Maternal Sensitivity in Parenting Preterm Children: A Meta-analysis
Ayten Bilgin, MSc, Dieter Wolke, PhD

BACKGROUND AND OBJECTIVES: Preterm birth is a significant stressor for parents and may adversely impact maternal parenting behavior. However, findings have been inconsistent. The objective of this meta-analysis was to determine whether mothers of preterm children behave differently (e.g., less responsive or sensitive) in their interactions with their children after they are discharged from the hospital than mothers of term children.

METHODS: Medline, PsychInfo, ERIC, PubMed, and Web of Science were searched from January 1980 through May 2014 with the following keywords: “premature”, “preterm”, “low birth weight” in conjunction with “maternal behavior”, “mother-infant interaction”, “maternal sensitivity”, and “parenting”. Both longitudinal and cross-sectional studies that used an observational measure of maternal parenting behavior were eligible. Study results relating to parenting behaviors defined as sensitivity, facilitation, and responsivity were extracted, and mean estimates were combined with random-effects meta-analysis.

RESULTS: Thirty-four studies were included in the meta-analysis. Mothers of preterm and full-term children did not differ significantly from each other in terms of their behavior toward their children (Hedges’ $g = 0.07$; 95% confidence interval: $-0.22$ to $0.08$; $z = 0.94$; $P = .35$). The heterogeneity between studies was significant and high ($Q = 156.42$; $I^2 = 78.9$, $P = .001$) and not explained by degree of prematurity, publication date, geographical area, infant age, or type of maternal behavior.

CONCLUSIONS: Mothers of preterm children were not found to be less sensitive or responsive toward their children than mothers of full-term children.
The survival rate of preterm infants has increased rapidly as a result of the improvements in medical and nursing care and technology in the past decades.\textsuperscript{1} Infants born preterm often require care in the NICU or Special Care Baby Units for weeks and often months.\textsuperscript{2}

Being in close contact with the mother in the early days of life has been proposed to be crucial for the development of mother-infant bonding.\textsuperscript{3} Preterm birth and incubator care might influence the infant, the mother, and their relationship. Preterm children experience more neurodevelopmental, cognitive, and behavioral problems in infancy and childhood\textsuperscript{4,5} and may be less attentive in their communication with their mothers,\textsuperscript{6} smile less often,\textsuperscript{7} and be less responsive.\textsuperscript{8,9} Furthermore, preterm birth might impair the mother’s own perception about her ability to take care of her newborn.\textsuperscript{10,11} Apart from separation, this is often a stressful time for parents because of the uncertain outcomes for their infants. Preterm birth has been reported to increase the risk of depression in mothers\textsuperscript{12,13} and lead to symptoms of posttraumatic stress disorder\textsuperscript{14} and may adversely affect the mother-infant relationship.\textsuperscript{15–17}

Maternal sensitivity has been defined as the mother’s ability to infer her infant’s signals and respond to them appropriately.\textsuperscript{10} In full-term children, sensitive and responsive parenting has been shown to increase cognitive, social, and emotional outcomes.\textsuperscript{19–21} On the other hand, insensitive parenting has been related to poor regulatory control in infancy\textsuperscript{22} and more psychological problems in young adulthood.\textsuperscript{23,24} Recent evidence indicates that sensitive parenting may be even more crucial for preterm children to achieve outcomes similar to full-term children.\textsuperscript{25} Thus, increasing maternal sensitivity and responsiveness with interventions has been reported to result in more developed communication skills, improved cognitive outcomes, and more positive mood in preterm infants.\textsuperscript{26–28}

However, there is considerable inconsistency in findings, with several studies that reported mothers of preterm infants to be as responsive or sensitive,\textsuperscript{29–31} or more so,\textsuperscript{32} than comparison mothers. Concepts used in observational studies of parenting also differed and mainly referred to “sensitivity” and “responsiveness.”\textsuperscript{33} Other than these 2 terms, behaviors such as directiveness (statement that directs the infant to do or say something), suggestions (question or statement that provides infant a choice), and the frequency of smiling\textsuperscript{34} were also used by some studies. We use the term “facilitation” to generally refer to these behaviors.

These inconsistencies may be due to the children studied (ie, whether they were born moderate to late preterm or very preterm). In addition, better parental access and more parental care in recent years (after 2000) have decreased stress for parents and infants.\textsuperscript{35} Infant age is also a critical factor because the differences in maternal behavior between preterm and full-term infants have been suggested to lessen after 6 months of age.\textsuperscript{30} Moreover, the differences between the measures used to evaluate types of parenting behavior (sensitivity, responsivity, facilitation) could be a critical factor to consider in the explanation of findings. Finally, geographical variations in NICU care practices (Europe versus North America) may account for some of the inconsistencies in the findings because care practices might differ between continents.

The aim of this meta-analysis was to systematically investigate whether the observed maternal behavior in interaction with their preterm infants or children differs systematically from that of mothers with their full-term infants or children. Furthermore, we investigated whether the following factors would moderate the results: degree of prematurity (ie, very preterm [<32 weeks’ gestation] versus moderate to late preterm birth [32–36 weeks’ gestation]), publication date before 2000 versus after 2000 (indicator of recent modern NICU care and open visiting patterns), type of parenting behavior, and infant age and geographical setting of the studies (Europe or North America).

