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Published in:
Journal of reproductive and infant psychology

DOI:
[10.1080/02646838.2019.1705261](https://doi.org/10.1080/02646838.2019.1705261)

IMPORTANT NOTE: You are advised to consult the publisher's version (publisher's PDF) if you wish to cite from it. Please check the document version below.

Document Version
Publisher's PDF, also known as Version of record

Publication date:
2020

[Link to publication in University of Groningen/UMCG research database](#)

Citation for published version (APA):

Ranjbar, F., Warmelink, J. C., & Gharacheh, M. (2020). Prenatal attachment in pregnancy following assisted reproductive technology: a literature review. *Journal of reproductive and infant psychology*, 38(1), 86-108. <https://doi.org/10.1080/02646838.2019.1705261>

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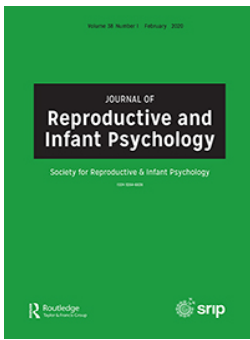
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To cite this article: Fahimeh Ranjbar, J. Catja Warmelink & Maryam Gharacheh (2020) Prenatal attachment in pregnancy following assisted reproductive technology: a literature review, *Journal of Reproductive and Infant Psychology*, 38:1, 86-108, DOI: [10.1080/02646838.2019.1705261](https://doi.org/10.1080/02646838.2019.1705261)

To link to this article: <https://doi.org/10.1080/02646838.2019.1705261>



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Prenatal attachment in pregnancy following assisted reproductive technology: a literature review

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ABSTRACT

Objective: To summarise the literature on prenatal attachment in pregnancies following Assisted Reproductive Technology (ART).

Background: Prenatal attachment can predict the quality of the postpartum parent–infant relationship and is linked to perinatal mental health of the parents and their adjustment to the parental role. It might be expected prenatal attachment will be influenced by fertility treatment such as ART, but there are contradictory results.

Methods: In this review, studies with a cross-sectional and longitudinal design, published in 1990–2019 were included. A search was conducted in MEDLINE/PubMed, EMBase, Web of Science and Scopus, and using the Google Scholar search engine. A total of 17 articles were found which met the inclusion criteria and after these articles were reviewed using the STROBE-checklist, 15 articles were included in the study.

Results: In most couples who conceived following ART, the level of prenatal attachment was either similar to or higher than in couples who conceive without ART.

Conclusions: The findings challenge the idea that infertility problems affect attachment in pregnancies following ART. However, ART- couples may be more susceptible to anxiety due to pregnancy loss and support may be better focused on the pregnancy-related anxiety in these couples rather than any attachment intervention.

ARTICLE HISTORY

Received 17 March 2018

Accepted 9 December 2019

KEYWORDS

Attachment; bonding; relationship; assisted reproductive technology; In vitro fertilisation

Introduction

The transition to parenthood is an important life stage for both men and women to accomplish developmental tasks and to adjust to the biological and psychosocial changes involved (in: Pinto, Samorinha, Tendais, Silva, & Figueiredo, 2017). For a woman, the transition to motherhood is a developmental process which begins in early pregnancy and develops throughout the pregnancy (Darvill, Skirton, & Farrand, 2010; DiPietro, 2010; Ladge, Clair, & Greenberg, 2012). Over the course of pregnancy, women imagine and spend time thinking about the growing fetus and form a mental image of the baby's appearance

and personality. The maternal-fetal attachment (MFA) is manifested in behaviours indicating care and commitment to the fetus, such as adopting a healthy lifestyle (eating well, abstaining from harmful substances, seeking appropriate antenatal care), speaking to the fetus, stroking the belly and physical preparation (buying baby clothes and equipment) and the mother is prepared to prioritise the needs of the fetus to her own needs and in other words, devote herself to her child (Rubin, 1976; Salisbury, Law, LaGasse, & Lester, 2003). Differentiation of self from fetus marks the woman's ability to identify the fetus as a unique individual separate from her body (Delavari, Mohammad-Alizadeh-Charandabi, & Mirghafourvand, 2017). Gradually, the fetus becomes an independent person, and women imagine their fetus and a fictionalised image of the personality and appearance of the child is formed in their minds (Rubin, 1976). These thoughts and behaviours are the foundation of the prenatal attachment concept.

Prenatal attachment is defined as a unique relationship, developing between parent and the unborn child, and has been demonstrated to be of significance due to its potential link with parental behaviour both in pregnancy and after childbirth (Condon & Corkindale, 1997). Prenatal attachment prompts good health practices in pregnancy (Brandon, Pitts, Denton, Stringer, & Evans, 2009), facilitates adjustment to the parenting role, and acts as a protective factor against perinatal depression (Barone, Lionetti, & Dellagiulia, 2014; Brandon et al., 2009; Salehi & Kohan, 2017). The intensity of attachment increases as pregnancy advances. The stage of pregnancy, the experience of fetal movement or the use of ultrasound during pregnancy and previous history of pregnancy may affect the timing and intensity of prenatal attachment during a normal pregnancy (Barone et al., 2014; Doan & Zimerman, 2008).

Despite pregnancy after fertility treatment being considered normal and 'low-risk' in some countries (Klock & Greenfeld, 2000; Warmelink, Meijer, Mulder, Mulder, & van Lohuizen, 2016), such a pregnancy is highly stressful (Rooney & Domar, 2018). Thus, prenatal attachment may be experienced differently by the parents conceiving through fertility treatments. Nowadays, the number of fertility treatments is mounting rapidly. In 1996, a total of 20,597 infants were born through 64,036 Assisted Reproductive Technology (ART) in the United States. Since then, the number of ART cycles and the number of children born from ART have nearly tripled. ART contributed to 1.7% of all children born in 2015 (Sunderam et al., 2018). In Europe, in two decades', not only had the numbers of reporting ART clinics increased (482 in 1997 to 1279 in 2014), but also the overall number of ART infants born (35 314 in 1997 to 776 556 in 2014). On average 2.1% of all children are born after ART (De Geyter et al., 2018), including up to 6% of all births in some European countries. It is reported that pregnancies conceived through ART are associated with higher risks of complications, such as small for gestational age babies, preterm birth, low birth weight and perinatal mortality (Allen, Wilson, & Cheung, 2006; McDonald et al., 2009; Pandey, Shetty, Hamilton, Bhattacharya, & Maheshwari, 2012). Next to the medical impact, the ART-pregnancy can have a psychological impact for the individuals involved, such as experiencing high levels of anxiety in pregnancy (Verhaak et al., 2006) and perception of the pregnancy as being risky (in: Klock & Greenfeld, 2000).

