



Review

The efficacy of interventions aimed at improving post-partum bonding: A review of interventions addressing parent-infant bonding in healthy and at risk populations



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ABSTRACT

Parent-infant bonding during the postpartum period allows babies to start establishing a relationship with their parents from birth, and it also plays an important role in child development. As the failure to building a close and positive bond is typically associated with poorer neuropsychological, behavioural, emotional, and social development from infancy to adulthood, early interventions that support parent-infant bonding seem particularly important. This review aims to determine and describe the effectiveness of interventions addressing parent-infant bonding during the postpartum period. Papers that were published between 2007 and 2017, written in English, and focused on an intervention aimed at improving postpartum parent-infant bonding were identified and assessed, concerning their eligibility for inclusion; thirteen such interventions met inclusion criteria and analysed. These studies addressed parent-infant bonding interventions, both in normative and at-risk situations, relative to both parents and their babies, and evaluated the impact of different strategies, such as educational and behavioural programs, psychosocial interventions, programs providing instruction in specific techniques, and interventions based on neurostimulation techniques. The heterogeneous methodologies employed by the various studies failed to enable us to pursue deep comparative analyses across our findings; this reflects a limitation that must be considered in further research aimed at implementing and evaluating future interventions.

Research on the parent-infant relationship dates back to a landmark study, conducted by Bowlby (1958), on attachment theory (Damato, 2005). In particular, subsequent research has shown that, during the first weeks after childbirth, mothers and fathers must engage in parent-infant bonding, thereby establishing an early emotional link that is crucial to the baby's healthy development and well-being (Solomon and George, 1996; Persico et al., 2017). Many studies postulate that this relationship actually begins during the pregnancy; according to that perspective, a bond between the parents and their baby starts from the moment parents can perceive foetal movements (Damato, 2005; Persico et al., 2017). This early bond is exceptionally important, as it promotes immediate postnatal interaction between babies and their parents, thereby affording babies a relationship with their parents as soon as they are born (Solomon, 1998; Persico et al., 2017; Alhusen, 2008).

Much research has shown that this early relationship, between a mother or father and the baby, plays a vital role in child development (Brockington, 1996; Misri and Kendrick, 2008; Muller et al., 2016). A

failure to build this relationship has proven to be associated with poorer neuropsychological, behavioural, emotional, and social functioning during infancy, adolescence and adulthood (Conrad and Ablow, 2010; Jonas et al., 2015; Conway and McDonough, 2006).

Various conditions, related either to the parents or the infants, have the potential to compromise the formation of a close and positive relationship (Ionio et al., 2017). For example, a mother suffering from depression may find it difficult to feel a prenatal bond with the foetus or a postpartum bond with the newborn, consequently demonstrating troubling emotions and behaviour, characterised by rejection, hostility, and aggressive impulses toward the infant (Brockington, 2004; Kumar, 1997), all of which may have long-term implications for the affected child (Misri & Kendrick, 2008; Klier, 2006). Further, post-traumatic stress disorder (PTSD) is frequently associated with depression and anxiety during the perinatal period (Smith et al., 2006), as well as with impaired mother-infant bonding (Ionio and Di Blasio, 2014; Ionio and Mascheroni, 2014; Seng et al., 2013).

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Moreover, factors related to the baby's condition at birth can undermine the development of effective postpartum parent-infant bonding. In particular, a premature birth can present a major challenge and trauma for the infant, as well as for the parents (Ionio et al., 2016a, 2016b, 2017, 2018a; Karatzias et al., 2007). Such an event can interfere with the natural and healthy transition into parenthood; the infant's adverse medical condition prevents parents from immediately and directly tending to and interacting with their newborn child (Axelin et al., 2010). Another factor that can impair parent-infant bonding is associated with the manifestation of a congenital condition or chronic illness of the baby (Hafetz and Miller, 2010). Prior research has indicated that such a diagnosis, which typically occurs during the pregnancy or immediately following birth, represents a serious threat to the child's development and tends to have a profound emotional impact on the entire family structure (Nabors et al., 2013; Ionio et al., 2011, 2018b; Wallander and Varni, 1998).

Several studies have demonstrated that both of the abovementioned situations (i.e., premature birth and congenital abnormalities), often experienced during the perinatal period, can negatively influence the process of parental bonding and hinder the formation of an affectionate parent-infant relationship (Flacking et al., 2012), and consequently, the parents' interaction style in the long term (Forcada-Guex et al., 2011).