**METHODS**

The current meta-analysis was conducted in line with the MOOSE (Meta-Analysis of Observational Studies in Epidemiology) guidelines.\textsuperscript{36}

**Search Strategy**

A literature search was conducted for cross-sectional and longitudinal studies of maternal behavior in preterm infant-mother dyads, published between January 1980 and May 2014. The article search was finalized on June 30, 2014. The following electronic databases were searched: Medline, PsychInfo, ERIC, PubMed, and Web of Science. The keywords used were as follows: “premature”, “preterm”, “low birth weight” in conjunction with “maternal behavior”, “mother-infant interaction”, “maternal sensitivity”, and “parenting”.

The Medline search yielded 3 articles, PsychInfo yielded 336 articles, ERIC yielded 11 articles, PubMed yielded 70 articles, and Web of Science yielded 111 articles. Overall, 531 articles were included in the literature search. Forty-three duplicates were removed from the search. Overall, the final literature search included 488 articles (see Fig 1).

**Study Inclusion and Exclusion Criteria**

Studies were included in the analysis according to 5 criteria. First, articles...
should report on the following maternal parenting behavior constructs: “maternal sensitivity”, which is defined as a mother’s ability to perceive and infer the meaning behind her infant’s behavioral signals and to respond to them promptly and appropriately; “maternal responsiveness”, such as providing stimulation to the infant; or “maternal facilitation”, such as positive regard and respect for the child’s autonomy. Because these terms tapped into similar constructs, our review used maternal parenting behavior as an umbrella term to refer to maternal sensitivity, maternal responsiveness, and maternal facilitation. Second, studies had to use an observational instrument to measure maternal parenting behavior. Third, studies had to include a full-term comparison group. Fourth, enough statistical information (correlations, means, and SDs; sample size; \( P \) or \( t \) values) should be reported in the articles or provided by authors after contacting them to enable computing effect sizes. Last, the articles had to be in English. Studies not fulfilling these criteria were excluded (Fig 1).

The titles and abstracts of 488 articles were reviewed, and 293 were excluded on the basis of the abstract only. We reviewed the full text of the remaining 195 articles according to the inclusion criteria, and 155 articles were excluded. Furthermore, 6 studies had no information to compute effect sizes. The contact information of one of the authors could not be found. The other authors of these studies were contacted; however, 3 of the authors did not reply and 2 could not provide the information. Thirty-four studies were included in the meta-analysis (Table 1). The article selection process was performed by Ayten Bilgin and Hayley Boulton independently. The overall agreement in the selection of articles according to the predefined criteria was Cohen’s \( \kappa \) 0.86 at the abstract selection stage and 0.83 at the full-text retrieval stage. The discrepancies in 10 articles were discussed and mutually resolved by the coders.

Quality Assessment

The Newcastle-Ottawa Scale was used to assess the quality of studies referring to selection, comparability, and outcome or exposure for case-control and cohort studies (see Supplemental Tables 2 and 3). Scores in this scale could range from 0 to 9, with higher scores indicating higher quality. Studies were rated by 2 independent coders, and agreement for the overall rating for each study was found to be high (\( \kappa = 0.82 \)). The overall ratings of the studies ranged from 7 to 9 (mean = 8.08, SD = 0.79), indicating overall high quality.

