Signs and Symptoms of Primary Tooth Eruption: A Meta-analysis
Carla Massignan, DDS, a Mariane Cardoso, DDS, MsC, PhD, a André Luís Porporatti, DDS, b Secil Aydinoz, MD, c Graziela De Luca Canto, DDS, MsC, PhD,a,d,e Luis André Mendonça Mezzomo, DDS, MsC, PhD,a,d Michele Bolan, DDS, MsC, PhD a

abstract

CONTEXT: Symptoms associated with the primary tooth eruption have been extensively studied but it is still controversial.

OBJECTIVE: To assess the occurrence of local and systemic signs and symptoms during primary tooth eruption.

DATA SOURCES: Latin American and Caribbean Health Sciences, PubMed, ProQuest, Scopus, and Web of Science were searched. A partial gray literature search was taken by using Google Scholar and the reference lists of the included studies were scanned.

STUDY SELECTION: Observational studies assessing the association of eruption of primary teeth with local and systemic signs and symptoms in children aged 0 to 36 months were included.

DATA EXTRACTION: Two authors independently collected the information from the selected articles. Information was crosschecked and confirmed for its accuracy.

RESULTS: A total of 1179 articles were identified, and after a 2-phase selection, 16 studies were included. Overall prevalence of signs and symptoms occurring during primary tooth eruption in children between 0 and 36 months was 70.5% (total sample = 3506). Gingival irritation (86.81%), irritability (68.19%), and drooling (55.72%) were the most frequent ones.

LIMITATIONS: Different general symptoms were considered among studies. Some studies presented lack of confounding factors, no clear definition of the diagnostics methods, use of subjective measures and long intervals between examinations.

CONCLUSIONS: There is evidence of the occurrence of signs and symptoms during primary tooth eruption. For body temperature analyses, eruption could lead to a rise in temperature, but it was not characterized as fever.

aDepartment of Dentistry, and bBrazilian Centre for Evidence-based Research, Federal University of Santa Catarina, Florianopolis, Santa Catarina, Brazil; cBauru School of Dentistry, Bauru, São Paulo, Brazil; dGulhane Military Medical Academy, Istanbul, Turkey; and eDepartment of Dentistry, University of Alberta, Edmonton, Canada

Dr Massignan worked on study conceptualization, design, data collection, data analysis, drafted the initial manuscript, and critically reviewed manuscript; Drs Cardoso and Porporatti worked on data analysis, and reviewed and revised the manuscript; Dr Aydinoz worked on data analysis and critically reviewed the manuscript; Drs De Luca Canto and Mezzomo worked on study conceptualization, design, data analysis, and critically reviewed manuscript; Dr Bolan worked on study conceptualization, design, data collection, data analysis, and critically reviewed manuscript; and all authors approved the final manuscript as submitted and agree to be accountable for all aspects of the work.

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Address correspondence to Michele Bolan, DDS, PhD, Departamento de Odontologia, Universidade Federal de Santa Catarina, UFSC, Campus Universitário, CCS-ODT-Trindade Florianópolis, Santa Catarina, Brasil 88040–900. E-mail: michelebolan@hotmail.com

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Tooth eruption is a physiologic process in which teeth move from their development position within the alveolar bone to break the gum toward the oral cavity. Nevertheless, this mechanism and the source of the eruptive force has not been established nor completely understood.2

Despite being a natural process of child development, the impacts of primary tooth eruption on the overall health of children are still controversial. Recent studies have suggested that tooth eruption could be accompanied by different benign symptoms, such as increased salivation, irritability, loss of appetite for solid foods, and rise in body temperature.3–11

Moreover, the eruption of primary teeth has been assumed among parents to be associated with behavioral and systemic changes.12–17 The period of time that tooth eruption occurs can be very frustrating and stressful for parents, especially when it happens to their first offspring. Many parents do not know how to identify the signs of tooth eruption in their children and, therefore, do not feel confident to relieve the discomfort of the child.18,19 Likewise, many health professionals also believe that there is an association between some signs and symptoms and the eruption of primary teeth. Surveys with pediatricians and other child health professionals showed that these beliefs are common.3,20,21

The use of this diagnostic label may lead to either parents not managing a likely illness10 or the doctors to ignore significant symptoms and fail in diagnoses.22

Nevertheless, consistent evidence on the association of tooth eruption and general signs and symptoms are rather low and out of date. In a review conducted by Tighe et al23 in 2007 to identify the existence of any pathognomonic sign and symptom of dental eruption, a variety of symptoms that may occur simultaneously with the tooth eruption was demonstrated and no evidence suggested the existence of any signs or symptoms that could predict the tooth eruption.