The transition towards parenthood can be psychologically demanding in ART pregnancies, moving from having an 'infertile identity' to a 'parental identity'. Although it might be expected that prenatal attachment will be influenced by ART, there are contradictory results in this area (Alhusen, 2008; Hammarberg, Fisher, & Wynter, 2008;

Olshansky, 1990). On one hand, there is evidence for a technology-induced delay in the development of attachment to the fetus (Rowe, Fisher, & Quinlivan, 2009). Couples in this position may try to postpone attachment to the fetus to avoid a potential crisis that may be encountered in the case of loss of the fetus (Covington, 1999). In the case of fertility treatment failure experience, frequent frustration affects women's self-esteem and body image and causes them to be worry about a miscarriage, fetal death, and abnormalities of the fetus (Lin, Tsai, & Lai, 2013). The potential for fetal loss in pregnancy after infertility is an 'unpleasant reality' and many women try to cope with it through the psychological mechanism of denial and through suppression of the physical signs and symptoms of pregnancy (Bernstein, Lewis, & Seibel, 1994). Denial may occur in women incapable of developing an attachment to the fetus due to the fear of negative events in pregnancy (e.g., miscarriage). Other women may develop an excessive concern about each normal physical change during pregnancy (Covington, 1999). On the other hand, a meta-analysis study on the predictors of MFA showed that high-risk pregnancy had a trivial effect size (Yarcheski, Mahon, Yarcheski, Hanks, & Cannella, 2009).

In the case of the transition to parenthood following ART, men and women experience this transition in different ways. While the ART women tend to experience parenthood as associated with a high level of general wellbeing, the ART men did not report such positive experiences (Gameiro, Moura-Ramos, Canavarro, & Soares, 2010). However, since the beginning of infertility treatments (ART), research concerning the parental-fetal relationship has predominantly focused on mothers (Kuo et al., 2013; McMahan et al., 2011; Udry-Jørgensen, Darwiche, Germond, Wunder, & Vial, 2015), and research on paternal-fetal attachment (PFA) following ART is scarce and has produced mixed results (Pinto et al., 2017). Some studies showed that ART fathers were highly attached to their fetus/infants compared to other fathers (Cairo et al., 2012; Hjelmstedt & Collins, 2008). In contrast, other studies suggest that after achieving pregnancy, the ART fathers may experience the increased distress related to the safety of the pregnancy and fetal health (Hammarberg et al., 2008), which can reduce men's parenting self-efficacy and increase depressive symptoms. Subsequently, the ART fathers may experience more difficulties in adjusting to the transition to parenthood and delay in the development of PFA (Pinto et al., 2017).

Given that pregnancy following ART is increasingly becoming a part of the life-reality of many couples pursuing their parenting role (Barnes, Roiko, Reed, Williams, & Willcocks, 2012), and prenatal attachment is one of the contradictory issues in pregnancy following ART, the question at hand is whether these parents need extra care and support or not. Since there is no recent systematic literature review on prenatal attachment in these pregnancies, the aim of this paper is to review prenatal attachment in pregnancy following ART.

Method

The review of the literature was performed based on the third edition of the Centre for Reviews and Dissemination guidance for undertaking systematic reviews by following the steps below in September 2019 (University of York. Centre for Reviews Dissemination. Systematic reviews: CRD's guidance for undertaking reviews in health care, 2009). The

Table 1. Search strategy in PubMed.

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((((((((Attach*[Title/Abstract]) OR Bond*[Title/Abstract]) OR Relation*[Title/Abstract]) OR Adjust*[Title/Abstract]) OR Adapt*[Title/Abstract]) OR 'Emotional adjust*[Title/Abstract]) OR 'Psychological Adjust*[Title/Abstract]) OR 'Emotional Adapt*[Title/Abstract])) AND (((((((Maternal[Title/Abstract]) OR Fetal [Title/Abstract]) OR Prenatal[Title/Abstract]) OR Perinatal[Title/Abstract]) OR Paternal[Title/Abstract]) OR Antenatal[Title/Abstract]) OR Parental[Title/Abstract])) AND (((((((((((('Assisted Reproductive Techn*[Title/Abstract]) OR 'reproductive Techn*[Title/Abstract]) OR ART[Title/Abstract]) OR 'assisted conception'[Title/Abstract]) OR 'In Vitro Fertilization'[Title/Abstract]) OR IVF[Title/Abstract]) OR 'Test Tube Fertilization'[Title/Abstract]) OR 'Test-Tube Fertilization'[Title/Abstract]) OR 'Test-Tube Baby'[Title/Abstract]) OR 'Test Tube Baby'[Title/Abstract]) OR 'sperm donation'[Title/Abstract]) OR 'oocyte donation'[Title/Abstract]) OR 'embryo donation'[Title/Abstract]) OR 'gamete donation'[Title/Abstract]) OR 'third party reproduction'[Title/Abstract]) OR 'donor conception'[Title/Abstract])

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objective of this paper was to summarise the literature on prenatal attachment in pregnancies following ART.

Inclusion and exclusion criteria

Primary original papers written in English that contained one of the keywords 'attachment', 'bonding' relationship", 'adjustment', 'Assisted Reproductive Technology' and 'In Vitro Fertilization', 'Maternal', 'Fetal', 'Prenatal', 'Perinatal', 'Antenatal', 'Parental' and 'Paternal' in the title, abstract or keywords or were a part of the words entered in the subject search were included in the review (Table 1).