Data Extraction

Eligible studies were reviewed to extract the observed maternal behavioral data. When available, information on the comparison of preterm and full-term groups was extracted directly from the article. Different studies provided the data in different formats: sample size with means and SDs, \( P \) value, or \( t \) value.
<table>
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<tr>
<th>Study</th>
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<th>Birth Weight, Mean (SD), Range g</th>
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<tr>
<td>Agostini et al46</td>
<td>P: 69; F: 60</td>
<td>3 mo</td>
<td>P: 1040.71 (127.49); F: 3410.24 (462.76)</td>
<td>P: 28.53 (1.7); F: 39.86 (1.13)</td>
<td>P: 45/24; F: 42/58</td>
<td>CS</td>
<td>5 min</td>
<td>Global rating scales47: 5-point scale to rate sensitivity, intrusiveness, remoteness, signs of depression 4-point scale to rate maternal responsiveness to infant’s distress or satiation cues</td>
<td>NS</td>
<td>Maternal sensitivity</td>
<td>VPT</td>
<td>After 2000</td>
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<td>≤6 mo</td>
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<td>Barratt et al57</td>
<td>P: 24; F: 24</td>
<td>4 mo</td>
<td>P: 1460–2420 (mean = 2099); F: 2849 to 4408 (mean = 5405)</td>
<td>P: 51–56 (mean = 54); F: 57–42 (mean = 40)</td>
<td>No information</td>
<td>CS</td>
<td>1 h, 10 min</td>
<td>Initiations of the following behaviors were coded: mother vocalizations, touches, and smiles</td>
<td>S</td>
<td>Maternal responsiveness</td>
<td>M/LPT</td>
<td>Before 2000</td>
<td>North America</td>
<td>≤6 mo</td>
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<td>Bendersky and Lewis49</td>
<td>P: 31; F: 28</td>
<td>3 mo</td>
<td>P: 1615.3 (709–2180); F: 3587.9 (2068–4564)</td>
<td>P: 32.2 (26–37); F: 40.14 (30–42)</td>
<td>No information</td>
<td>CS</td>
<td>15 mins</td>
<td>A checklist developed by Lewis and Lee-Painter50; responsiveness was conceptualized as the amount of behavior that involves response to the infant</td>
<td>NS</td>
<td>Maternal responsiveness</td>
<td>M/LPT</td>
<td>Before 2000</td>
<td>North America</td>
<td>≤6 mo</td>
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<td>Coppola et al51</td>
<td>P: 20; F: 20</td>
<td>3 mo</td>
<td>P: 1201.25 (166.2); F: 3368 (4453)</td>
<td>P: 29.9 (26); F: 38.9 (8)</td>
<td>18/22</td>
<td>CS</td>
<td>10 min</td>
<td>Parental sensitivity items from Emotional Availability Scale52</td>
<td>NS</td>
<td>Maternal sensitivity</td>
<td>VPT</td>
<td>After 2000</td>
<td>Europe</td>
<td>≤6 mo</td>
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<tr>
<td>Crawford &amp;53</td>
<td>P: 16; F: 17</td>
<td>6, 8, 10, and 14 mo</td>
<td>P: 1287 (660–1850); F: 3242 (2610–5740)</td>
<td>P: 29.6 (24–53); F: 39.6 (28–54)</td>
<td>No information</td>
<td>LN</td>
<td>10 min</td>
<td>The frequency of the following behaviors: holding the infant, attending to the needs of the infant, affectionate kissing or hugging, talking to infant</td>
<td>S/S/N</td>
<td>Maternal facilitation</td>
<td>VPT</td>
<td>Before 2000</td>
<td>North America</td>
<td>&gt;6 mo</td>
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<tr>
<td>Davis and Thomas &amp;54</td>
<td>P: 10; F: 29</td>
<td>2, 3, 4, and 5 wk</td>
<td>P: 1520 (1200–2100); F: 5536 (2750–4593)</td>
<td>P: 31 (28–35); F: 40 (37–42)</td>
<td>P: 5/5; F: 17/12</td>
<td>LN</td>
<td>7 h</td>
<td>Frequency of the following behaviors: move, rock, pat, caress, talk, look, vis-a-vis (eye to eye contact), hold/carry, smile/laugh, suck/stimulate</td>
<td>S</td>
<td>Maternal facilitation</td>
<td>M/LPT</td>
<td>Before 2000</td>
<td>North America</td>
<td>≤6 mo</td>
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<tr>
<td>DeWitt et al &amp;55</td>
<td>P: 115; F: 105</td>
<td>6 and 12 mo</td>
<td>P: 1072.5; F: 3111</td>
<td>P: 29.2; F: 39.7</td>
<td>P: 51/64; F: 32/53</td>
<td>LN</td>
<td>70 min</td>
<td>5-point rating scale based on Ainsworth &amp;56 and Crockenberg &amp;57</td>
<td>S</td>
<td>Maternal sensitivity</td>
<td>VPT</td>
<td>Before 2000</td>
<td>North America</td>
<td>&gt;6 mo</td>
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<tr>
<td>Feldman and Eidelman &amp;58</td>
<td>P: 56; F: 52</td>
<td>Term, 3 mo</td>
<td>P: 1278.1 (634.1); F: 5321 (457.1)</td>
<td>P: 30.58 (23); F: 58.82 (238)</td>
<td>P: 30/26; F: 29/25</td>
<td>LN</td>
<td>15 min at term, 90 min at 3 mo</td>
<td>At term coded by the Mother-Newborn Coding System of the Coding Interaction Behavior Manual, at 3 mo HOME &amp;59 and a microanalytic computerized coding system</td>
<td>S/NS</td>
<td>Maternal facilitation</td>
<td>VPT</td>
<td>After 2000</td>
<td>Europe</td>
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<tr>
<td>Forcada-Guex et al &amp;60</td>
<td>P: 47; F: 25</td>
<td>6 and 18 mo</td>
<td>No information</td>
<td>P: &lt;34.31 (2); F: &gt;37.40 (1)</td>
<td>P: 22/29; F: 0/15</td>
<td>LN</td>
<td>10 min</td>
<td>Third revision of Care Index &amp;61 assesses 3 scales: sensitivity, control, and unresponsiveness</td>
<td>S</td>
<td>Maternal sensitivity</td>
<td>M/LPT</td>
<td>After 2000</td>
<td>Europe</td>
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<tr>
<td>Greene et al(^6)</td>
<td>P: 50, F: 32</td>
<td>3 mo</td>
<td>P: 1642 (303); F: 3518.5 (588.5)</td>
<td>P: 32.8 (2.4); F: 40 (1.2)</td>
<td>P:15/15; F:16/16</td>