Thus, the purpose of this systematic review was to answer the following focused question: “In children aged 0 to 36 months, are there local or systemic signs and symptoms during the eruption of the primary teeth?”

**METHODS**

This systematic review was oriented following the Preferred Reporting Items for Systematic Reviews and Meta-Analyses protocol.24

**Protocol Registration**

The systematic review protocol was recorded at the International Prospective Register of Systematic Reviews25 under number CRD 42015020822.

**Eligibility Criteria**

**Inclusion Criteria**

Observational studies assessing the occurrence of local and systemic signs and symptoms during the spontaneous eruption of primary teeth in healthy children aged between 0 and 36 months, by means of either clinical examination or a questionnaire directed to the parents or health care professionals, were included. The local and systemic signs and symptoms evaluated were all reported complications related to teething described in the studies (eg, decreased appetite, diarrhea, drooling, fever, inflammation, swelling, vesicles or ulceration of the gum, irritability, rash, rhinorrhea, sleeping disturbances, vomiting).

**Exclusion Criteria**

Exclusion of the studies was performed in 2 phases. In phase 1 (titles and abstracts), the exclusion criteria were as follows: (1) studies conducted in children aged >36 months old; (2) reviews, letters, conference abstracts; (3) studies in which the sample included patients with genetic syndromes (eg, Down syndrome, craniofacial anomalies, neuromuscular disorders); (4) studies in which the sample included malignancies, malnutrition, and chronic diseases; (5) studies in which the sample included nonsprontaneous eruption of primary teeth; and (6) studies in which the eruption of primary teeth was not the primary outcome. Besides the 6 cited criteria, in phase 2 (full-test) the following exclusion criteria were added: (7) studies in which clinical examination was not performed by a health care professional, and (8) articles that evaluated the same sample.

**Information Sources and Search Strategies**

A systematic search was conducted on the following electronic databases: Latin American and Caribbean Health Sciences (LILACS), PubMed, ProQuest Dissertations and Theses Database, Scopus, and Web of Science, for titles and abstracts relevant to the research question. The syntax has been adapted to each database (Supplemental Appendix 1). A partial gray literature search was taken using Google Scholar limited to the first 100 most relevant articles published in the past 5 years. The reference lists of the included articles were scanned to identify additional studies of relevance. All references were managed by reference manager software EndNote Basic (Thomson Reuters, New York, NY) and duplicate hits were removed. The end search date was May 6, 2015. No language or date restrictions were applied.

**Study Selection**

The selection occurred in a 2-phase process to minimize bias. In phase 1, studies were independently screened by 2 reviewers (CM, MB) based on the titles and, if available, the abstracts derived from the search. Any study that clearly did not fulfill...
the inclusion criteria was discarded. In phase 2, the full text of relevant papers was retrieved for further analysis by the same 2 reviewers (CM, MB) and was either included or excluded for review on the basis of the eligibility criteria. Disagreements of inclusion/exclusion were handled through discussion, and the third reviewer (MC) was consulted to make a final decision.

Data Collection Process

Two authors (CM, MB) independently collected the required information from the selected articles. After that, all the collected information was crosschecked and confirmed for its accuracy. Again, any disagreement was resolved by discussion and mutual agreement between the authors. The third author (MC) was involved, when required, to make a final decision.

Data Items

For all of the included studies, the following structured information was recorded: study characteristics (authors, year of publication, country, study design, setting), population characteristics (sample size, age of participants), intervention characteristics (type of diagnostic approach: clinical examination, body temperature, questionnaire) and, finally, outcome characteristics (assessed teeth, symptoms, mean temperature in noneruption days, mean temperature in eruption days, and conclusions pertaining to the occurrence of local and systemic signs and symptoms during the eruption of primary teeth). Authors were contacted for further details when relevant information was not reported or there was doubt remaining about duplicate publication.

Risk of Bias in Individual Studies

Two reviewers (CM, MB) independently assessed the methodological quality of the included studies, using the “Quality in Prognosis Studies Tool” (QUIPS). The QUIPS tool comprises 6 domains: study participation, study attrition, prognostic factors measurement, outcome measurement, study confounding and statistical analysis and reporting to guide ratings of high, moderate, or low risk of bias. Disagreements were resolved through consensus when possible, or a third reviewer (MC) made the final decision.

