendar days clear of any tooth eruption. Calendar days before and after the eruption day were numbered sequentially from 0 to -28 and 0 to $+28$, respectively; when 2 teeth erupted in quick succession, calendar days between the 2 eruption days were numbered forwards and backwards until they met, to avoid overlapping data.

A *toothday* was defined as any day within a specified close proximity to the eruption day, reasoning that symptoms resulting from tooth eruption would likely be most marked over the few days closest to the eruption day. Therefore, comparison of symptoms between these days and non-toothdays would be most likely to establish which symptoms were associated with tooth eruption. Two sets of initial analyses were conducted, first defining a toothday as any of the 5 days *surrounding* the eruption day, and second, defining a toothday as any of the 5 days *leading up to and including* the eruption day. Because the results were almost identical, the latter was chosen for analyses reported here because of reported parental beliefs² and some empirical evidence^{16,19} that teething symptoms are most marked in the period leading up to an eruption day.

Ethics Approval

The study was approved by the Royal Children's Hospital Ethics in Human Research Committee.

RESULTS

Participants

Twenty-one children participated in the study (78% response rate). All completed the study; however, 2 children began child care after commencement of the study and contributed only 6 and 5 months of data, respectively. Child and parent characteristics are recorded in Table 1. Parents' beliefs about most teething symptoms in the current study were similar to those of parents in our earlier community-based study² (Table 2). All parents retrospectively reported that their own child had suffered teething symptoms. The mean number of symptoms reported per child in the study sample was 8, although children in general were believed to suffer a mean of 11 of a possible 19 symptoms; there was a very high correlation between symptoms reported for a parent's own child and those believed to be experienced by children in general ($r = 0.79$, $P < .001$). Five parents (24%) believed that teething could cause fevers higher than 38°C , and 2 (10%) believed that fever could be higher than 39°C . Seventeen (81%) rated infant distress during teething as mild to moderate and 3 (14%) as severe. Eighteen (86%) reported using paracetamol and 11 (52%) reported using teething gels to relieve symptoms of teething.

TABLE 1. Sample Characteristics

Characteristic	Category	Values
Child		
Gender	Female	10 (48%)
	Male	11 (52%)
Age (mo) at start of study	Mean \pm SD	14.4 \pm 4.9
	Range	6.8–22.5
	None	7 (33%)
Number of siblings	1	11 (52%)
	2 or more	3 (14%)
	Nuclear	18 (86%)
Family configuration	Sole mother	3 (14%)
	Parent	
Age (y) at start of study (mean \pm SD)	Mother	35.8 \pm 4.0
	Father	35.2 \pm 4.3
Days worked per wk (mean \pm SD)	Mother	3.9 \pm 1.1
	Father	5.5 \pm 0.7
Tertiary education	Mother	16 (75%)
	Father	10 (48%)

TABLE 2. Symptoms Suffered Resulting From Teething: Beliefs of Study Parents Compared With Beliefs of Community Sample of Parents²

Symptom	% of Study Parents Reporting	% of Community Sample Reporting
Pain	67	85
Irritability	71	82
Sleep disturbance	71	78
Drooling/dribbling	57	77
Red cheeks	76	75
Fever	48	70
Diaper rash	52	50
Sooky clingy	52	49
Runny nose	43	41
Loose stools	33	36
Smelly urine	33	14
Other rashes	10	13
Constipation	0	7

Quality of Data

Two thousand sixty-seven days of data were collected prospectively, including 236 days that could be categorized as toothdays and 895 that could be categorized as non-toothdays. Six percent of dental therapist data, 13% of day care staff data, and 17% of parent data were missing. Discreet inquiry suggested that missing data were because of rushed adult schedules rather than confounding child attributes on missing data days. There was no evidence that children were less likely to be present (ie, to contribute data) on toothdays; in fact, using interpolated data, children had fewer unexpected absences on toothdays than on non-toothdays (odds ratio [OR] = 0.83, 95% confidence interval [CI] = 0.71, 0.99).

Age of Children

On average, children were younger on toothdays than on non-toothdays (mean: 16.7 months vs 18.9 months), indicating that tooth eruption is more frequent at the younger end of the age range. Children also tended to be younger on days with fever than on nonfever days (mean: 14.9 months vs 17.9 months, $P < .01$, independent t test), and for all symptoms except parent- and staff-reported diarrhea, parent reports of mood and staff reports of wellness/illness, implying that age could potentially confound any

observed relationships between tooth eruption and symptoms.