<td>CS</td>
<td>15 min</td>
<td>Checklist sheet developed by Lewis and Lee-Painter(^5); frequency of the following maternal behaviors was rated: (1) touch, (2) hold, (3) vocalization to infant (vocalization to other category omitted), (4) look, (5) smile/laugh, (6) play with infant, (7) change diaper/bathe wash his/her hands, face), (8) feed (includes breast, bottle, spoon), (9) rocks subject, (10) read, (11) kiss, and (12) give toy/pacifier</td>
<td>S</td>
<td>Maternal facilitation</td>
<td>M/LPT</td>
<td>Before 2000</td>
<td>North America</td>
<td>≤6 mo</td>
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<tr>
<td>Halpern and McLean(^6)</td>
<td>P: 20, F: 20</td>
<td>4 mo</td>
<td>P: 1673.5; F: 3421.5</td>
<td>P: 32.8 (28–56); F: 40 (38–43)</td>
<td>No information</td>
<td>CS</td>
<td>15 min</td>
<td>12-item rating scale(^6) that rated supportiveness, patience, expression of positive and negative feelings, responsiveness, behavioral repertoire</td>
<td>NS</td>
<td>Maternal facilitation</td>
<td>VPT</td>
<td>Before 2000</td>
<td>North America</td>
<td>≤6 mo</td>
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<tr>
<td>Jaekel et al(^9)</td>
<td>P: 267, F: 298</td>
<td>6 y, 3 mol 8 y, 5 mo</td>
<td>P: 1296 (508); F: 5588 (450)</td>
<td>P: 30.4 (23); F: 59.6 (1.2)</td>
<td>P: 143/124; F: 152/146</td>
<td>LN</td>
<td>12 min</td>
<td>A standardized coding system, &quot;Assessment of Mother-Child Interaction with the Etch A Sketch&quot;(^6)</td>
<td>S/S</td>
<td>Maternal sensitivity</td>
<td>VPT</td>
<td>After 2000</td>
<td>Europe</td>
<td>&gt;6 mo</td>
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<td>Jean and Stack(^6)</td>
<td>P: 40, F: 40</td>
<td>5 mo</td>
<td>P: 1092 (237); F: 3476 (305)</td>
<td>P: 28.5 (23); F: 59.74 (1.08)</td>
<td>P: 18/22; F: 20/20</td>
<td>CS</td>
<td>6 min</td>
<td>Sensitivity scale of Emotional Availability scale(^5)</td>
<td>S</td>
<td>Maternal sensitivity</td>
<td>VPT</td>
<td>After 2000</td>
<td>North America</td>
<td>≤6 mo</td>
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<td>Korja et al(^29)</td>
<td>P: 52, F: 36</td>
<td>6 and 12 mo</td>
<td>P: 1008 (289); F: 3589 (406)</td>
<td>P: 28 (3); F: 40 (1)</td>
<td>P: 19/15; F: 19/17</td>
<td>LN</td>
<td>5 min</td>
<td>Parent-Child Early Relational Assessment(^6) 5-point Likert scale</td>
<td>NS/NS</td>
<td>Maternal facilitation</td>
<td>VPT</td>
<td>After 2000</td>
<td>Europe</td>
<td>&gt;6 mo</td>
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<td>Landry et al70</td>
<td>P: 48; F: 21</td>
<td>36 mo</td>
<td>P: 1258.5 (283); F: 5200 (780)</td>
<td>P: 30.4 (2.11); F: 41 (2.1)</td>
<td>P: 25/25; F: 12/9</td>
<td>CS</td>
<td>20 min</td>
<td>Frequency of the following behaviors: directives, suggestions, restrictions, praise</td>
<td>S Maternal facilitation</td>
<td>VPT Before 2000</td>
<td>North America</td>
<td>&gt;6 mo</td>
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<tr>
<td>Laucht et al71</td>
<td>P: 119; F: 228</td>
<td>3 mo</td>
<td>P: 1625.5 (229.5); F: 3274 (419)</td>
<td>P: 33 (2.3); F: 59.4 (1.7)</td>
<td>P: 171/176</td>
<td>CS</td>
<td>10 min</td>
<td>Mannheim rating system [72]</td>
<td>NS Maternal sensitivity</td>
<td>VPT After 2000</td>
<td>Europe</td>
<td>≤6 mo</td>
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<td>Levy-Shiff and Mogilner73</td>
<td>P: 38; F: 38</td>
<td>2, 3, and 4 wk</td>
<td>P: 1254 (375); F: 50 (450)</td>
<td>P: 30 (5.2); F: 41 (0.8)</td>
<td>P: 19/19; F: 19/19</td>
<td>LN</td>
<td>30 min</td>
<td>Behaviors coded: caregiving, talking, playing and stimulating, expressing positive affection, holding, looking</td>
<td>S Maternal facilitation</td>
<td>M/LPT Before 2000</td>
<td>Europe</td>
<td>≤6 mo</td>
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<tr>
<td>Mijkovitch et al74</td>
<td>P: 48; F: 23</td>
<td>6 and 18 mo</td>
<td>No information</td>
<td>P: &lt;3; F: &gt;37</td>
<td>No information</td>
<td>LN</td>
<td>5 min</td>
<td>Ainsworth Maternal Sensitivity Scale and the Care Index, which codes the following behaviors sensitivity, controlling, unresponsive</td>
<td>S/NS Maternal sensitivity</td>
<td>VPT After 2000</td>
<td>Europe</td>
<td>&gt;6 mo</td>
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<td>Minde et al75</td>
<td>P: 20; F: 20</td>
<td>1, 2, and 3 mo</td>
<td>P: 1124 (173); F: 3196 (526)</td>
<td>P: 26–32</td>
<td>P: 10/10; F: 8/12</td>
<td>LN</td>
<td>10 min</td>
<td>Frequency and duration of the following behaviors: look, verbalize, touch, hold, nipple in mouth</td>
<td>S/S/S Maternal facilitation</td>
<td>VPT Before 2000</td>
<td>North America</td>
<td>≤6 mo</td>
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<td>Montirosso et al70</td>
<td>P: 25; F: 25</td>
<td>9 mo</td>
<td>P: 1516 (483), 845–2450; F: 3293 (382)</td>
<td>P: 32.1 (2.8); F: 39.9 (1.2); 37–41</td>
<td>P: 14/11; F: 15/12</td>
<td>CS</td>
<td>6 min</td>
<td>Infant and caregiver engagement phases [76]</td>
<td>NS Maternal facilitation</td>
<td>M/LPT After 2000</td>
<td>Europe</td>
<td>&gt;6 mo</td>
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<tr>
<td>Muller-Nix et al15a</td>
<td>P: 47; F: 25</td>
<td>6 and 18 mo</td>
<td>No information</td>
<td>P: 31 (2); F: 40 (1)</td>
<td>P: 22/25; F: 10/15</td>
<td>LN</td>
<td>10 min</td>
<td>Third revision of Care Index, assesses 3 scales: sensitivity, control, and unresponsiveness</td>