Summary Measures

Presence of local and systemic signs and symptoms and differences in body temperature during the eruption of primary teeth were considered the main outcomes. For body temperature, the threshold point was considered according to a recent meta-analysis on accuracy of infrared tympanic thermometry, between 37.4°C and 37.8°C for tympanic temperature and 38.0°C for rectal temperature. Any type of related outcome measurement was computed (categorical variables and continuous variables).

Synthesis of Results

A meta-analysis was planned within the studies presenting enough data. The occurrence of signs and symptoms of the eruption of primary teeth was analyzed by 2 types of meta-analysis, for fixed and random effects following the appropriate Cochrane Guidelines. Meta-analysis was performed with the aid of MedCalc Statistical Software version 14.8.1 (MedCalc Software, Ostend, Belgium). Heterogeneity was calculated by inconsistency indexes (I²), and a value >50% was considered an indicator of substantial heterogeneity between studies. The significance level was set at 5%.

Risk of Bias Across Studies

Clinical heterogeneity (differences in participants, interventions, and outcomes) and methodological heterogeneity (study design, risk of bias) were explored.

RESULTS

Study Selection

The search identified 1318 citations across 5 databases. After duplicates removal, 1179 articles were screened in phase 1. A total of 65 articles met criteria for full-text screening. Additionally, 100 citations from Google Scholar were considered. From these, 4 further studies met the inclusion criteria. A hand search on the reference lists was performed for any study that might have been inadvertently missed by the electronic search procedures and 6 additional references were identified. Based on exclusion criteria for phase 2 (full-text screening), 59 articles were excluded. Two articles evaluated the same sample and 1 was not found. The reasons for exclusion are compiled in a comprehensive list (Supplemental Appendix 2). Therefore, 16 articles were selected for data collection with the aim of answering the review question. A flowchart of the process of identification and selection of studies is shown in Fig 1.

Study Characteristics

Research was conducted in 8 different countries: Australia, Brazil, Colombia, Finland, India, Israel, Senegal, and United States. The sample size ranged widely from 16 to 1165 children. The search involved papers published between 1969 and 2012. A summary of the study descriptive characteristics can be found in Table 1.

Risk of Bias Within Studies

The reported methodological quality of the included studies ranged between low and high risk of bias following QUIPS domains. Studies selected have shown to be heterogeneous considering bias, 7
presented high risk of bias, 4 moderate, and 5 low. None of them fulfill all the methodological criteria. Summarized assessment considering risk of bias can be found in Table 2. Detailed results on the use of QUIPS tool in selected studies can be found in Supplemental Appendix 3.

**Results of Individual Studies**

There were 2 studies that investigated exclusively local modifications. Other studies evaluated, besides general problems, local disturbances that could be involved on primary tooth eruption. Hulland et al observed that 85% of 128 teeth in 21 children presented gingival hyperemia in the early stages of eruption. Chakraborty et al reported that anterior teeth erupted with fewer local signs than posterior. King et al suggested that local signs could be confound with oral herpetic infection.

Shapira et al observed an increase in inflammatory cytokine levels in the gingival crevicular fluid surrounding erupting teeth, whereas Galili et al found that multiple eruptions occurring at the same time were associated with diseases. Bengtson et al, Carpenter, Cunha et al, and Yam et al observed that eruption of primary teeth was associated with symptoms. Kiran et al, Noor-Mohammed and Basha, and Peretz et al found more symptoms associated with the eruption of the incisors. Tasanen evaluated that mild symptoms like sucking fingers, rubbing gums, and drooling increased during teething, whereas Wake et al reported that primary tooth eruption was not associated with symptoms. Jaber et al found that tooth eruption in children was associated with fever and Ramos-Jorge et al found that there was a slight rise in body temperature.

The frequency of body temperature measurement varied between studies. In some of them daily registration could be assessed whereas in others every week day, twice a week, or monthly. From the studies in which type of thermometer and measurement were informed, 4 studies used rectal temperature and 2 tympanic. In studies that presented these data, the cutoff point to consider a child with high temperature ranged from 37.5°C to 39°C in a single assessment (not informed). A summary of body temperature assessment can be found in Table 3.

In relation to individual signs and symptoms, some investigations demonstrated that fever, diarrhea, irritability, loss of appetite, sleeping problems, and rhinorrhea were associated with primary tooth eruption. In the opposite site, other studies exposed that fever, irritability, sleep disturbances, and loose stools had no association with the eruption.