Using these issues as a foundations, researchers and practitioners have attempted to develop interventions aimed at addressing and promoting parent-infant bonding. In fact, a variety of studies report that parent-infant bonding is essential to the cultivation of future parent-child interactions and healthy infant development (Damato, 2005; Siddiqui & Hägglöf, 2000). Given the importance of this bond to the sound construction of future parent-child interaction and the infant's developmental outcomes, supportive postpartum interventions are likely to have important implications for both parents and child, not merely during the postpartum period, but throughout the entire developmental course. Based on this premise, the present paper provides a review of recent studies aimed at enhancing postpartum parent-infant bonding. The purpose and aims of this review consisted of identifying, describing, and evaluating the effectiveness of recent interventions and strategies intended to improve parent-infant bonding.

1. Methods

1.1. Search strategy

We conducted a search, strategically devised to mine information from the major relevant databases, in June 2017, using various combinations of the following search terms: *bonding*, *parental bonding*, *postpartum bonding*, *parent-infant relationship* and *intervention*. Further, we performed a manual search of the reference lists cited in relevant publications, to identify any additional papers eligible for inclusion. The first phase of establishing the relevance of assembled papers involved a process of screening titles, keywords, and abstracts. The full text of a given paper was obtained only if that paper was deemed to be potentially eligible. Subsequently, such potentially viable papers were read, in their entirety, to determine whether they met the inclusion criteria of the review.

In general, a paper was eligible for inclusion if it presented research related to an intervention that specifically addressed parent-infant bonding in the postpartum period, and employed specific and adequately validated indices or self-developed tools to facilitate measurement of the relative effectiveness of the intervention. As such, a paper that provided a description of the study protocol, but lacked an account of the intervention's outcome, as well as any account of an intervention that failed to provide some index or measurement of parental bonding during the perinatal period, were excluded. More precisely, the inclusion criteria for published studies were as follows: clearly focused on an intervention aimed, primarily or secondarily, at improving postpartum parental bonding; provision of outcomes and data related to the

intervention, rather than a mere qualitative description; published between the years of 2007 and 2017; written in English; and consisting of either manifestly quantitative research or, at the least, mixed methodology. Among those papers deemed suitable for inclusion were those that involved randomized (RCT) and non-randomized (non-RCT) controlled trials, observational and non-comparative studies, before and after studies, and case studies. Exclusion criteria for papers were as follows: absence of an assessment of postpartum parental bonding, relative to the outcome of the intervention; assumed the style or format of an editorial or commentary, as well as a conference paper or study protocol.

Initially, both authors engaged in assessing of eligibility for inclusion and subsequently, they reached a final decision about the inclusion of a given paper via collaboration and discussion. A total of 13 papers, concerning interventions addressing the postpartum parental bonding, met the eligibility criteria. The descriptions of the interventions descriptions are provided and synthesised in the following section.

2. Results

The description of each of the 13 interventions incorporated attributes of the research, such as aims, research design and tools, as well as characteristics and the relevant outcome of the intervention. Extracted data from the included papers are provided in Table 1.

The eligible studies were conducted in Europe ($n = 8$), North America ($n = 4$), and Africa ($n = 1$).

The assembled papers comprised five RCTs, one non-RCT, one open-label single-arm pilot study, one mixed-methodology pilot study, one quasi-experimental study with intervention and control group, one multiple-baseline single case series study, one observational single cohort study, one single case study, one prospective cohort study, and one concurrent cohort study.

Two studies employed interviews designed specifically in accordance with the purpose of the research, while 11 studies used self-report tools; seven studies used the Postpartum Bonding Questionnaire (PBQ; Brockington et al., 2006), with one study using both the PBQ and the My Baby and I questionnaire (MBI; Furman and O'Riordan, 2006); one study used the Prenatal Bonding questionnaire (PB; Reading et al., 1984); and two studies used the Mother-to-Infant Bonding Scale (MIBS; Taylor et al., 2005).

The majority of the studies consisted wholly of female participants ($n = 10$), while one study included both mothers and fathers and one included only fathers.

The studies described and evaluated interventions aimed at disparate and specific target populations: parents of preterm infants ($n = 2$), parents of healthy infants ($n = 2$), mothers with postpartum depression ($n = 5$), immigrant and socially-isolated mothers ($n = 1$), mothers with HIV ($n = 1$), mothers with abuse-related PTSD ($n = 1$), and mothers with pregnancy complications during preterm labour ($n = 1$).