Fever

A possible association between teething and fever was investigated in several ways. Mean temperatures were almost identical on toothdays and non-toothdays for each child (36.21 vs 36.18, $P = .46$, paired t test), but there was substantial variation in mean daily temperature between children. Therefore, each child's temperature recordings were converted to individualized z scores to account for these variations. A graph of mean z score temperatures for the 28 days either side of an eruption day showed no trends toward raised or rising temperature near eruption days (Fig 1). Two separate logistic regression analyses adjusting for age were performed to examine possible associations between toothday status (independent variable) and fever (dependent variable). In the first, high fever (z score >2) was compared with no fever (z score <2 ; OR = 1.35, 95% CI = 0.80, 2.27), whereas in the second low fever (z score >1) was compared with no fever (z score <1 ; OR = 1.34, 95% CI = 0.48, 3.77). Neither analysis indicated a relationship between tooth eruption and fever.

Other Symptoms

All staff- and parent-reported variables were transformed to dichotomous variables (symptom vs no symptom in the preceding 24 hours) for analysis. Logistic regression models were fitted to staff and parent reports of mood, wellness/illness, drooling, sleep, diarrhea, wet diapers, red cheeks, and rashes/flushing on the face or body (all dependent variables) to investigate associations with toothday status (independent variable; Table 3). All models allowed for within-child cluster effects by using robust estimates of SE and were adjusted for age. The only variable independently associated with tooth eruption was diarrhea; parents but not child care staff reported looser stools on toothdays (OR = 1.86, 95% CI = 1.26, 2.73). However, this relationship was not evident when the eruption period was varied to the 10 days leading up to (OR = 1.42, 95% CI = 0.98, 2.05) or to the 5 days surrounding eruption (OR = 1.47, 95% CI = 0.97, 2.21), respectively, and was not reported by staff in either the 5-day or the 10-day lead-up periods (OR = 1.03, 95% CI = 0.59, 1.78 and OR = 1.14, 95% CI = 0.63, 2.05, respectively).

DISCUSSION

This study did not confirm that tooth eruption in infants and toddlers is associated with fever, mood disturbance, an appearance of illness, sleep disturbance, drooling, diarrhea, strong urine, red cheeks, or rashes/flushing on the face or body. These results contrast with published reports of strong parent^{2,16} and professional beliefs⁵ across cultures⁴ and over many decades.¹⁶ The objective findings also contrast with the beliefs of parents within this cohort, who unanimously reported at the end of the study that their children had suffered many teething symptoms