**Synthesis of Results**

To easily interpret the results, the studies were clustered into overall...
<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Intervention</th>
<th>Outcome</th>
</tr>
</thead>
<tbody>
<tr>
<td>Bengtson et al 1988 Brazil 31</td>
<td>Institutionalized children living in a shelter 36</td>
<td>5–11</td>
<td>Children were examined for admission to the research. Examiner NI.</td>
</tr>
<tr>
<td>Carpenter 1978 United States 46</td>
<td>Well-infant clinic of a medical university hospital (South Carolina) 120 records</td>
<td>4–10</td>
<td>Medical student and a board-certified pediatrician. Records used in the study indicated teeth were erupting that time or in previous visit one month before.</td>
</tr>
<tr>
<td>Chakraborty et al 1994 India 36</td>
<td>Pediatric departments of different hospitals of Calcutta and pedodontic department Dr. R. Ahmed Dental College 201</td>
<td>6–12</td>
<td>Dentist/2-mo interval.</td>
</tr>
</tbody>
</table>

Main Conclusion:
- Children had their teeth erupted with symptoms.
<table>
<thead>
<tr>
<th>Study</th>
<th>Design</th>
<th>Setting</th>
<th>Total n</th>
<th>Age, Mean or Range, mo</th>
<th>Clinical Assessment</th>
<th>Body Temperature °C (Who/How)</th>
<th>Questionnaire</th>
<th>Assessed Teeth</th>
<th>Symptoms</th>
<th>Follow-Up Period</th>
<th>MTNED/MTED °C</th>
<th>Main Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Cunha, et al. 2004, Brazil</td>
<td>RS</td>
<td>Infant clinic of Araçatuba Dental School</td>
<td>1165 records</td>
<td>0–36</td>
<td>Examiner NI/2-mo intervals.</td>
<td>Parents were asked regarding the occurrence of fever, type of thermometer, measurement NI.</td>
<td>NI/NI</td>
<td>95% of the records reported some type of manifestation, 85% gingival irritation, 74% agitation, 70% increased salivation, 46% fever, 39% agitated sleep, 35% diarrhea, 26% runny nose. The most frequent teeth involved were the lower central incisors 52%, maxillary central incisors 20%, maxillary lateral incisors 19%.</td>
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<tr>
<td>Galili et al. 1969, Israel</td>
<td>PS</td>
<td>Institutionalized children residents of a Wizo Baby Home, Jerusalem</td>
<td>43</td>
<td>5–23 Mean 11.07 (± 0.8)</td>
<td>Author/Weekly. Eruption was registered if any portion of the occlusal surface had penetrated the gingiva.</td>
<td>Nurses/Daily/Rectal temperature of at least 37.5°C over a period of 2 d was designated as fever.</td>
<td>Nurses daily registered stool, consistence and number, vomiting, sickness, drooling and restlessness. They referred the child to the resident pediatrician in case of any sign of disturbance.</td>
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<tr>
<td>Study</td>
<td>Author, Year, Country</td>
<td>Study Design</td>
<td>Setting</td>
<td>Total n</td>
<td>Age, Mean or Range, mo</td>
<td>Clinical Assessment</td>
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<tr>
<td>Hulland et al 2000, Australia</td>
<td>PS</td>
<td>3 day care centers</td>
<td>21</td>
<td>6–24</td>
<td>Mean 14.4 (± 4.9)</td>
<td>Dental hygienist examined (tactile and visual) the alveolar ridges to identify redness or swelling and stage of tooth eruption/every weekday, mid-morning.</td>
<td>NA</td>
<td>NA</td>
<td>128</td>
<td>Only 16 observations of swelling. Redness occurred in 85% of teeth in the early stages of eruption.</td>
<td>NA/NA</td>
<td>During eruption most of teeth showed signs of gingival reddening (hyperemia) and soft tissue swelling is uncommon.</td>
</tr>
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<td>Jaber et al 1992, Israel</td>
<td>PS</td>
<td>Author's private clinic to confirm tooth eruption</td>
<td>46</td>
<td>6–18</td>
<td>Mothers examined gums daily. Professional confirmation of tooth eruption.</td>
<td>Mothers/Daily/Rectal</td>
<td>Mothers, daily noted if there was any diarrhea, convulsions, bronchial symptoms, or any other disease; medications and medical examinations. All data refer to the previous 20 d.</td>
<td>Number of teeth N</td>
<td>Only data collected up to the eruption of the first tooth (incisors) were analyzed</td>
<td>Since the day that tooth eruption was registered was referred to day 0, and all data refer to the previous 20 d. The results of comparison of days 0 to 9 and 10 to 19 showed 47 vs 67 d of otitis media, 85 vs 72 d of diarrhea, and 52 vs 58 d with cough; no convulsions occurred.</td>
<td>MTNED MTED 36.9 and 37.1 from day 19 to day 4. Three days before the tooth eruption occurred, the MTED increased to 37.14 (0.66) on day 5, 37.2 (0.68) on day 2, 37.4 (0.76) on day 1, and 37.6 (0.85) on the day the teeth erupted (95% CI 37.33–37.86).</td>
<td>Infants cut their teeth with fever.</td>
</tr>
<tr>
<td>Study</td>
<td>Author, Year, Country</td>
<td>Study Design</td>
<td>Setting</td>
<td>Total n</td>
<td>Age, Mean or Range, mo</td>
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<td>King et al 1999, United States</td>
<td>CS</td>