Studies were grouped and synthesised, according to the intervention strategies used and divided into four main categories, described as follows: (a) educational and behavioural interventions ($n = 7$); (b) psychosocial interventions ($n = 3$); (c) interventions teaching specific techniques ($n = 2$); and (d) interventions reliant on neurostimulation techniques ($n = 1$).

2.1. Educational and behavioural interventions

The papers identified and assembled for inclusion involved, for the most part, educational and behavioural interventions addressing parent-infant bonding in the relevant time period. Educational and behavioural programs targeting parents usually aim to boost competency and knowledge, and also to encourage cooperation in a healthy way. Seven of the included studies explore the influence of educational and behavioural interventions designed specifically to enhance parent-

Table 1
Data summary of Interventions for parent-infant bonding in the postpartum period.

N	Authors (year)	Country	Intervention	Target population	Category	Study design, sample size, relevant scale used	Key relevant outcomes
1	Kleberg, Hellström-Westasb and Widströma (2007)	Sweden	Newborn Individualized Developmental Care and Assessment Program (NIDCAP)	mothers of preterm babies	Educational and behavioural interventions	RCT, 20 mothers of preterm infants with gestational age < 32 weeks, a questionnaire was designed to evaluate various aspects of the mothers' attitudes and apprehension of their maternal role, perception of their infant and the neonatal care.	The mothers in the NIDCAP-group perceived more closeness to their infants than did the control mothers (p = .022). Closer examination of the subscale feeling of closeness to her infant revealed that the mothers in the NIDCAP group presented higher level of emotional bonding with their infant.
2	Garcia et al. (2010)	USA	Repetitive transcranial magnetic stimulation (rTMS)	mothers with postpartum depression	Interventions that used neurostimulation techniques	Open-label, single-arm 4-week pilot study, 9 antidepressant-free women with Post Partum Depression, Postpartum Bonding Questionnaire (PBQ).	There was a statistically significant improvement in bonding scores from pretreatment (Md = 20.00) to posttreatment (Md = 7.00, P = .010) assessment.
3	Cheng et al. (2011)	Canada	Infant massage intervention	fathers with healthy infants	Interventions that teach specifically techniques	Pilot study using a mixed methodology approach, 24 infant–father dyads (12 dyads per group), infants ranged in age from 5 to 14 months old, qualitative Interview	Fathers perceived the infant massage instruction as a great bonding tool and a gateway to becoming more comfortable with their baby.
4	Yuan and Freeman (2011)	UK	Chinese Immigrant Mothers oral health Education programme, a culturally-sensitive oral health education intervention	socially-isolated immigrant mothers	Educational and behavioural interventions	Quasi-experimental design, 32 Chinese immigrant mothers with 8-week-old infants was divided into intervention and control groups, Postpartum Bonding Questionnaire (PBQ).	At 12 month follow-up the intervention group mothers had statistically significantly greater decreases in mean scores for the scales bonding disorder compared with control group mothers.
5	Bevan et al. (2013)	UK	Metacognitive therapy in the treatment of depression	mothers with postpartum depression	Psychosocial interventions	Multiple-baseline single case series, 6 mothers (age from 21 to 41 years), and their infants aged between 5 and 7 months, Postpartum Bonding Questionnaire (PBQ).	Participants reported improvements in their relationship and bond with their infants posttreatment as demonstrated by a significant reduction in scores on the PBQ.
6	O'mahen, Richards, Woodford, Wilkinson, McGinley, Taylor and Warren (2014)	USA	Internet behavioural activation (BA) treatment modified to address postnatal-specific concerns	mothers with postpartum depression	Educational and behavioural interventions	RCT, 83 women meeting DSM-IV criteria for major depressive disorder, randomized to NetmumsHWD (n = 41) or treatment-as-usual (TAU; n = 42), Postpartum Bonding Questionnaire (PBQ).	There were no between-group differences in postnatal self-reported bonding scores between women in the NetmumsHWD group and those in the TAU group, reflecting a small (0.29, 95% CI –0.80 to –0.22) effect size.
7	Rotheram-Borus et al. (2014)	South Africa	Peer Mentors to Support South African Women Living with HIV and Their Infants	mothers with HIV	Psychosocial interventions	RCT, 1200 mothers grouped by intervention condition, Postpartum Bonding Questionnaire (PBQ).	Bonding with infants was similar across conditions.
8	Rowe et al. (2014)	USA	Psychoeducational intervention for pregnant women with a history of childhood maltreatment focused on the management of PTSD symptoms	mothers with Abuse-related Posttraumatic Stress	Educational and behavioural interventions	Observational prospective cohort study, a sample of 128 women with baseline data were considered, outcomes data exist for 17 pilot intervention study participants and 43 matched observational study participants, Postpartum Bonding Questionnaire (PBQ).	This trauma-specific prenatal intervention appeared to provide benefit in terms of improved labor experience, less postpartum PTSD, a slight attenuation of postpartum depression, and less bonding impairment.
9	Scherer et al. (2014)	Switzerland	Cognitive-behavioural self-help, online program. It provided strategies to reduce anxiety and stress.	mothers with complications during pregnancy and preterm labour	Educational and behavioural interventions	Case study, 1 woman with cervical insufficiency, prenatal bonding questionnaire.	The Prenatal Bonding score increased from 56 pretreatment, to 62 post-treatment.
10	Hoffenkamp et al. (2015)	The Netherlands	Hospital-based Video Interaction Guidance	mothers and fathers of preterm babies	Educational and behavioural interventions	RCT, 150 families of preterm babies (n = 150 infants, with n = 150 mothers and n = 144 fathers) were randomized to either the intervention (n = 75) or control group (n = 75), Postpartum Bonding Questionnaire (PBQ, MBI-ER).	Both mothers and fathers in the intervention group reported significantly higher scores on enjoyment about and responsiveness to the infant (MBI-ER) as compared with the control group (p = .002) in the short term period. There were no effects on maternal reported bonding problems (PBQ) while paternal bonding problems were significantly different between the intervention and control group. Fathers who received VIG reported fewer difficulties in parent–infant bonding in the short term (p = .04) as well as in the long term (p = .02).