<td>S/S Maternal sensitivity</td>
<td>M/LPT After 2000</td>
<td>Europe</td>
<td>&gt;6 mo</td>
<td></td>
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<td>Study</td>
<td>N</td>
<td>Age</td>
<td>Birth Weight, Mean (SD), Range g</td>
<td>Gestational Age, Mean (SD), Range, wk</td>
<td>Gender (Male/ Female), n</td>
<td>Design Duration of Observation</td>
<td>Instrument</td>
<td>Result</td>
<td>Type of Parenting</td>
<td>Degree of Prematurity</td>
<td>Publication Date</td>
<td>Geographical Setting</td>
<td>Infant Age</td>
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<tr>
<td>Pothast et al&lt;sup&gt;41&lt;/sup&gt;</td>
<td>P: 94; F: 84</td>
<td>5 y</td>
<td>P: &lt;1000, F: &gt;2500</td>
<td></td>
<td>No information</td>
<td>CS 15 min</td>
<td>The NICHD (2000) Early Child Care Research Network coding system&lt;sup&gt;77&lt;/sup&gt;, which measures mother’s supportive presence and respect for the child’s autonomy&lt;sup&gt;78&lt;/sup&gt; and quality of relationship&lt;sup&gt;79&lt;/sup&gt;</td>
<td>NS Maternal sensitivity</td>
<td>VPT</td>
<td>After 2000</td>
<td>Europe</td>
<td>&gt;6 mo</td>
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<tr>
<td>Rahkonen et al&lt;sup&gt;51&lt;/sup&gt;</td>
<td>P: 48; F: 16</td>
<td>2 y</td>
<td>P: 876 (194), F: 3613 (354)</td>
<td></td>
<td>P: 26.3 (12), F: 40.2 (0.9)</td>
<td>CS 15 min</td>
<td>Mutually responsive orientation&lt;sup&gt;78&lt;/sup&gt; and quality of relationship&lt;sup&gt;79&lt;/sup&gt;</td>
<td>NS Maternal sensitivity</td>
<td>VPT</td>
<td>After 2000</td>
<td>Europe</td>
<td>&gt;6 mo</td>
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<tr>
<td>Schermann-Eizirik&lt;sup&gt;80&lt;/sup&gt;</td>
<td>P: 142; F: 70</td>
<td>2, 4, 6 mo</td>
<td>P: 1829.5 (440), F: 5558 (469)</td>
<td></td>
<td>P: 31.4 (17), F: 39.7 (1.1)</td>
<td>LN 5 min</td>
<td>Behaviors rated on a 5-point scale were sensitivity, intrusiveness, and involvement</td>
<td>NS/NS/NS Maternal sensitivity</td>
<td>VPT</td>
<td>Before 2000</td>
<td>Europe</td>
<td>≤6 mo</td>
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<td>Schmücker et al&lt;sup&gt;53&lt;/sup&gt;</td>
<td>P: 79; F: 33</td>
<td>3 mo</td>
<td>P: 938.5 (288.4), F: 3333 (400.3)</td>
<td></td>
<td>P: 27.5 (27), F: 59 (1.2)</td>
<td>CS 10 min</td>
<td>Microanalytic coding system of mother-infant interaction&lt;sup&gt;81&lt;/sup&gt;</td>
<td>S Maternal responsiveness</td>
<td>VPT</td>
<td>After 2000</td>
<td>Europe</td>
<td>≤6 mo</td>
<td></td>
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<td>Singer et al&lt;sup&gt;82&lt;/sup&gt;</td>
<td>P: 171; F: 117</td>
<td>8 and 12 mo</td>
<td>P: 1111 (2053), F: 3463 (520)</td>
<td></td>
<td>P: 28.8 (2), F: 39.8 (1)</td>
<td>LN No information</td>
<td>The Nursing Child Assessment Feeding Scale&lt;sup&gt;83&lt;/sup&gt;</td>
<td>NS/NS Maternal sensitivity</td>
<td>VPT</td>
<td>After 2000</td>
<td>America</td>
<td>&gt;6 mo</td>
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<td>Stevenson et al&lt;sup&gt;58&lt;/sup&gt;</td>
<td>P: 17; F: 17</td>
<td>8 mo</td>
<td>P: 2140 (216), F: 5509 (494)</td>
<td></td>
<td>P: 34.1 (1.3), F: 39.9 (1.6)</td>
<td>CS 10 min</td>
<td>Onset and offset of the following behaviors were recorded: proffer food, vocalize, look toward, touch infant, smile, present objects</td>
<td>S Maternal facilitation</td>
<td>M/LPT</td>
<td>Before 2000</td>
<td>America</td>
<td>&gt;6 mo</td>
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<td>Watt and Strongman&lt;sup&gt;84&lt;/sup&gt;</td>
<td>P: 14; F: 10</td>
<td>2 and 3 mo</td>
<td>No information</td>
<td>P: 53.1 (31–53)</td>
<td>No information</td>
<td>LN P: 52.4 (21.8–43) min; F: 54.7 (19.8–47.8) min</td>
<td>Frequency of the following behaviors were recorded: vocalize, look, smile, kiss, hug, rock, tickle, affectionate touch, play</td>
<td>NS/NS Maternal facilitation</td>
<td>M/LPT</td>
<td>Before 2000</td>
<td>Europe</td>
<td>≤6 mo</td>
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<td>Wille&lt;sup&gt;85&lt;/sup&gt;</td>
<td>P: 36; F: 18</td>
<td>6 mo</td>
<td>P: 1929.5 (553), F: 3495 (218)</td>
<td></td>
<td>P: 34 (1.3), F: 40 (1)</td>
<td>CS 15 min</td>
<td>Second-by-second monadic phase system&lt;sup&gt;86&lt;/sup&gt;</td>
<td>S Maternal facilitation</td>
<td>M/LPT</td>
<td>Before 2000</td>
<td>America</td>
<td>≤6 mo</td>
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<td>Study</td>
<td>N</td>
<td>Age</td>
<td>Birth Weight, Mean (SD), Range g</td>
<td>Gestational Age, Mean (SD), Range, wk</td>
<td>Gender (Male/ Female), n</td>
<td>Design</td>
<td>Duration of Observation</td>
<td>Instrument</td>
<td>Result</td>
<td>Moderators</td>
<td>Type of Parenting Behavior</td>
<td>Degree of Prematurity</td>
<td>Publication Date</td>
<td>Geographical Setting</td>
<td>Infant Age</td>
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<td>Zarling et al8</td>
<td>P: 34;  F: 30</td>
<td>6 mo</td>
<td>P: 1243 (218); F: &gt;2500</td>
<td>P: 30 (2); F: 30–40</td>
<td>P: 51/39; F: 63/52</td>
<td>CS</td>
<td>5 min</td>
<td>5-point scale that measures the reciprocity, intrusiveness, responsiveness, affect, successfulness with infant, appropriateness of verbal and nonverbal techniques</td>
<td>S</td>
<td>Maternal sensitivity</td>
<td>VPT</td>
<td>Before 2000</td>
<td>America</td>
<td>≤6 mo</td>
<td></td>
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</table>