<td>SG patient at a dental school pediatric dentistry clinic, a community hospital, and the private offices of a pediatric dentist and a pediatrician; CG selected by age-matching to SG, at local church’s infant care facility</td>
<td>40 Total</td>
<td>7–30</td>
<td>Responsible personnel at each location made examination and viral sampling protocol for HVS, for SG and one of the authors for CG subjects. Samples for viral culture were obtained from subject’s gingiva in both groups.</td>
<td>N, only that information obtained on each subject was recorded on a prepared form and included name, age, gender, temperature, and oral findings.</td>
<td>SG Positive cultures for HVS in 9 infants, they presented inflammation, swelling, and ulceration limited to area adjacent/beyond to erupting tooth (teeth). CG all negative for HVS and normal oral findings</td>
<td>7–30</td>
<td>NA</td>
<td>Single clinical assessment</td>
<td>N/S</td>
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<td>Kiran et al 2011, India</td>
<td>PS</td>
<td>Department of Pediatric and Preventive Dentistry, Institute of Dental Sciences, and the Department of Pediatrics, Rohilkhand Medical College</td>
<td>894</td>
<td>6–36</td>
<td>Examiner N/3-month intervals. Eruption was defined as visible clinical crown of the tooth, but not exceeding 5 mm of exposure in the oral cavity.</td>
<td>Nurse/After dental examination. Type of thermometer, measurement N/S</td>
<td>Parents were asked about the occurrence of local and systemic disturbances. Analysis of the records showed the presence of the following symptoms: gingival irritation, diarrhea, fever, loss of appetite; irritability; increased salivation; running nose; agitation; sleep; fever with diarrhea; fever with increased salivation; diarrhea with increased salivation; fever with diarrhea and increased salivation.</td>
<td>Number of teeth N/NI</td>
<td>Incisors, canines, and molars.</td>
<td>11 mo</td>
<td>N/S</td>
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<td>Study</td>
<td>Author, Year, Country</td>
<td>Study Design</td>
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<td>Noor-Mohammed and Basha 2012, India</td>
<td>CS Child health institute and research center</td>
<td>1100</td>
<td>4–36</td>
<td>Eruption was determined if the clinical crown of the tooth was visible, but not exceeding 3-mm exposure above the gingiva. Mothers complete a short and simple questionnaire in a yes/no manner including fever.</td>
<td>NA, Single clinical assessment</td>
<td>NA</td>
<td>Number of teeth NI</td>
<td>Incisors, canines, and molars.</td>
<td>The most frequent clinical manifestations were fever (16%), drooling (12%), diarrhea (8%), fever-drooling (15%), fever-diarrhea (8%), drooling-diarrhea (6%), and the combination of these symptoms.</td>
<td>There was association between general objective signs (drooling, fever, and diarrhea) and the eruption of primary teeth. Most signs appeared during the eruption of the primary incisors.</td>
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<tr>
<td>Perez et al 2003, Colombia</td>
<td>CS Public child center</td>
<td>585</td>
<td>4–36</td>
<td>Parents accompanying the child completed a questionnaire. Information was relayed in a yes/no manner about 3 objective manifestations noted during the eruption of the primary teeth including drooling, diarrhea, fever, and the combination of these symptoms. The dentist and the nurse confirmed drooling and fever during the clinical checkup.</td>
<td>NA</td>
<td>Number of teeth NI</td>
<td>Incisors, canines, and molars.</td>
<td>CG 93% of the children did not present any clinical manifestation. In the SG, only 39%. The most frequent clinical manifestations were drooling (15%), diarrhea (13%), and drooling-diarrhea (8%).</td>
<td>An association has been shown between general objective signs (drooling) and the eruption of primary teeth with drooling being the most prevalent sign. Most signs appeared during the eruption of the primary incisors.</td>
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<td>Study</td>
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<td>Intervention</td>
<td>Outcome</td>
<td>Main Conclusion</td>
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<tr>
<td>Ramos-Jorge et al 2011, Brazil</td>
<td>Residences of the infants</td>
<td>47 5–15</td>
<td>11 validated trained dentists/daily</td>
<td>The associations between signs and symptoms reported by mothers and tooth eruption were statistically significant. The most common symptoms on days of eruption were irritability, increased salivation, runny nose, and loss of appetite. Fever was reported % times more often in the RS.</td>
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<td>Noninstitutionalized</td>
<td>Mean 8.9 (± 2.7)</td>
<td>The day of eruption was defined as the first day on which the incisor edge emerged in the oral cavity without being completely covered by gingival tissue.</td>
<td>Infrared auricular thermometer and a digital axillary thermometer.</td>
<td>Axillary 35.98 (0.36) MTD 36.51 (0.20)</td>
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**TABLE 1 Continued**