The study used the Population Intervention Comparison Outcomes (PICO) framework to determine the eligibility of the research question, but having a control group was not a part of our inclusion criteria. The study population included pregnant women or their partners. Studies involving pregnancy after recurrent pregnancy loss, pre-implantation genetic diagnosis (PGD), sex selection or surrogacy were excluded. We included studies on prenatal attachment in previously infertile couples who conceived following ART such as IVF (In vitro fertilisation) and ICSI (Intra-cytoplasmic Sperm Injection) [with donor or non-donor gametes].

Study design: The study design was restricted to only primary quantitative studies (cross-sectional and longitudinal studies) on prenatal attachment in pregnancy following ART which used self-rating scales for measuring prenatal attachment. Qualitative and interventional studies were excluded.

Identifying research evidence

Databases and valid electronic articles from the network of the Digital Library of Iran University of Medical Sciences were searched. Databases included MEDLINE/PubMed, EMBASE, Science Direct, ISI Web of Science, Scopus and the Google Scholar search engine. To determine the proper keywords in the MeSH (Medical Subject Headings) database, the PubMed database was searched and the combination of the obtained keywords was used (Table 1).

Study selection

Two researchers (FR, MG) simultaneously performed the search, review and initial selection of articles and saved the results from each database separately. In the next database check, duplicates were deleted and new cases were selected and saved. To determine the criteria for including an article in the study, the title and abstract of studies were examined. Most articles were excluded from the study after checking the title and abstract. Articles that met the inclusion criteria based on the title and abstract were separately checked by two researchers (FR, MG), and finally the full-text version of articles were reviewed to judge their relevance. In cases where the two researchers disagreed about the relevance of the paper, the third researcher (CW) who had experience in this field was consulted.

Data extraction

Initially, 7723 articles were found and four studies also were obtained through the search for grey literature (conference abstracts, dissertations, unpublished studies and the bibliographies of all relevant publications). After removing duplicates, the title and abstract of the remaining articles were reviewed, and the irrelevant articles were excluded prior to further evaluation. The full-text version of 68 articles were prepared and assessed. In our review, 17 studies met the inclusion criteria.

Reporting quality

The most recent version of the STROBE Statement was used for evaluating the quality of reporting in studies that met the inclusion criteria. This tool is a checklist of 22 items to assess the reporting of observational studies (Von Elm et al., 2007). The STROBE checklist criteria that could be used for eligible studies were adapted. The included 17 studies were evaluated with four criteria based on STROBE statement: 1) measurement of prenatal attachment by using standardised and validated tools, 2) random sample selection, 3) control of confounding variables and 4) explanation about the study size calculation. Studies that measured prenatal attachment by using standardised, validated tools and met at least two criteria out of the other three methodological assessment criteria were included in the present review. We excluded two studies, so 15 articles were included in the study (Figure 1).

Results

In this study, 15 studies about prenatal attachment in pregnancy following ART were reviewed (Table 2). These studies were conducted in the following countries: Australia (5 studies), Sweden (3 studies), Taiwan and Switzerland (2 studies), England, Italy and United States of America (1 study). Among the 15 included studies, 10 studies had a longitudinal design and five studies had a cross-sectional design for the assessment of attachment. Ten studies had a control group consisted of individuals who conceived spontaneously.

Four studies measured both MFA and PFA, eight studies measured only MFA and three studies only measured PFA. Included studies measured prenatal attachment once (9

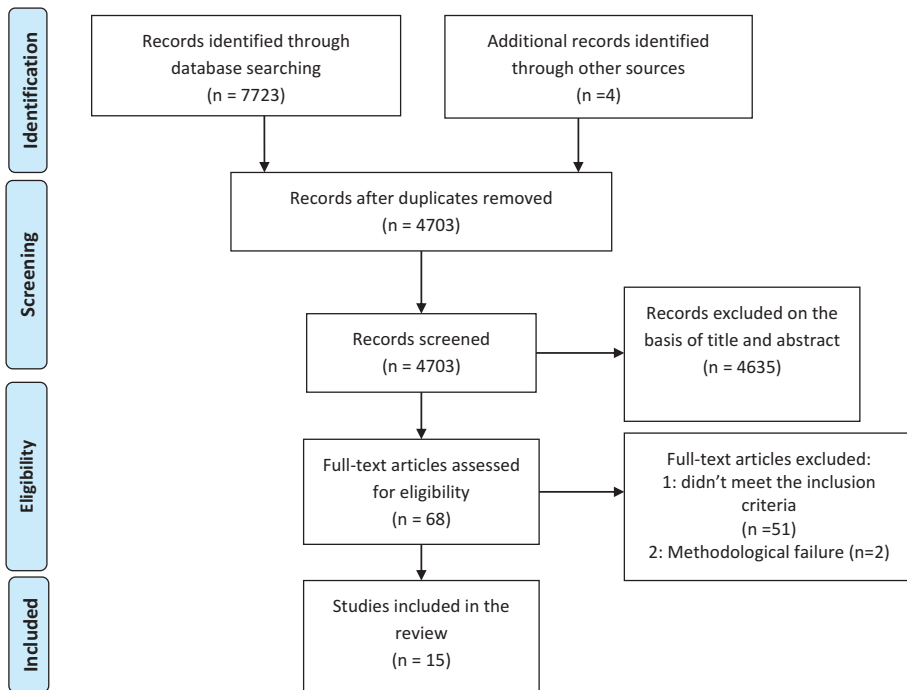


Figure 1. The flow-chart of search process.

studies), twice (4 studies) or three times (2 studies). Measurement of prenatal attachment was conducted more in the second (9 times), third (9 times) and first (5 times) trimesters of pregnancy, respectively. Most studies measured prenatal attachment in both the second trimester and third trimester of pregnancy (5 studies). Only one study measured attachment in the first, second and third trimesters of pregnancy but this study did not have a control group (Kuo et al., 2013).