1 Mean, SD, and range values are reported if available. CS, cross-sectional; F, full-term; HOME, Home Observation for Measurement of the Environment; LN, longitudinal; M/LPT, moderate to late preterm; P, preterm; NICHD, Eunice Kennedy Shriver National Institute of Child Health and Human Development; NS, no significant difference; S, significant difference; VPT, very preterm.

* These 2 studies reported findings from the same sample. We used the 18-month data from the Muller-Nix et al study and the 6-month data from the Forcada-Guex et al study.
When any of this information was unavailable, it was requested from the authors. In cases in which the researchers reported the statistical information for each observed maternal behavior separately, a mean score and a pooled SD score were computed. Furthermore, categorical information regarding the degree of prematurity, publication before or after 2000, geographical setting, type of parenting, and infant age was extracted from the articles (Table 1). Furthermore, type of parenting behavior was coded as maternal sensitivity or responsivity in accordance with what was reported in the Results section. Facilitation was coded when maternal behaviors were reported separately without being referred to as sensitivity or responsiveness. One exception was Barnard et al,39 which was coded as facilitation, even though responsivity was also reported in the study, because facilitation was reported at all measurement times. The categorization of these variables was completed by the first author (A.B.) under the supervision of the second author (D.W.).

**Data Analysis**

Analysis was conducted with Comprehensive Meta-Analysis version 2 software.91 All studies provided continuous measures of observed maternal parenting behavior, comparing preterm and full-term control samples. Mean effect sizes were calculated with the Comprehensive Meta-Analysis software when studies reported group differences at different time points. A random-effects model was used to generate the combined estimate of the effects (Hedges' g). Random-effects models take into account that effect sizes will differ from 1 study to another because they are sampled from an unknown distribution.67 Heterogeneity of studies was assessed with Cochran’s Q and Higgins I². Moderator analyses were conducted with 5 variables: degree of prematurity, publication before or after 2000, geographical setting, infant age, and type of parenting behavior. Sensitivity analysis was undertaken with the outlier.

Publication bias analysis was assessed as follows:

1. Rosenthal’s fail-safe number was used to address the file-drawer problem. Rosenthal’s fail-safe number test produces the number of unpublished studies needed to bring the combined effect size to a statistically non-significant level. Publication bias does not exist if Rosenthal’s fail-safe number exceeds 5k + 10, where “k” is the number of studies used in meta-analysis.

2. The trim and fill procedure was used to examine the symmetry of effect sizes plotted by the inverse of the SE. Ideally, the effect sizes should mirror one another on either side of the mean.

3. The Begg and Mazumdar rank correlation test was used to examine the likelihood of bias in favor of small sample size studies. Nonsignificance of correlation indicates no publication bias.

4. Egger’s test examined whether publication bias related to the direction of study findings. The intercept value provided by this test shows the level of funnel plot asymmetry from the standard precision.