<table>
<thead>
<tr>
<th>Study</th>
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**Notes:**
- MTNED: Mean time of symptom onset before eruption.
- MTED: Mean time of symptom onset after eruption.
- Tymp: Tympanic.
- Axil: Axillary.
- MTD: Mean temperature difference.
- %: Percentage.

**Methods:**
- Mothers were interviewed to investigate the occurrence of signs and symptoms such as increased salivation, rash, runny nose, diarrhea, loss of appetite, irritability, fever, smelly urine, constipation, vomiting, colic, and seizure, in the previous 24 h and 1 week after the end of data collection, the mothers answered the same questionnaire.
- The associations between symptoms reported by mothers and tooth eruption were statistically significant.
- The most common symptoms on days of eruption were irritability, increased salivation, runny nose, and loss of appetite. Fever was reported % times more often in the RS.
### TABLE 1

<table>
<thead>
<tr>
<th>Study</th>
<th>Population</th>
<th>Intervention</th>
<th>Outcome</th>
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<tbody>
<tr>
<td><strong>Author, Year, Country:&lt;sup&gt;a&lt;/sup&gt;</strong></td>
<td>Study Design</td>
<td>Setting</td>
<td>Total n</td>
</tr>
<tr>
<td>Shapira et al 2003, Israel&lt;sup&gt;b&lt;/sup&gt;</td>
<td>PS</td>
<td>Day care center</td>
<td>16</td>
</tr>
</tbody>
</table>

<sup>a</sup>MTNED, MTED, and MDT refer to medication taken before the study, during the study, and after the study, respectively.

<sup>b</sup>MDT NI indicates medication taken after the study, and NI refers to no indication.

---

**Fluid from the sulcus** was collected on the day of eruption or on 1 of the following 3 d, and was again collected for the control group from the same tooth 1 mo later.

A child with a temperature <37.5°C was classified as having "no fever." A temperature of 37.6°C to 38.5°C was regarded as low/moderate fever, and a temperature >38.5°C was classified as high fever.

**Type of thermometer, measurement NI.**
<table>
<thead>
<tr>
<th>Study</th>
<th>Author, Year, Country*</th>
<th>Study Design</th>
<th>Setting</th>
<th>Total n</th>
<th>Age, Mean or Range, mo</th>
<th>Clinical Assessment</th>
<th>Intervention</th>
<th>Outcome</th>
<th>Follow-Up Period</th>
<th>MTNED/MTED (°C)</th>
<th>Main Conclusion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Wake et al 2000, Australia 10</td>
<td>PS/RS 3 child care centers</td>
<td>21</td>
<td>6 – 24 Mean 14.4 (+ 4.9)</td>
<td>Dental therapist examined for tooth eruption every weekday (midmorning)</td>
<td>Infrared tympanic thermometer</td>
<td>Two questionnaires to staff (afternoon) and parents (morning) inquired about the child’s mood, wellness/illness, drooling/dribbling, sleep, stools, wet diapers, and rashes/flushing over the preceding 24 h</td>
<td>90 (incisive, canine, molar).</td>
<td>Analysis did not indicate a relationship between tooth eruption and fever. All parents retrospectively reported that their own child had suffered teething symptoms.</td>
<td>7 mo MTNED 36.18 MTED 36.21</td>
<td>Tooth eruption is not associated with fever, mood disturbance, illness, sleep disturbance, drooling, diarrhea, strong urine, red cheeks, or rashes/flushing on the face or body.</td>
<td></td>
</tr>
<tr>
<td>Yam et al 2002, Senegal 11</td>
<td>PS Child health institute Centre de Protection Maternelle et Infantile in Dakar-Médina</td>
<td>499</td>
<td>5–30</td>
<td>Medical service Monthly.</td>
<td>Information provided by parents</td>
<td>Information provided by parents</td>
<td>Number of teeth NI Incisors, canines, and molars.</td>
<td>Local observation: 7 hematoma of eruption, 5 widespread gingivitis, 297 local gingivitis. At least 60% of the children had ≥ 1 of the symptoms: hyperthermia, vomiting, diarrhea, and appetite problems</td>
<td>NI NI/NI</td>
<td>Children cut their teeth with local and systemic disturbances.</td>
<td></td>
</tr>
</tbody>
</table>