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Table 1 (continued)

N	Authors (year)	Country	Intervention	Target population	Category	Study design, sample size, relevant scale used	Key relevant outcomes
11	Tsivos et al. (2015)	UK	Baby Triple P Positive Parenting Program in mothers with postnatal depression	mothers with postpartum depression	Educational and behavioural interventions	RCT, 7 female participants aged from 18 to 45 years with a primary diagnosis of major depression and an infant under 12 months, randomly allocated to receive either eight Baby Triple P sessions in addition to TAU or TAU only, Postpartum Bonding Questionnaire (PBQ).	There were non-significant, $U = 54.0$, $z = -0.40$, $p = .69$, improvements to subjective bonding scores from baseline to post-treatment for women receiving Baby Triple P (median = 9.5, range = 0–67.0) compared with those receiving TAU (median = 9.75, range = 1.0–38.0).
12	Posmontier et al. (2016)	USA	Certified nurse-midwife telephone-administered interpersonal psychotherapy (CNM-IPT).	mothers with postpartum depression	Psychosocial interventions	Prospective cohort study, a sample of 61 women meeting DSM-IV-TR criteria for depression (41 women in the treatment group and 20 in the control group), Mother-to-Infant Bonding Scale (MIBS).	There were no significant differences in bonding scores between women in the intervention group and those in the control group.
13	Persico et al. (2017)	Italy	Singing lullabies during pregnancy to the foetus	mothers with healthy infants	Interventions that teach specifically techniques	Concurrent Cohort Study, 196 women (97 allocated to the singing cohort and 99 allocated to the concurrent cohort), Mother-to-Infant Bonding Scale (MIBS) were used to assess maternal-fetal attachment and postnatal bonding.	Postnatal Bonding was significantly greater in the singing group 3 months after birth (mean 1.28 vs 1.96; $p = .001$).

infant bonding. All of these interventions addressed parent-infant bonding in at-risk populations, such as parents of preterm babies, socially-isolated immigrant mothers, mothers with postpartum depression, mothers with abuse-related PTSD, and mothers with pregnancy complications.