Three studies included women who conceived through donor gametes (Fisher, Hammarberg, & Baker, 2008; McMahon et al., 2011; McMahon, Gibson, Allen, & Saunders, 2007) but did not discuss the difference in prenatal attachment between women who conceived with their own eggs and women who conceived with donor eggs. Six studies excluded participants who conceived through donor gametes (Bernstein et al., 1994; Cohen, McMahon, Tennant, Saunders, & Leslie, 2000; Hjelmstedt & Collins, 2008; Hjelmstedt, Widström, & Collins, 2006, 2007; McMahon, Ungerer, Beaurepaire, Tennant, & Saunders, 1997), and the use of donor gametes in participants was not reported in six studies (Cairo et al., 2012; Chen, Chen, Sung, Kuo, & Wang, 2011; Kuo et al., 2013; Pellerone & Micciche, 2014; Stanton & Golombok, 1993; Udry-Jørgensen et al., 2015).

Five common standardised tools were used for measuring prenatal attachment (MFA and PFA) including the Condon's Maternal Antenatal Attachment Scale (MAAS) (Condon, 1993), the Cranley's Maternal-Fetal Attachment Scale (MFAS) (Cranley, 1981), the Muller's Prenatal Attachment Inventory (PAI) (Muller & Mercer, 1993), the Condon's Paternal



Table 2. The selected studies on MFA and PFA in pregnancies through ART (sorted by time).

Study	Design	Country	Population and sample size	Having control group	Measures	Measurement Frequency	Study tool	Findings
1 Udry-Jørgensen et al., 2015	Longitudinal	Switzerland	52 couples in the ART group and 51 couples in control group	Yes	MFA/PFA	Twice (12w & 14 w)	Condon's Maternal Antenatal Attachment Scale/MAAS & Condon's paternal Antenatal Attachment Scale	There was no difference between two groups
2 Pellerone & Micciche, 2014	Cross-sectional	Italy	43 women in the IVF group and 48 women in control group	Yes	MFA	Once (23–37 w)	Cranley's Maternal-Fetal Attachment Scale/MFAS	A higher level of attachment in women who conceived spontaneously
3 Kuo et al., 2013	Longitudinal	Taiwan	160 women in the IVF group	No	MFA	Three times (9&12& 20w)	Taiwanese version of Cranley's Maternal-Fetal Attachment Scale/MFAS	The level of attachment increased as pregnancy progressed
4 Cairo et al., 2012	Longitudinal	Switzerland	31 IVF couples	No	MFA/PFA	once (the fifth month of pregnancy)	Condon's Maternal Antenatal Attachment Scale/MAAS & Condon's Paternal Antenatal Attachment Scale/PAAS	The global scores for parental bonding are also higher in the IVF sample compared with the reference samples

(Continued)

Table 2. (Continued).

Study	Design	Country	Population and sample size	Having control group	Measures	Measurement Frequency	Study tool	Findings
5 McMahon et al., 2011	Cross-sectional	Australia	297 women in the ART group and 295 in spontaneously pregnant control group	Yes	MFA	Once (25–40 w)	Cranley's Maternal-Fetal Attachment Scale/MFAS	There was a significant association between assisted pregnancy and more intense maternal-fetal attachment.
6 Chen et al., 2011	Longitudinal	Taiwan	60 women in the infertility-treated pregnant group and 65 women in spontaneously pregnant group	Yes	MFA	once (> 28w)	Cranley's Maternal-Fetal Attachment Scale/MFAS	A higher maternal-fetal attachment in women who became pregnant after fertility treatment
7 Hjelmsstedt & Collins, 2008	Longitudinal	Sweden	63 IVF fathers and 36 controls	Yes	PFA	Once (26 w)	Cranley's Paternal Fetal Attachment Scale (PFA)	IVF Fathers were as strongly attached to their fetus as the controls.
8 Fisher et al., 2008	Quantitative and qualitative* (longitudinal data for Maternal-Fetal Attachment)	Australia	183 women in ART group	Comparison with normal population	MFA	Twice (First and third trimester)	Condon's Maternal Antenatal Attachment Scale/MAAS	A higher level of attachment in the ART group
9 McMahon et al., 2007	Longitudinal (Cross-sectional data for Maternal-Fetal Attachment)	Australia	38 couples aged 35 or younger and 28 couples aged 38 or older	No	MFA/PFA	Once (20w)	Condon's Maternal Antenatal Attachment Scale/MAAS & Condon's paternal Antenatal Attachment Scale	No age-group differences for mothers or fathers for the factors quality of attachment and time in the attachment mode

(Continued)



Table 2. (Continued).

Study	Design	Country	Population and sample size	Having control group	Measures	Measurement Frequency	Study tool	Findings
10 Hjelmsstedt et al., 2007	Longitudinal	Sweden	53 IVF men and 37 control	Yes	PFA	Twice (26 & 36 w)	Cranley's Paternal Fetal Attachment Scale (PFAS) (1981)	IVF fathers are attached to their unborn children to the same extent as other fathers.
11 Hjelmsstedt et al., 2006	Longitudinal	Sweden	56 IVF women and 41 control women	Yes	MFA	Twice (26 & 36 w)	Muller's Prenatal Attachment Inventory/PAI	No difference in MFA between two groups
12 Cohen et al., 2000	Longitudinal	Australia	62 IVF fathers and 56 control fathers	Yes	PFA	Once (30w)	Condon's paternal Antenatal Attachment Scale	There were no group differences in their reported attachment to their unborn baby.
13 McMahon et al., 1997	Quantitative and qualitative * (Cross-sectional data for Maternal-Fetal Attachment)	Australia	70 couples in the IVF group and 63 couples in control group	Yes	MFA & PFA	Once (28–33 w)	Condon's Maternal Antenatal Attachment Scale/MAAS & Condon's paternal Antenatal Attachment Scale	There were no differences between the IVF and control group for mothers or fathers on self-reported 'time spent in the attachment mode' or 'quality of attachment'

(Continued)

Table 2. (Continued).