**RESULTS**

The 34 studies included a total of 3905 participants, 1981 preterm and 1924 full-term comparison children. Thirteen of the studies investigated moderate to late preterm (32–36 weeks’ gestation) and 21 studies reported on very preterm children (<32 weeks’ gestation). Mean birth weight was 1374 g (SD = 234 g) for the preterm participants and 3450 g (SD = 545 g) for the full-term participants. The mean gestational age of the preterm children was 30.4 weeks (SD = 2.2 weeks) compared with 39.8 weeks (SD = 1.1 week) for the full-term comparisons. Fifty percent (n = 17) of the studies were longitudinal (ie, had >1 assessment point). Four of the studies reported on observed maternal responsivity (12%), 14 on observed maternal sensitivity (41%), and the rest described observed mother behavior as maternal facilitation (47%). The overall sample size of the studies ranged from 33 to 565 (median = 71). The mean age of the participants included in the studies was 13.9 months (median = 6 months). Twenty-one of the studies included participants <12 months, with a mean age of 4 months (range: 2 weeks to 9 months). The other 13 studies included participants aged ≥12 months (mean = 28.07 months; range: 12 months to 8 years, 5 months).

The combined mean effect size of observed maternal parenting behavior was Hedges’ g = -0.07 (95% confidence interval: -0.22 to 0.08; z = -0.94; P = .35), indicating no difference in the parenting behavior of mothers of preterm and full-term comparison children. Heterogeneity analysis indicated significant and high variation in effects between studies (Q = 156.42; I² = 78.9, P = .001) (Fig 2).

**Moderator Analysis**

Planned moderator analysis revealed that the degree of prematurity was not a significant moderator (Q = 0.02, P = .88) (see Supplemental Fig 4). Being published before or after 2000 was also not a significant moderator for the main analysis (Q = 1.47, P = .23) (see Supplemental Fig 5), nor was whether the studies were carried out in North America or Europe (Q = 0.77, P = .38) (see Supplemental Fig 6). Similarly, infant age (Q = 0.01, P = .92) (see Supplemental Fig 7) and the type of observed maternal parenting behavior did not moderate the findings (Q = 2.76, P = .25) (see Supplemental Fig 8).
Outliers and Sensitivity Analysis

Outliers are defined as studies that had significantly different effect sizes from the other studies.97 One study61 was identified as an outlier because it had substantially higher effect sizes than the other studies. As suggested by Borenstein et al,97 we repeated the meta-analysis excluding the outlier to check whether this result altered the combined effect size and reduced heterogeneity. Results remained nonsignificant when the outlier was removed from the analysis (Hedges’ $g = -0.02$, $P = .76$) (Fig 3) and the level of heterogeneity decreased ($Q = 103.07$; $I^2 = 68.95$, $P = .001$).

Publication Bias

The fail-safe number addresses the concern that the observed differences may be false and was not relevant in the current study because the combined result did not indicate group differences. Under the random-effects model, the point estimate (95% confidence interval) for the combined studies is $-0.097$ ($-0.33$ to $0.13$). With the use of trim and fill, these values remained unchanged, indicating no publication bias. Furthermore, the Begg and Mazumdar rank correlation was not significant and Egger’s test was not statistically significant, indicating no evidence of publication bias.

DISCUSSION

Meta-analysis revealed no evidence of differences in mothers observed parenting behavior with their preterm infants or children compared with mothers of full-term comparisons. The findings did not alter significantly when moderators such as degree of prematurity, geographical location, infant age, type of parenting behavior, or time of neonatal care (before or after the 2000) were considered. Furthermore, excluding the outlier did not alter the findings and the results cannot be accounted for by publication bias.

 Mothers of preterm children repeatedly have been described at risk of being less sensitive in their interactions with their infants.45,98 It has been proposed that mothers’ ability to respond to their preterm infants’ needs appropriately might be negatively affected by long-term incubator care3,99,100 or by mothers’ high levels of stress.15 Nevertheless, the results from our meta-analysis indicate that mothers of preterm children provide, on average, similar observed sensitive and responsive parenting for their preterm offspring as mothers with a full-term infant. This finding provides support to the studies that reported similar levels of

FIGURE 2
Difference between preterm and full-term mother infant dyads. CI, confidence interval. Favors A, Favors full-term infants; Favors B, favors preterm infants.
observed maternal behavior in preterm and full-term infants during the first year of life.\textsuperscript{29,30,46,63,80}

Maternal sensitivity has been previously reported to be a predictor of the development of secure infant-to-mother attachment.\textsuperscript{101} In preterm infants, maternal sensitivity has been linked to positive developmental outcomes,\textsuperscript{102} whereas insensitivity has been found to increase impairments in self-regulation.\textsuperscript{103} Similar outcomes in preterm infants were also observed when maternal responsibility and facilitation were measured.\textsuperscript{43,84,104} We carefully distinguished between the different maternal parenting behaviors: sensitivity, responsivity, and facilitation. This method allowed us to examine the impact of all parenting behavior as well as the moderating role of using different constructs in analysis. Nevertheless, type of parenting did not make a difference in the outcome, which suggests that our findings are generalizable across these different maternal parenting behaviors.

Increased levels of maternal stimulation and intrusiveness have been associated with negative outcomes.\textsuperscript{105} However, Wijnroks\textsuperscript{106} showed that intrusive parenting did not lead to negative outcomes in preterm children. On the contrary, preterm children were found to have better cognitive outcomes and better ability to sustain attention at the age of 2 years. Similarly, Jaekel et al\textsuperscript{25} and Eryigit Madzwamuse et al\textsuperscript{107} reported that differences in parenting behavior disappeared once intellectual abilities of the infants/children were controlled for. Thus, children who were delayed and had lower IQ scores may need more framing and directive parenting, which may be considered as intrusive in normally developing children. Knowing that preterm children are more likely to have developmental delay, our finding of no differences in observed parenting is even more remarkable.