The Neonatal Individualized Developmental Care and Assessment Program (NIDCAP) is a developmentally-focused intervention that targets mothers of preterm children. In particular, it aims to train mothers to detect and interpret their early-preterm babies' (i.e., born prior to 32 weeks' gestation) reactions to their care and to the environment in the care is given (Kleberg et al., 2007). An RCT, involving 20 mothers of preterm infants (singleton infants with gestational age below 32 weeks), was conducted, to test the effectiveness of NIDCAP, specifically, by evaluating the effects of care provided on the basis of NIDCAP guidance, relative to standard neonatal care, using a specific questionnaire comparing mothers' attitudes toward various styles of neonatal care in terms of a mother's perceived feelings of closeness to her infant (each answer was scored on a 4- point scale). Subsequent to participation in NIDCAP, each mother exhibited significantly higher scores, with regard to perceived closeness to her infant. Moreover, the study's authors observed that, upon closer examination of the results, they were able to draw conclusions about the significance of their findings, which indicated that mothers who participated in NIDCAP demonstrate higher levels of post-intervention emotional bonding with their infants.

Yuan and Freeman (2011) designed an intervention intended to promote maternal-infant bonding among Chinese immigrant mothers babies born in the United Kingdom (Yuan and Freeman, 2011). The Chinese immigrant mothers oral health education intervention (ChIME) aimed to provide Chinese immigrant mothers with culturally-sensitive social support and appropriate information concerning the appropriate way to care for their children, from birth through 12 months of age. A quasi-experimental design was employed, to evaluate the effectiveness of this intervention on a convenience sample of 36 Chinese immigrant mothers with 8-week-old infants. At the 12-month follow-up, mothers were assessed, to evaluate the impact of the intervention on mother-infant bonding. Follow-up reports showed that mothers were exhibiting statistically significant increases in reduced experiences of bonding disorder, rejection and pathological anger, and infant-focused anxiety, relative to control group mothers. As such, this intervention has been shown to positively influence maternal outcomes, in terms of mother-infant bonding, among a group of socially-isolated Chinese immigrant mothers.

O'Mahen et al. (2014) examined the effects of an online behavioural-activation treatment (Addis and Martell, 2004), specifically adapted to address the concerns of postnatal women suffering from depressive and anxious symptoms. Using an RCT, with a sample of 83 mothers, all meeting the Diagnostic and Statistical Manual of mental disorders Fourth Edition (DSM-IV) criteria for major depressive disorder, the study encouraged mothers assigned to the intervention group to perform interactive exercises, mixing didactic training and role-play revolving around conducting functional analyses related to perinatal-specific domains, over the course of 12 sessions. Women received support via weekly phone calls from mental health workers, and also could find peer support in a specific chat room. Despite the demonstrably positive of this supportive online intervention on depression and anxiety, reflected by the results of the RCT, there were no significant identifiable differences related to postnatal self-reported mother-infant bonding.

Rowe et al. (2014) employed a quasi-experimental method, to test the effectiveness of a psychoeducational intervention targeting pregnant women with a history of childhood maltreatment; the intervention focused managing the symptoms of PTSD. Thirty-two women were enrolled in the psychoeducational program that included both 10-modules of self-study and a 30-min telephone consultation with an expert. This trauma-specific intervention during the postpartum period

appeared to provide benefits, in terms of improved labour experience, reduced postpartum PTSD-related symptoms, and a slight, but not adequately significant attenuation, of bonding impairment. The authors have indicated that this could be improved by prolonging the psychoeducational intervention, so that it continues after the actual birth (Rowe et al., 2014).

Scherer et al. (2014) evaluated the feasibility of an online self-help program targeting anxiety and stress-management among pregnant women with preterm labour, using a case study methodology. It was analysed the case of an expectant mother, hospitalised with pregnancy complications, who worked independently online for 6 weeks along with engaging in regular written communication with a psychologist. The program had a demonstrably positive impact, both on anxiety, depression and stress levels, as well as on mother-infant bonding. However, despite the identifiable improvement, the methodology employed does not permit us to generalize the validity of the results to the rest of the population.

Finally, the hospital-based short-term intervention, video interaction guidance (VIG), guides parents, via video-feedback, to reflect on their own interactions with their preterm babies. This intervention was designed to promote parental bonding, as well as to facilitate enhanced quality of interactive parental behaviour and reduced levels of parental stress (Eliëns et al., 2010). Hoffenkamp et al. (2015) employed a pragmatic, multi-centre RCT, to test the effectiveness of this intervention, in 150 mothers and 144 fathers of 150 infants born preterm (between 25 and 37 weeks of gestation). Their results indicate that, a one day after the VIG intervention, both mothers and fathers assigned to the intervention group reported significantly higher scores related to enjoyment of, and responsiveness to, the infant; however, long-term differences between VIG conditions were observed only in fathers, and not in the mothers. Moreover, there were no discernible effects of VIG on maternal bonding problems; paternal bonding problems, by contrast, were significantly distinct, between the intervention and control group, both in the short- and long-term. VIG thereby has proven to be effective, given its significantly positive impact on several aspects of parental bonding, especially among fathers.