* HSV, herpes simplex virus; I, infected; MDT, mean daily temperature; MTED, mean temperature in eruption days; MTNED, mean temperature in noneruption days; MTFPE, mean temperature before eruption; MTFP, mean temperature after eruption; NA, not applicable; NI, not informed; N, no; NoI, noninfected; PS, prospective study; RS, retrospective study; SG, study group.

* Data were modified by authors (°F to °C).

* Data calculated by authors.
prevalence of signs and symptoms (Fig 2) and separately prevalence for each individual sign or symptom (Fig 3). A total of 10 studies were included in the meta-analysis. Eight studies had data enough to conduct

### TABLE 3 Summarized Body Temperature Assessment

<table>
<thead>
<tr>
<th>Measurement</th>
<th>MTNED</th>
<th>MTDE</th>
<th>Study Reference</th>
<th>Association</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rectal2</td>
<td>NI</td>
<td></td>
<td>37.7°C</td>
<td>Yes</td>
</tr>
<tr>
<td>Rectal3</td>
<td>NI</td>
<td></td>
<td>37.5°C</td>
<td>Yes</td>
</tr>
<tr>
<td>Rectal4</td>
<td>36.9–37.1°C</td>
<td>37.6°C</td>
<td></td>
<td>Yes</td>
</tr>
<tr>
<td>Rectal5</td>
<td>37.0°C</td>
<td>36.9°C</td>
<td></td>
<td>No</td>
</tr>
<tr>
<td>Tympamic1T</td>
<td>36.39°C</td>
<td>36.51°C</td>
<td>NI</td>
<td>Yes (slight rise)</td>
</tr>
<tr>
<td>Tympamic1T</td>
<td>36.18°C</td>
<td>36.21°C</td>
<td>NI</td>
<td>No</td>
</tr>
</tbody>
</table>

It was not possible to calculate the weighted average because data were insufficient. MTED, Mean temperature in eruption days; MTNED, Mean temperature in noneruption days.

### FIGURE 2

Forest plot for all signs and symptoms that occurred during the eruption of primary teeth. Sample = 3506.

### FIGURE 3

Pooled prevalence for each individual sign or symptom that occurred during the eruption of primary teeth.

prevalence of signs and symptoms
Although cooperative, parents can be helpful in assisting in the detection of related problems. They can follow the development of children and witness any change in behavior, mood, or health. Thus, they can be helpful in assisting in the detection of related problems.

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Risk of Bias Across Studies
The studies were heterogeneous and had different designs. Analysis revealed that the weakness in methods was not considered an important confounder capable of masking possible signs and symptoms related to other diseases that could occur simultaneously with primary tooth eruption.

DISCUSSION
This systematic review investigated the available evidence about primary tooth eruption and local and systemic signs and symptoms. Currently, the American Academy of Pediatric Dentistry guidelines have indications that eruption of primary teeth leads to local discomfort, irritation, and drooling. Parents follow the development of children and witness any change in behavior, mood, or health. Thus, they can be helpful in assisting in the detection of related problems. Although cooperative, parents can be helpful in assisting in the detection of related problems. They can follow the development of children and witness any change in behavior, mood, or health. Thus, they can be helpful in assisting in the detection of related problems.

Regarding the most frequent general symptoms during primary tooth eruption, irritability and drooling were the most observed followed by decreased appetite, sleeping problems, rhinorrhea, fever, diarrhea, rash, and vomiting. Eruption was associated with fever, did not influence the body temperature, or lead to a slight rise in body temperature. In contrast, symptoms that were not related to primary tooth eruption in the selected studies were in this sequence: sickness, sleeping disturbances, loose stools, drooling, vomiting, and fever. Three of most robust studies in this systematic review showed that sucking fingers, gum rubbing, daytime restlessness, loss of appetite, sleep disturbance, increased salivation, rash, rhinorrhea, diarrhea, irritability, and coughing increased during teething.