Study	Design	Country	Population and sample size	Having control group	Measures	Measurement Frequency	Study tool	Findings
14 Bernstein et al., 1994	Quantitative and qualitative (longitudinal data for Maternal-Fetal Attachment)*	United states of America	5 never infertile women, 10 women pregnant through conventional infertility therapies, 10 women pregnant through IVF	No	MFA	Three times (First, second and third trimesters)	Cranley's Maternal-Fetal Attachment Scale/MFAS	Difference in the process of transition to parenthood among previously infertile women
15 Stanton & Golombok, 1993	Cross-sectional	England	15 in the IVF group and 20 in the spontaneously pregnant women group	Yes	MFA	Once (≥20w)	Cranley's Maternal-Fetal Attachment Scale/MFAS	No difference in MFA between two groups

*Only the quantitative part included in the present study

ART = Assisted Reproductive Technology; IVF = In vitro fertilisation; MAAS = Maternal Antenatal Attachment Scale; MFA = Maternal-Fetal Attachment; MFAS = Maternal-Fetal Attachment Scale; PAAS = Paternal Antenatal Attachment Scale; PAI = Prenatal Attachment Inventory; PFA = Paternal Fetal Attachment; PFAS = Paternal Fetal Attachment Scale; w = gestational age in weeks

Antenatal Attachment Scale (PAAS) (Condon, 1993) and Cranley's Paternal Fetal Attachment Scale (PFAS) (Cranley, 1981) described in Table 3.

MFA and its development throughout pregnancy

In women who conceived through ART, prenatal attachment begins in early pregnancy (Kuo et al., 2013) and increases with progression of the pregnancy (Fisher et al., 2008; Hjelmstedt et al., 2006; Kuo et al., 2013; Udry-Jørgensen et al., 2015).

Levels of MFA during ART pregnancy have been measured in several studies but the findings are conflicting. In the reviewed studies, MFA in pregnant women who conceived through ART was lower (Pellerone & Micciche, 2014), or higher than (Bernstein et al., 1994; Cairo et al., 2012; Chen et al., 2011; Fisher et al., 2008; McMahon et al., 2011) or similar (Hjelmstedt et al., 2006; McMahon et al., 1997; Stanton & Golombok, 1993; Udry-Jørgensen et al., 2015) compared with that in women who conceived spontaneously. In the study of Bernstein et al. (1994), the higher level of attachment was reported only in sub-scale of 'giving of self' (Bernstein et al., 1994). Two studies (Fisher et al., 2008; Kuo et al., 2013) described the development of MFA in IVF pregnancies without a control group but the study by Fisher et al. (2008) compared the level of MFA between the ART group and a general population norm (Fisher et al., 2008).

PFA and its development throughout pregnancy

In most of the studies, IVF fathers were attached to their unborn child to the same extent as other fathers (Cohen et al., 2000; Hjelmstedt & Collins, 2008; Hjelmstedt et al., 2007; McMahon et al., 1997; Udry-Jørgensen et al., 2015). One study found that the scores for PFA were significantly higher in the IVF group compared to the reference samples (Cairo et al., 2012). PFA significantly increased during pregnancy from the first trimester to the second trimester (Hjelmstedt et al., 2007; Udry-Jørgensen et al., 2015). There was a positive correlation between PFA scores in the 26th week of gestation and 36th week among the IVF fathers and among the control fathers (Hjelmstedt et al., 2007).

Role of participants' characteristics

The association of prenatal attachment with participants' characteristics including socio-demographic variables (Chen et al., 2011; Hjelmstedt et al., 2006, 2007; McMahon et al., 2011, 2007), personality traits (Fisher et al., 2008; Hjelmstedt & Collins, 2008; Hjelmstedt et al., 2006, 2007), medical background (Pellerone & Micciche, 2014), childbirth-related attitudes (Hjelmstedt et al., 2006, 2007; Kuo et al., 2013; Stanton & Golombok, 1993), marital satisfaction (Cairo et al., 2012; Hjelmstedt et al., 2006, 2007; McMahon et al., 2011) and social support (Kuo et al., 2013) had been assessed in the included studies.

Socio-demographic variables

The findings about maternal age were contradictory. McMahon et al. (2007), showed that regardless of parents' age, the quality of attachment was good in the ART-treated parents and there were no age-group differences for the quality of attachment and time in the attachment mode. Conversely, in the study of McMahon et al. (2011), advanced maternal

Table 3. Standardised self-rating scales for measuring MFA and PFA.

Instrument	Items	Subscales	Total score	Studies
(1) Maternal-fetal attachment				
Maternal Antenatal Attachment Scale (MAAS) (Condon, 1993)	19	1- Quality of attachment 2- Time spent in the attachment mode	19–95	Cairo et al., 2012; Fisher et al., 2008; McMahon et al., 2007; McMahon et al., 1997; Udry-Jørgensen et al., 2015
Maternal Fetal Attachment Scale (MFAS) (Cranley, 1981)	24	(1) Differentiation of self from the fetus (2) Interaction with the fetus (3) Attributing characteristics and intentions to the fetus (4) Giving of self (5) Role-taking	24–120	Bernstein et al., 1994; Chen et al., 2011; Kuo et al., 2013; McMahon et al., 2011; Pellerone & Micciche, 2014; Stanton & Golombok, 1993
Prenatal Attachment Inventory (PAI) (Muller & Mercer, 1993)	21	(1) Fantasy (2) Interaction (3) Affection (4) Differentiation of self from the fetus (5) Sharing pleasure	21–84	Hjelmstedt et al., 2006
(1) Paternal-fetal attachment				
Paternal Fetal Attachment Scale (PFAS) (Cranley, 1981)	24	1- Differentiation of self from the fetus 2- Interaction with the fetus 3- Attributing characteristics and intentions to the fetus 4- Giving of self 5- Role-taking	24–120	Hjelmstedt & Collins, 2008; Hjelmstedt et al., 2007
Paternal Antenatal Attachment Scale (PAAS) (Condon, 1993)	16	1- Quality of attachment 2- Time spent in the attachment mode	16–80	Cairo et al., 2012; McMahon et al., 2007; Udry-Jørgensen et al., 2015

age was associated with a low level of MFA. While in the ART-mothers, younger age was also associated with high prenatal attachment in gestational week 36 (Hjelmstedt et al., 2006), in the ART-fathers, no relationship was found between age and PFA (Hjelmstedt et al., 2007). Regarding education, the IVF mother's educational level was a main factor that increased MFA (Chen et al., 2011). However, no association was observed between the scores of PFA and educational level in the IVF-fathers (Hjelmstedt et al., 2007).