Tsivos et al. (2015) used an RCT, to evaluate the feasibility and effectiveness of a parenting intervention for a sample of 27 women suffering postpartum depression. The Baby Triple P intervention aims to raise parental knowledge and parenting best practices ability, by promoting parenting competence regarding childcare, and enhancing social, emotional and intellectual outcomes for children as well. Although results were found to be oriented in the predicted direction, with regard to subjective bonding, level of happiness, self-regulation, and depression in the post-treatment phase, this study failed to provide sound evidence demonstrating the effectiveness of the intervention.

2.2. Psychosocial interventions

Among the selected papers, three used psychosocial interventions aimed at improving postpartum parental bonding. Studies included in this category investigated the influence of psychological therapies, or supportive interventions involving social and peer mentorship, to improve parent-infant bonding. All interventions described within this category addressed bonding in at-risk mothers (i.e., mothers with postpartum depression and mothers with HIV).

Bevan et al. (2013) conducted a pilot study using a non-concurrent multiple-baseline single case series, to examine the impact of metacognitive therapy on maternal functioning during the postpartum period, using with a sample of 6 women suffering postpartum depression. In particular, the authors aimed to evaluate the impact of metacognitive therapy on maternal depression, as well as on maternal bonding and metacognitive beliefs in the short- and long-term. The treatment was found to be associated with good outcomes, and recovery from postpartum depression. Moreover, mothers also showed a significantly reduction in scores on the PBQ. Treatment gains made were

sustained by participants within the normal range, and this was reaffirmed again, 3 months post-treatment. It has therefore been observed that this intervention represents an effective mode of treatment for postpartum depression that also improves the maternal relationship and bond with their infants.

The study conducted by Rotheram-Borus et al. (2014) relied on social support techniques in a cluster-RCT, in KwaZulu-Natal, South Africa, to evaluate the effectiveness of a peer mentorship program among a sample of 1200 African women with HIV. On the day of their HIV diagnosis, women were invited to attend eight meetings with peers, in addition to the standard supplementary programs. The findings indicate that despite this program, additional support for those suffering from HIV is efficacious in helping a woman engage in positive health behaviours for themselves and their infants, from 6 to 12 months postpartum; results concerning maternal bonding with infants were similar across conditions.

Posmontier et al. (2016) designed a prospective cohort study, to evaluate the applicability and effectiveness of certified nurse-midwife telephone-administered interpersonal psychotherapy (CNM-IPT), in a sample of 41 women with postpartum depression. The findings of this study indicate that CNM-IPT significantly reduces the severity of symptoms of postpartum depression, but no significant group differences, related to maternal bonding, were discernible in their post-test results.

2.3. Interventions that teach specific techniques

Two of the papers included used interventions teaching specific techniques aimed at improving parent-infant bonding. In particular, the two studies included in the review investigated the influence of two methods or techniques that, in these specific cases, aimed to improve a parent's relationship with the child. In this category, both of the studies addressed parents of healthy children.

The study by Cheng et al. (2011) aimed to increase bonding among fathers of healthy babies, using infant massage. This intervention used a mixed-method approach, to evaluate the effectiveness of an intervention that consisted of a 4-week infant massage class, in which fathers were taught how to safely practice infant massage on their babies (International Association of Infant Massage, 2005). To create a comprehensive education program, the fathers were taught to use a combination of Indian massage, Swedish massage, yoga, and reflexology. During the classes, the instructor never touched the infant, instead using a doll to furnish practical demonstrations of the strokes the fathers were meant to use with their own children. Parental outcomes for these interventions included improved father-child bonding and reduced parenting stress. Qualitative analyses were used to evaluate the effectiveness of paternal bonding, while quantitative analyses were calculated, to evaluate the impact of the intervention on parental stress. Findings of the study indicated that fathers perceive the infant massage instruction as a great bonding tool and a mode of amplifying closeness with their babies. Moreover, quantitative analyses conducted on Parenting Stress Index (Abidin, 2012) scores reflected a relevant decrease in parental stress after infant massage intervention, for the experimental group. It therefore appears possible to obtain positive paternal outcomes via instruction in father-infant massage.