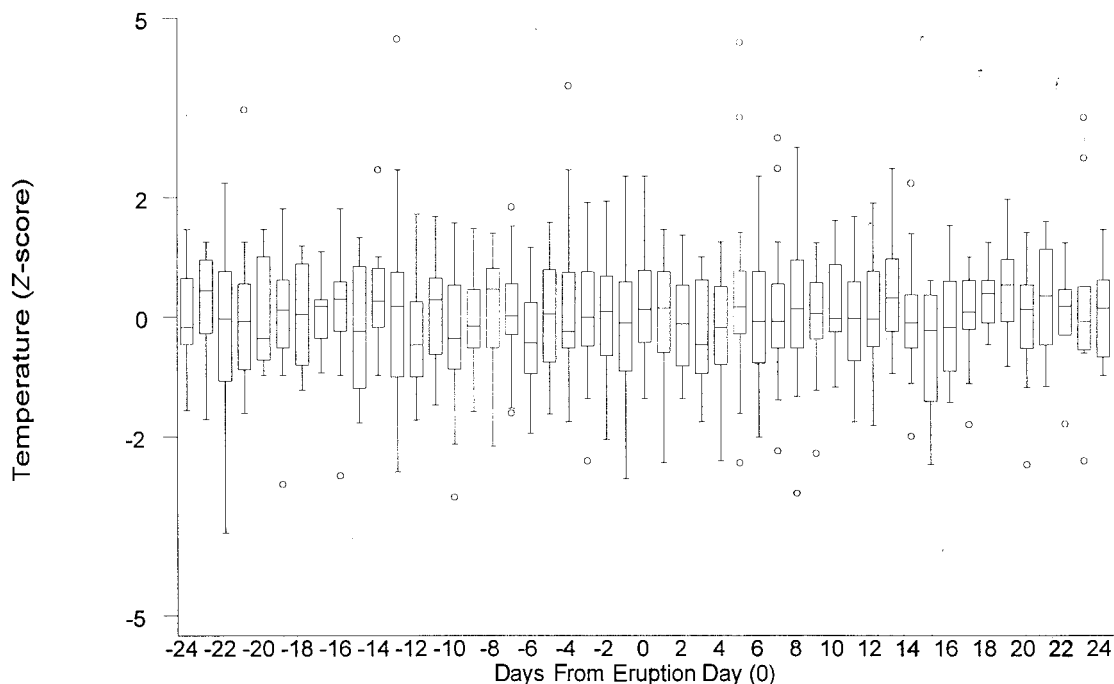


Fig 1. Mean z score temperatures.

TABLE 3. ORs for Symptom Statust as a Function of Tooth Eruption and Age‡ for 90 Teeth

Symptoms	Child Care Staff			Parents		
	OR for Tooth Eruption (95% CI)	OR for Age (95% CI)	OR for Tooth Eruption Adjusted for Age (95% CI)	OR for Tooth Eruption (95% CI)	OR for Age (95% CI)	OR for Tooth Eruption Adjusted for Age (95% CI)
Mood	2.05* (1.10, 3.84)	0.97 (0.91, 1.04)	1.94 (0.96, 3.94)	1.29 (0.71, 2.34)	1.00 (0.95, 1.06)	1.36 (0.76, 2.44)
Wellness/illness	1.62 (0.81, 3.21)	0.98 (0.91, 1.06)	1.60 (0.82, 3.10)	0.88 (0.38, 2.04)	0.94 (0.86, 1.02)	0.69 (0.24, 2.02)
Drooling	1.31 (0.65, 2.63)	0.91 (0.82, 1.01)	1.09 (0.56, 2.11)	1.68 (0.76, 3.72)	0.89* (0.79, 0.99)	1.27 (0.50, 3.19)
Sleep	1.47 (0.74, 2.92)	0.97 (0.92, 1.01)	1.29 (0.63, 2.66)	2.05* (1.11, 3.79)	0.96* (0.91, 1.00)	1.74 (0.92, 3.28)
Diarrhea/constipation	1.13 (0.66, 1.94)	0.98 (0.91, 1.05)	1.03 (0.59, 1.78)	1.87* (1.25, 2.79)	1.02 (0.97, 1.07)	1.83* (1.24, 2.70)
Strong diapers	1.75 (0.74, 4.12)	0.93* (0.86, 1.00)	1.50 (0.71, 3.15)	1.22 (0.52, 2.85)	0.88* (0.79, 0.97)	0.90 (0.41, 1.98)
Red cheeks	1.46 (0.76, 2.81)	0.93 (0.86, 1.01)	1.22 (0.62, 2.40)	2.83* (1.05, 7.65)	0.87* (0.77, 0.98)	2.18 (0.82, 5.80)
Rashes/flushing on face or body	1.14 (0.62, 2.10)	0.96 (0.89, 1.04)	1.09 (0.59, 2.03)	1.64 (0.91, 2.95)	0.94 (0.87, 1.01)	1.37 (0.73, 2.55)

† Symptom versus no symptom.

‡ All analyses allowed for within-child cluster effects by using robust estimates of SE.

* $P < .05$.

despite the lack of supporting prospectively collected evidence.

One of the most universal of all beliefs about teething is its association with diarrhea.⁴ Parents in this study did report looser stools in the 5 days leading up to the eruption of a tooth. This single statistically significant relationship out of 32 separate analyses could well have occurred purely by chance. No evidence was found to suggest a rise in temperature in the days surrounding eruption, contradicting previous research.¹⁹ The standardized recording methods used in this study and larger sample size (90 teeth compared with 46) allow confidence in these findings, even allowing for possible cluster effects.

We believe that these findings are more valid and robust than those of earlier studies.^{15,16,18,19} We used appropriate statistical techniques which take into account normal between-child variations and within-child cluster effects over successive eruptions. We avoided the use of a control group¹⁶ and the possibility of failing to find true signs/symptoms because of contamination by imminent or recent eruptions. All tooth sites were meticulously observed on the days leading up to eruption, so that the definition of tooth eruption days was more accurate than in previous studies. In particular, we did not merely confirm the day of tooth eruption, because in our view this could only confirm a tooth's presence today, but

not its absence yesterday. Finally, we used techniques to minimize observer bias, which could have accounted for much of the relationship between teething and fever reported by Jaber et al.¹⁹

This study had a number of possible limitations. First, it was not possible to keep all participants completely blinded to the purpose of the study for 7 months, and, therefore, parents and staff may have been biased toward reporting more symptoms when a child was erupting a tooth. Such bias might explain both the observed weak trend toward associations between tooth eruption and symptoms and the uniformity of this trend across symptoms.