Personality traits

In the ART-mothers, no differences were found in the personality measure compared to the general population, indicating that they were no more likely than mothers, in general, to worry and be unassertive (Fisher et al., 2008). Also, Hjelmstedt et al. (2006) showed that low scores in the personality trait detachment were among the factors contributing to high prenatal attachment in the ART-mothers. (Hjelmstedt et al., 2006) In the ART-fathers, the personality trait detachment and psychasthenia were related to fathers' attachment to their unborn child (Hjelmstedt et al., 2007). Fathers, who were more assertive and less irritable, had higher attachment scores in relation to their unborn child compared to other fathers (Hjelmstedt & Collins, 2008).

Medical background

A study by Pellerone and Micciche (2014) showed the MFA total score was affected by gestational age, waiting time for conception and the number of failed attempts at pregnancy in the ART group. There was a significant difference between the two groups in terms of the sub-scale of differentiation of self from the fetus, and this score was higher in spontaneously pregnant women than in the IVF group. Gestational age was a predictor of the ability to differentiate self from the fetus (Pellerone & Micciche, 2014). In none of the included studies, had the association between medical background of ART-fathers and prenatal attachment been reported.

Childbirth-related attitudes

Childbearing attitude played a role in the development of MFA in the first half of pregnancy and negative attitude towards childbearing was associated with a low level of prenatal attachment in the ART couples (Hjelmstedt et al., 2006; Kuo et al., 2013; Stanton & Golombok, 1993). Hjelmstedt et al. (2006), found that regardless of method of conception, women (IVF women/control women) who were more ambivalent about the pregnancy, were less attached to their unborn child in 36 weeks of gestation, than women who were less ambivalent. In the ART-fathers, low ambivalence was related to higher prenatal attachment compared to the control group (Hjelmstedt et al., 2007).

Marital satisfaction

The quality of the partner relationship was a major factor in predicting prenatal attachment (McMahon et al., 2011). Hjelmstedt et al. (2006), reported that IVF mothers who were satisfied with their partner relationship were more likely to be attached to the unborn child; however, the effect of marital satisfaction on prenatal attachment was significant only in the 26th week of gestation. While in a study on ART-fathers, Hjelmstedt et al. (2007) found no relationship between prenatal attachment and marital satisfaction, Cairo et al.

(2012) reported similar or higher levels of marital satisfaction in the IVF couples than those in the reference sample.

Social support

Kuo et al. (2013), found that social support was a predictor of MFA. A high level of social support was associated to a high MFA. However, none of the included studies explored the association between social support and prenatal attachment in the ART fathers.

Mood

General anxiety and depression were measured with the State-Trait Anxiety Inventory/STAI (Spielberger, 1970) and Edinburgh Postnatal Depression Scale/EPDS (Cox, Holden, & Sagovsky, 1987) in seven and four studies, respectively. Mood was assessed with the Profile of Mood States/POMS (McNair, Lorr, & Droppleman) in one study. The results about the correlation of depression and anxiety with prenatal attachment were heterogeneous. Some of the studies showed that the attachment was not related to the general psychological mood state (anxiety and depression) (Fisher et al., 2008; Hjelmstedt et al., 2006; Pellerone & Micciche, 2014) but other studies showed that anxiety and depression negatively impact prenatal attachment (Bernstein et al., 1994; Kuo et al., 2013; Udry-Jørgensen et al., 2015).

Specific tools also were used to measure pregnancy-related anxiety in five studies. Three scales used in these studies were 'Anxiety concerning Health and Defects in the Child' scale (Gloger-Tippelt, 1983), the Emotional Responses to Pregnancy Scale/ERPS (Hjelmstedt, Widström, Wramsby, Matthiesen, & Collins, 2003) and the Pregnancy-related Anxiety Scale/PAS (Wadhwa, Sandman, Porto, Dunkel-Schetter, & Garite, 1993). In the study of McMahon et al. (2011), women who conceived through ART experienced higher levels of prenatal attachment and of pregnancy-focused anxiety compared to spontaneously conceived women. In contrast, Kuo et al. (2013), and Pellerone and Micciche (2014) found that pregnancy-related anxiety in the ART-women was not a significant predictor of MFA. In a study on the IVF-fathers, Hjelmstedt et al. (2007), reported a correlation between anxiety concerning the loss of the pregnancy and PFA but there was no association between depression and prenatal attachment. Furthermore, in another study, Hjelmstedt and Collins (2008) found the ART fathers who were less anxious, experienced a high level of prenatal attachment. However, Udry-Jørgensen et al. (2015) showed no differences in anxiety and depression symptoms between the ART parents and those conceiving spontaneously, and as anxiety and depression reduced, prenatal attachment increased.

Discussion

In this study, we reviewed the literature on prenatal attachment in ART pregnancy. Most studies showed that couples who conceived through ART experienced a similar or higher level of prenatal attachment compared to couples who conceived spontaneously. In addition, prenatal attachment increased with the progression of pregnancy in ART-treated women (Fisher et al., 2008; Hjelmstedt et al., 2006; Kuo et al., 2013; Udry-Jørgensen et al., 2015). Two studies (Bernstein et al., 1994; Kuo et al., 2013) looked at

progression over three time points. In the studies of Bernstein et al. (1994) and Kuo et al. (2013) MFA increased with the progression of pregnancy in ART-treated women. However, in the Bernstein et al. (1994) study the increase in MFA with the progression of pregnancy was not significantly different in that of the control group. The study of Kuo et al. (2013) had no control group.