Another robust study, which accompanied 90 erupting teeth from 21 children every weekday, reported that fever, mood disturbance, illness, sleeping disturbance, drooling, diarrhea, strong urine, red checks, or rashes did not have association with primary tooth eruption.

The stage of eruption considered to represent the day of eruption for the studies differed from the first day the edge of an incisor or a cusp of a molar could be seen or felt emerging through the gum, palpable with the fingernail; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva; clinical crown of the tooth visible but not exceeding 3 mm of exposure above the gingiva.

Regarding the local signs, the most frequent was inflammation of the gum or gingival reddening (hyperemia), mostly in posterior teeth. The timing of eruption of the primary teeth (6 months onward) coincides with the age when infants start to explore the environment. In this phase, the introduction of the hands and objects into the mouth is normal; this, in turn, can bring harmful microorganisms and cause infection. Even sucking behavior, nutritive and nonnutritive, may lead to bruising or may traumatize the gums causing inflammation.

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occurred in monthly intervals may have lost or overestimated some signs or symptoms.

It seems that symptoms associated with primary tooth eruption decrease with age. Most manifestations were observed during the eruption of primary incisors, or were studied only in incisors. Also, there was a significant difference between the mean age at which eruptions were accompanied by disturbances (11.8 months) and the average age (14.8 months) at which teeth erupted without general disturbances. On the other hand, there seems to be an association between multiple eruption with fever and respiratory and alimentary illnesses that could be due to the stress that led to the low resistance of the body against infections.

Accurate determination of body temperature is essential to diagnose fever. A recent systematic review investigating the accuracy of infrared tympanic thermometry used in the diagnosis of fever in children, disclosed that the accuracy of this kind of thermometer is high, using rectal measurement as the “gold standard.” Besides, as temperature measured by tympanic thermometry was always 0.6°C to 0.2°C less than rectal temperature, the threshold of fever diagnosed by tympanic thermometry can be decreased. Therefore, if 38.0°C is the fever diagnosed by rectal temperature, the threshold of infrared tympanic thermometry should be 37.4°C to 37.8°C. Under these circumstances, in this systematic review, in 1 study using rectal temperature, mothers on a daily basis verified temperature and the threshold point was not informed. Fever was associated with teething and the mean daily temperature in days of noneruption was between 36.90°C and 37.10°C, and on the eruption day 37.60°C. Two studies with moderate risk of bias used rectal temperatures >37.77°C (100°F) and >37.50°C; these authors stated that fever was associated with tooth eruption, but mean daily temperature was not informed. Analyzing the 3 most robust studies, 1 used rectal temperature and detected that eruption did not interfere in body temperature with mean daily temperature in noninfected children (37.0°C in noneruption days and 36.9°C in eruption days) in twice-daily examinations. The others used tympanic measurements. One study discovered a slight rise from 36.39°C in noneruption days to 36.51°C in eruption days in a daily check by dentists, whereas the other stated that children do not have fever during the teething period, with 36.18°C in noneruption days and 36.21°C in eruption days every weekday by the dental therapist.

LIMITATIONS

Some methodological limitations of this review should be considered. Different general symptoms were considered among studies and not all studies related confounding factors, such as other disease that might have occurred with tooth eruption, or several symptoms happening at the same time. All of these may obscure the actual findings.

Most studies failed to expose a clear definition of the diagnostic methods. Examinations were performed in long intervals that could compromise adequate data collection. Besides, some symptoms did not use objective measures, but parents’ observation, such as irritability and loss of appetite. In addition, some symptoms need more specific examination, such as diarrhea that may be caused by infection and, without a virology study the diagnostic is not conclusive.

Most of the selected studies demonstrated a high risk of bias, especially in relation to study design. Articles with lower risk of bias had small samples: 21 to 126 children evaluated. The biggest samples were found in studies with high risk of bias, although a random effect for meta-analysis was used, this might have affected the results.

CONCLUSIONS

Based on the current limited evidence, there are signs and symptoms during primary tooth eruption. Gingival irritation, irritability, and drooling were the most common. For body temperature analyses, it was possible to evaluate that eruption of primary teeth is associated with a rise in temperature, but it was not characterized as fever.
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