Second, even for a trained dental observer, ascertainment of tooth eruption presented some challenges. Any effect of inaccuracies was minimized by defining a halo of several toothdays close to the eruption of a tooth and assuming that any teething effects would most likely be seen during this time. How to define this halo also posed problems, with little evidence available to suggest when symptoms would be most likely to occur in relation to eruption, and whether this would be the same for all symptoms. Analysis of the data using 3 different haloes (10 days before, 5 days before, and 5 days surrounding eruption) all yielded similar results. Twenty-eight percent of parents in an earlier survey believed that symptoms may last for more than 2 weeks and 12% more than 4 weeks.² If this were true, children would exist in a near-constant state of teething over a period of many months. It is difficult to conceptualize a study design which could confirm or refute this scenario.

Third, although 90 erupting teeth were observed, only 21 children took part in the study. Although our analyses adjusted for possible clustering, uncommon effects would not have been detected. However, the symptoms studied are widely believed to affect the majority of teething children, including those comprising our sample. Rather than being common, this study indicates that, at the very most, these symptoms could be unusual effects of tooth eruption.

Finally, most children in the study were from nuclear families with generally higher-than-average education and income. However, objective effects of teething are unlikely to differ greatly across sociodemographic classes, and parents in this study reported similar beliefs about symptoms to parents from a broader sociodemographic range in an earlier community-based study.²

Why are these findings so different from the beliefs of parents and professionals, and why do these beliefs persist? It seems likely that teething is the scapegoat for many other events occurring between about 6 and 24 months of age,²¹ after a relatively trouble-free first 6 months of life. These may include the sudden rise in respiratory, middle ear, and diarrheal infections at this age as well as specific infections such as mild herpetic gingivostomatitis and human herpesvirus 6.¹² In this study, some symptoms not independently related to tooth eruption were significantly more prevalent at the younger end of our age range of 6 to 30 months, supporting the

idea that behaviors such as drooling, dribbling, and sleep disturbance represent normal developmental stages rather than pathology. During this phase of frequent illness and behavioral changes, parents may find it helpful to attribute minor but bothersome and persistent symptoms to an understandable cause that they can manage simply and legitimately, with the nonjudgmental support of friends, family, and health professionals.

Nonetheless, these beliefs may prevent parents from implementing simple, effective measures such as sleep²²⁻²⁴ and behavior management²⁵ programs with marked and lasting benefits for both parents and children. They may be costly, with children receiving oral and/or topical medication over periods of months to years.² They may also prevent prompt assessment and management of a range of illnesses, such as urinary tract infection, gastroenteritis, and febrile illnesses, which on occasion have serious consequences.¹

It is time to relinquish our long-held cultural beliefs about teething, to acknowledge that there is good evidence that tooth eruption is not strongly associated with significant symptoms, and to start to manage the issues of late infancy and toddlerhood more effectively. Just as a child with language delay might benefit more from language remediation than from tympanostomy tubes regardless of the presence of middle ear effusion, so a child with sleep disturbance may benefit more from a simple sleep intervention than analgesia, regardless of the presence of an erupting tooth.

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CHILDREN

For military commanders in some of the poorest countries of the world, no strategy would be complete without children. They are more fragile, impressionable, and expendable than adult soldiers. They can stand watch at dangerous checkpoints, scout for mines, and infiltrate enemy lines. Their natural empathy can be beaten out of them.

We would like to think that such attitudes are rare, isolated. The reality is different. Every day, all around the world, children are abducted and recruited into armed forces. An estimated 300,000 children are actively participating in 36 ongoing (or recently ended) conflicts in Asia, Europe, Africa, the Americas, and the former Soviet Union. In Sierra Leone some 80% of all rebel soldiers are aged 7 to 14. During the Liberian Civil War from 1989 to 1997, 7-year-olds took part in combat. In the hostilities in Cambodia that nominally ended in the early 1980s, a fifth of wounded soldiers were between the ages of 10 and 14.

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