A high level of education (Chen et al., 2011), high level of marital satisfaction (Hjelmstedt et al., 2006; McMahon et al., 2011), sufficient social support (Kuo et al., 2013) and low scores of the personality trait detachment (Hjelmstedt et al., 2006) were associated with a high level of prenatal attachment in ART pregnancies. Negative attitude towards childbearing (Hjelmstedt et al., 2006, 2007), more waiting time for conception and the greater number of failed attempts at pregnancy (Pellerone & Micciche, 2014) were associated with a low level of prenatal attachment. The findings on general anxiety, pregnancy-related anxiety and maternal age were contradictory.

Comparison with other literature

MFA

In the study by Bernstein et al. (1994), the only difference was in the dimension of self-sacrifice ('Giving of self'), as previously infertile women were more likely to 'give up things to help the baby'. Perhaps this attitude is a reflection of the sacrifices these women have already made in the treatment for infertility and the intensity of their desire to achieve a good outcome.

Considering that couples who conceived through ART experience anxiety concerning possible pregnancy loss, despite similar or higher levels of MFA compared to spontaneously conceived couples, they may benefit from opportunities to acknowledge their feelings as they may deny and suppress their stress in coping emotionally with assisted pregnancy (McMahon et al., 1997). Although these women feel well-supported, opportunities to be involved in a realistic assessment of the demands as well as the pleasures of motherhood, including allowing them to complain and express uncertainties, may be helpful in improving optimal adjustment after childbirth (Fisher et al., 2008). Chen et al. (2011), proposed a special support groups for ART mothers, such as prenatal education and providing useful resources for pregnant women with low educational level. The results of a study by Udry-Jørgensen et al. (2015), strongly suggest that counselling, particularly around the time of the first-trimester screening test, can address women's anxiety during pregnancy.

PFA

The present review mostly focused on MFA. Research concerning the father-fetus relationship and paternal-child attachment is limited, but similar to our outcomes on MFA. The existing literature showed that ART fathers are attached to their unborn children to the same (or greater) extent as other fathers (Cairo et al., 2012; Cohen et al., 2000; Hjelmstedt et al., 2006; Udry-Jørgensen et al., 2015). Attachment increased significantly in ART fathers as the pregnancy progressed (Hjelmstedt et al., 2006; Udry-Jørgensen et al., 2015). There were no reported differences in father-child attachment scores between ART fathers and father who had children conceived spontaneously (Cairo et al., 2012; Gibson, Ungerer, Tennant, & Saunders,

2000; Golombok et al., 2004; Hjelmstedt & Collins, 2008). More in-depth and systematic research is needed on the father–fetus relationship and paternal-child attachment and the link with parenting competence after the birth.

Studies that focused on the concept of internal working models or representations of the unborn child have not been included in the present study. Several studies were recently published (Fonseca, Nazaré, & Canavaro, 2018; Hopkins, Clarke, & Cross, 2014; Pajulo, Helenius, & Mayes, 2006; Rusanen, Lahikainen, Pölkki, Saarenpää-Heikkilä, & Paavonen, 2018) on maternal mental representations of the unborn baby showing that in situations of possible psychosocial risk like pregnant women with many small children in the family and/or whose pregnancy is unplanned (Pajulo et al., 2006); or pregnant women with depression (Rusanen et al., 2018; van Bussel, Spitz, & Demyttenaere, 2009b), anxiety (van Bussel, Spitz, & Demyttenaere, 2009a) or mothers in societies undergoing transition (Raphael-Leff, 2003), mothers may have more difficulties in building up the representation of herself-as-mother and in adapting to the real situation of motherhood. There are only a few studies on maternal representations during and following ART pregnancies, and most of the articles were written in Italian or had a qualitative design (in: Agostini et al., 2009), so they did not meet the inclusion criteria for our study. However, maternal mental representations can be important for the midwives and pregnant women because this concept provides another understanding in relation to the psychological dimension of pregnancy. Even more so, potentially risky situations like ART pregnancies may incur enactment of negative mental representation. Further research on the relationship between maternal mental representation and psychological morbidity in ART pregnancies is indicated.

Role of participants' characteristics

Fisher et al. (2008), concluded that different psychosocial factors may have led to a high level of MFA in the ART group. ART-treated pregnant women had high levels of education, socioeconomic status, marital satisfaction, husbands' support and advanced maternal age (which results in job security and housing), and therefore women who conceived through ART might experience stronger attachment to their fetus compared to spontaneously conceived women (Fisher et al., 2008). Conversely, in the study of McMahon et al. (2011), advanced maternal age was associated with a low level of MFA (McMahon et al., 2011). Indeed, although demographic variables such as maternal age, socioeconomic status and educational level showed only a small effect on prenatal attachment in spontaneous pregnancies (Barone et al., 2014; Cannella, 2005; Yarcheski et al., 2009), the advanced maternal age and the high socio-economic level should be taken into account as possible confounding variables in future studies on attachment to the fetus in ART. In addition to the socio-demographic factors, more time spent awaiting conception and the greater number of failed attempts at pregnancy were associated with low levels of prenatal attachment (Pellerone & Micciche, 2014).

Attitude towards childbirth was a predictor of prenatal attachment and ART-couples with negative attitudes towards childbirth associated with a low level of prenatal attachment (Hjelmstedt et al., 2006; Kuo et al., 2013) and women who were less positive about pregnancy, childbirth and childcare show poorer attachment to their unborn child (Stanton & Golombok, 1993). In general, women with reproductive problems are

thought to be more vulnerable because pregnancy and childbirth may be considered less of a continuous process, and more of a series of events, with each event having to be overcome prior to the couples be able to look forward to the birth of the child (Allot, Deborah, & Dann, 2013). Mothers with a history of infertility treatment usually protect their babies more carefully, and the stronger attachment to the fetus in women with a history of infertility has been attributed to their stronger motivation to have a child because of the frustrating process of pregnancy (Chen et al., 2011). The study of Pellerone and Micciche (2014) was the only study which showed MFA scores were lower in ART-treated pregnant women than in spontaneously pregnant women. In this study, the fear of not becoming pregnant significantly explained the decrease in MFA in the ART-women. The higher the fear of not becoming pregnant, the lower attachment to the fetus would be. Understanding women's childbirth-related attitudes may help health-care professionals to tailor their interactions with these women.