Persico et al. (2017) have recently developed an intervention, aimed at developing and strengthening the relationship between mother and baby. In particular, they used a concurrent cohort study with 83 (singing cohort) and 85 (concurrent cohort) women, to evaluate the impact of having mothers sing lullabies to their babies during pregnancy on bonding, maternal stress, and babies' behaviour. This intervention started during pregnancy; in particular, instructions were provided during antenatal classes. Mothers in the singing cohort learned nine lullabies, together with the midwife. After 4 weeks of training, women were invited to select one or two lullabies, to sing at home to their babies. This intervention resulted in improved postpartum

bonding, reduced parental stress and enhancement in babies' behaviour. Moreover, this intervention was also found to be effective on both maternal stress and newborn behaviour, as the latter exhibited fewer episodes of crying and neonatal colic.

2.4. Interventions that used neurostimulation techniques

As reported above, educational and psychological interventions have been shown to be helpful during the postpartum period, at reducing anxiety, stress, and depression, as well as promoting parental bonding. However, neurostimulation techniques also appear to be effective in reducing negative mood states and minimizing stress (Garcia et al., 2010). One of the selected papers described and evaluated the effectiveness of a brain stimulation therapy, primarily on postpartum depression, but also on maternal bonding (Garcia et al., 2010). In particular, Garcia et al. (2010) conducted an open-label repetitive transcranial magnetic stimulation treatment (rTMS) trial, involving a sample of 9 women diagnosed with postpartum depression, to estimate the impact of this treatment on this population, while also examining its effect on maternal bonding. Twenty rTMS treatments were administered five times per week over a period of 4 weeks. In addition to having demonstrably positive effects on postpartum depression, as hypothesized, a positive impact on maternal bonding was also observed. In particular, the analyses conducted noted a significant improvement in maternal bonding, from pre-treatment to the post-treatment 6-month follow-up evaluation.

3. Discussion

This work aimed to review the existing literature, to evaluate the extent to which these interventions effectively promote and improve parent-infant bonding. The present review suggests that there is a variety of research concerning parent-infant bonding interventions that addresses parents that live in both typical and atypical conditions. However, despite the fact that most of these studies were able to offer proof substantiating the effectiveness of these interventions, it remains difficult to generalize findings. In fact, research included in the review used different methodology, heterogeneous research design, small sample size and different sample types.

Beyond these general considerations, a synthesis of the reviewed studies points to some general and relevant issues. First, it has been noted observed most of the interventions included were aimed at promoting parent-infant bonding in risk situations for both parents and for their baby (Kleberg et al., 2007; Yuan and Freeman, 2011; O'Mahen et al., 2014; Rowe et al., 2014; Scherer et al., 2014; Eliëns et al., 2010; Hoffenkamp et al., 2015; Tsivos et al., 2015; Bevan et al., 2013; Rotheram-Borus et al., 2014; Posmontier et al., 2016; Garcia et al., 2010). Several studies indicate that different types of stressors, typically during the perinatal period, can lead to feelings of anxiety, depression, and even symptoms of PTSD among parents (Ionio et al., 2016a; Nix and Ansermet, 2009; Obeidat et al., 2009). Also observed was an association between mothers' ability to feel connected to their infants and effective as parents, with actual presence of these feelings (Parfitt and Ayers, 2009). Within this framework, it becomes particularly relevant that most of the studies included in the present review aimed to address the need to enhance and strengthen healthy parenting behaviours, to prevent future difficulties in the parent-infant relationship and throughout child development. However, despite findings indicating that the presence of a genetic syndrome or chronic illness in the baby represents a serious potential risk to establishing a healthy parent-infant relationship (Hafetz and Miller, 2010; Nabors et al., 2013; Ionio et al., 2011, 2018b; Wallander and Varni, 1998), to date, we know of no interventions designed to address parent-infant bonding in that context.