Evidence from some recent studies suggests that differences between preterm and full-term infants in observed maternal behavior may decrease after the first 6 months.\textsuperscript{28,29} In this meta-analysis, 19 studies included infants aged \( \leq 6 \) months and 15 studies included children aged \( \geq 7 \) months. No impact of infant age on maternal observed behavior was found in moderator analysis.

Previous research considered the length of stay in hospital and the degree of neonatal illness as important predictors of the

\begin{figure}
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\includegraphics[width=\textwidth]{figure3.png}
\caption{Difference between preterm and full-term mother infant dyads- Without outlier. CI, confidence interval. Favors A, Favors full-term infants; Favors B, favors preterm infants.}
\end{figure}
socioemotional development of preterm infants. Increased neonatal morbidity and prolonged hospital stay may adversely shape the quality of the relationship between the mother and infant. Very preterm infants experience, on average, more neonatal complications and interventions and longer hospital stay than moderate to late preterm infants. However, no difference in observed parenting behavior of mothers of very preterm versus moderate to late preterm infants was found in the current meta-analysis. This finding provides no evidence for the suggestion that lower gestational age, often associated with longer hospitalization, adversely affects observed maternal parenting and is in line with studies that directly explored the impact of severity of neonatal illness or birth weight on maternal parenting behavior. Alleviating maternal stress by early intervention has been shown to increase the amount of sensitivity of mothers of preterm infants at 12 months. Recent improvements in neonatal support were proposed to have led to more involved care and improved interaction during initial hospitalization. Practices in NICU care regarding parent involvement started changing in the 1990s but have varied widely between units within and between countries. We used the year 2000 as an “approximation” cutoff point to distinguish between less and more family-centered care. European NICUs, in particular the United Kingdom, implemented parental 24-hour visiting routines in the 1980/1990s, whereas this practice appears to have been later in many North American NICUs. However, our moderator analyses did not show a significant effect of studies being conducted before or after 2000 or of being conducted in Europe or North America.

The finding that preterm and full-term mothers do not differ in their observed parenting behavior is highly reassuring for health professionals and parents. The stress of having a preterm child has been often considered to adversely affect parenting behavior and long-term development. Nevertheless, our findings indicate considerable resiliency in observed parenting behavior. New longitudinal research indicates that preterm children may need increased sensitive and facilitative parenting to scaffold their behavior to deal with tasks and emotional regulation. This approach may include more guided and directive behavior. Furthermore, the finding that preterm infants are more influenced by low- or high-sensitive parenting suggests more susceptibility to parenting. Thus, we speculate that mothers of preterm children may need to be even more responsive and facilitative than mothers of full-term children for their children to reach the same potential.

Strengths and Limitations

Our study’s strengths are that we included only studies that had direct observations of maternal parenting behavior with usually high interobserver reliability. We excluded studies that used self-report questionnaires of maternal parenting behavior. Direct observations provide only a short window into maternal parenting behavior, whereas maternal reports of behavior refer to longer periods but may often be influenced by maternal factors such as depression. Furthermore, the use of expert observations, verified by interobserver agreement, is less likely to be biased by previous experiences and mental state than maternal reports of parenting.

A limitation is that the current meta-analysis included only articles published in English. We cannot be certain whether this may have introduced bias. However, for the studies analyzed here and published in the English language no indication of publication bias was found. Furthermore, heterogeneity was high, indicating considerable variation between studies. This heterogeneity might arise from incorporating studies that have various designs and sample sizes. To address this possibility, we used random-effects model in the analysis and conducted moderator analysis with potential variables. However, the predefined moderator variables could not explain the heterogeneity between studies and additional moderators may be considered in future research. Major heterogeneity may arise by the use of a wide range of observation methods. However, we could not test this possibility because measures differed from one study to another. Moreover, we used the year 2000 as an artificial cutoff point, which is a convenient approximation of changed NICU care (visiting patterns) and might not represent the exact time for the improvements in the NICUs included in the meta-analysis. Finally, we computed mean scores if the study reported observations of maternal behavior over several time points. Therefore, longitudinal changes were not addressed in the current analysis but may be of interest in future. The influence of specific medical complications on any potential differences between mothers of preterm and full-term infants could not be addressed. Very few studies provided information on medical complications and thus could not be considered as a moderator. However, it is critical for future studies to consider the level of medical complications in preterm infants when studying mothers’ behavior.

Conclusions

Despite being born preterm and often spending weeks or months in neonatal care, mothers’ observed parenting behavior in interaction with their preterm children was not found to be less sensitive, facilitative, or responsive than that of mothers of full-term children. The findings provide reason for optimism that most mothers, despite their initial
shock and stress and the challenges of dealing with a preterm infant, show sensitive and responsive behavior that is comparable to mothers of full-term children. However, whether these similar levels of observed maternal behavior are sufficient or appropriate to foster optimal development of preterm children requires further longitudinal investigation.24,25

ACKNOWLEDGMENT
We thank Dr Hayley Boulton, PhD, for her contributions to the study.

REFERENCES
interaction is influenced by the amount of holding in preterm infants. *Early Hum Dev*. 2008;84(4):257–267


84. Watt J, Strongman KT. Mother-infant interactions at 2 and 3 months in preterm, small-for-gestational-age, and full-term infants: their relationship with cognitive development at 4 months. *Early Hum Dev*. 1985;11(3-4):231–246


90. Wells GA, Shea B, O’Connell D, et al. The *Newcastle-Ottawa Scale (NOS) for Assessing the Quality of Nonrandomized Studies in Meta-analysis*. Ottawa, Canada: Ottawa Health Research Institute; 1999