Our analyses indicate that only two interventions were aimed at improving parent-infant bonding in typical situations (Persico et al.,

2017; Cheng et al., 2011), although both interventions have been shown to be effective. Both interventions fall within the same category, as they teach parents specific techniques (infant massage and singing lullabies) intended to improve their relationships with their children. In one case, touch was used, and in the other, music. Touch and music are both powerful techniques: in the case of touch, it seems to pass along our own sensations to another individual (Hertenstein et al., 2006); in the case of music, there seems to be a direct influence on the emotions and neurotransmitter system (Arya et al., 2012). These interventions appear to be valid options for teaching parents how to improve their relationships with their babies. These studies, while reporting brief and specific interventions, suggest that participating parents were helped, increasing their ability to bond with their infants and reducing parental stress. For these reasons, interventions like these may offer practitioners working with parents, during the perinatal period, feasible and cost-effective tools that can be proposed to parents in the context of antenatal classes, to improve their parenting experiences and strengthen parent-infant bonding (Persico et al., 2017).

Moreover, another relevant aspect was that both interventions that relied on a medium (O'Mahen et al., 2014; Posmontier et al., 2016) to educate and support parents (internet and phone) were not effective at improving parent-infant bonding. We can hypothesize that the use of such media may interfere with communicating the empathy, caring, and attention of the expert toward mothers (Scharer et al., 2009). Moreover, both of these interventions were used only with mothers experiencing postpartum depression, and were aimed at reducing depression and anxiety. Research suggests that women with bonding difficulties might require specific interventions, directed at remediating these difficulties and that do not consider bonding as a secondary outcome (Poobalan et al., 2007).

It is also worth noting that fathers have been considered in only two of the 13 studies included in our review (Hoffenkamp et al., 2015; Cheng et al., 2011). This reflects the fact that most of the extant interventions aimed at improving and promoting parent-infant relationships continue to focus on mothers. This is in contradiction to recent research that indicates the importance of fathers' involvement in their children's development (Goldberg and DiVitto, 1995; Sarkadi et al., 2008; Ramchandani et al., 2005; Ionio et al., 2018a). Further, recent studies have indicated that fathers play a crucial role during the perinatal period, helping new mothers to overcome challenges that they may encounter and providing them with emotional support and protection from excessive and undue psychological suffering (Baldoni, 2005; Ionio et al., 2018a).

3.1. Limitations and future directions

This review has a summary of currently available interventions that aim at improving or promoting parent-infant bonding. Despite identifying some evidence and various relevant issues, it is important to be cautious when considering the results of the review, because of limitations regarding the studies that we included. The methodologies used in the different studies are too heterogeneous, thereby disallowing an in-depth comparison of the results of different studies. Moreover, the heterogeneity of the samples, as well as the differences across the sample sizes used in each study, prevent us from being able to generalize the results; this must be considered in any interpretation of the significance of the results presented.

Starting from these weaknesses observed in the studies that we included in the review, it appears that this work might serve to guide researchers and practitioners to implement the future intervention in more suitable ways. In general, it might lead them to use more valid ways of evaluating the effectiveness of the interventions, to enable generalization of research findings; studies should include more participants and use more adequately analogous methodology. It will be also necessary to monitor longer-term parent and infant outcomes to better determine treatment efficacy.

3.2. Conclusions and recommendations

This work provided a synthesis of recently available interventions aimed at addressing parent-infant bonding in both healthy and at-risk populations. On the basis of the selected studies, the review has concluded that most of the interventions were designed to prevent difficulties in at-risk conditions, instead of promoting parent-infant bonding in healthy populations, despite the proven effectiveness of the interventions. We believe that, after our analyses, it is not possible to identify a specific intervention that should be invariably and definitively suggested for use in clinical practice. On the other hand, this work allows us to underline some gaps in current interventions aimed at improving parent-infant bonding, helping in the identification of different specific considerations and recommendations for researchers and clinical practitioners. In particular: (a) it will be important to implement interventions that systematically address parent-infant bonding as a primary outcome; (b) it will be necessary to raise awareness healthy parents and teach them specific and cost-effective techniques implementing educational and practical programs about early parent-infant relationships during antenatal classes; (c) it will be useful to implement face-to-face interventions that start during the antenatal period and continue on through the postpartum, with more intensive interventions for higher risk situations; (d) it will be necessary to include fathers in all interventions and from the earliest postpartum moment postpartum or, even better, from the antenatal period; and (e) it will be important to design and test specific interventions aimed at addressing parent-infant bonding in parents of children with a genetic syndrome or a chronic illness condition in the perinatal period.

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