Mood

Although women in assisted pregnancy had a similar prevalence of general anxiety to controls, women who conceived through ART were more prone to anxiety about the loss of their pregnancy (Hjelmstedt et al., 2006). Both men (Hjelmstedt et al., 2007) and women (McMahon et al., 2011) who conceived by ART may experience high levels of anxiety in pregnancy due to fear of pregnancy loss or gestational complications. In addition, couples with a history of two or more treatment cycles had significantly greater anxiety about the health of the fetus than those who became pregnant during the first cycle of treatment (McMahon et al., 1997). In the study of Udry-Jørgensen et al. (2015), as anxiety and depression decreased, attachment increased, revealing these variables are interrelated. Low-risk results of prenatal screening and a normally progressing pregnancy allow for increasing prenatal attachment. This study found that regardless of the mode of conception, anxiety in couples over the prenatal testing period was associated with more depression and less attachment to the fetus. Attachment to the fetus may sometimes be difficult to develop because of anxiety about the loss of pregnancy. We may need to be cautious in interpreting general anxiety and depression, and anxiety about pregnancy loss, which may be very specific and not necessarily linked (Sinesi, Maxwell, O'Carroll, & Cheyne, 2019). Indeed, general anxiety and depression should be differentiated from pregnancy-related anxiety.

It is possible that a woman who has conceived under the much more difficult circumstances of ART feels a low sense of entitlement to complain or to express any doubts, uncertainty, or mixed feelings about the realities of motherhood (Ranjbar, Akhondi, Borimnejad, Ghaffari, & Behboodi-Moghadam, 2015; Warmelink et al., 2016). Expressing uncertainty is a key mechanism in evoking social support, and in having few doubts about the pregnant state, the ART women receive less social support than spontaneously pregnant women (Fisher et al., 2008). On the other hand, the ART conceiving women with a long infertility period, may have become used to treatment failure; therefore, they presented more persistence in fighting for their goals (achieving pregnancy) than the women conceiving spontaneously and those who had shorter periods of infertility. Internal resources contributing to the women's self-confidence include behavioural flexibility and professional engagement that help successfully adapt to change (Yakupova, Zakharova, & Abubakirov, 2015).

Strengths and limitations

One of the strength of our study is that we summarised the existing studies on prenatal attachment in ART pregnancies. We focused merely on prenatal attachment, and not on broader psychological and social aspects of pregnancy, childbirth and early parenting (Hammarberg et al., 2008), well-being (Wilson & Leese, 2013) or psychosocial needs (Younger, Hollins-Martin, & Choucri, 2015) of women who became pregnant after assisted conception. We extended our search beyond major databases, which increases the effectiveness of our review (Savoie, Helmer, Green, & Kazanjian, 2003). The search and interpretation of the data were conducted by several researchers with different backgrounds and perspectives (midwife, psychologist, expert by experience, Middle East, Europe) enhancing the investigator triangulation. To round off the study, we used the adapted Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) checklist (Moher, Liberati, Tetzlaff, & Altman, 2009) to ensure that the investigation complied with a universally agreed-upon set of standards and guidelines.

A number of limitations were observed in the reviewed studies. Some were conducted only in one private infertility centre (Bernstein et al., 1994) or in women with relatively advantaged socioeconomic status (Fisher et al., 2008; McMahon et al., 2007). Therefore, the lack of validity and generalisability was a major concern. One episode of data collection in some reviewed studies was another limitation (Chen et al., 2011; McMahon et al., 2007; Stanton & Golombok, 1993; Udry-Jørgensen et al., 2015). Moreover, in most studies, the prenatal attachment was measured during the second or third trimester of pregnancy when fears of foetal loss or congenital abnormalities decrease. Gestational age is one of the best predictor of prenatal attachment both in spontaneous (Barone et al., 2014; Yarcheski et al., 2009) and assisted pregnancies (Kuo et al., 2013; Udry-Jørgensen et al., 2015) but comparing the results of the studies were difficult because of variations in gestational age.

There could be distorting factors affecting the causal relationships or differences between variables. In our review, the studies differed in measurement instruments used (MFAS, MAAS, PIA, PFAS and PAAS), the timing (with participants at different weeks of gestation) and frequency of measurement (one, twice or three times during pregnancy). The heterogeneity of groups in terms of demographic variables (maternal age, education, marital status, socioeconomic status), in reproductive history (parity, history of miscarriage, number of ultrasound scan) and in terms of infertility-related factors (diagnostic criteria, cause of infertility, type of infertility treatment, use of donor gametes, experience of treatment failure, number of previous ART cycles, waiting period for pregnancy and multiple pregnancies) contributed to the heterogeneity. Consequently, in this review, the samples were so heterogeneous that few firm conclusions could be drawn and there were many characteristics not controlled for that could make a difference to the development of attachment to the fetus. Further research is needed to address the contradictions described and the methodological limitations of these studies.

Studies that included donor gametes, did not discuss the difference in prenatal attachment between women who conceived with their own eggs and women who conceived with donor eggs. Consequently, it is difficult to draw conclusions about attachment in relation to possible differences between donor and non-donor gametes and further studies are necessary.

The present review only included self-reported scales (MFAS, MAAS, PAI, PFAS and PAAS). In most studies on prenatal attachment in assisted pregnancies, brief self-rated questionnaires

were commonly used and the deficiencies of these questionnaires should be taken into account. We must also be cautious in talking about 'higher' and 'lower' scores of prenatal attachment, because there are no guidelines as to what constitutes an 'optimal' or non-optimal' score. We might read 'higher' as 'better' for some of these scales, but there is little evidence about the way in which scores might predict better 'adaptation'. A statistical difference might not imply a clinically significant one.

Few qualitative studies have specifically addressed the attachment issue in assisted pregnancies and such studies on couples who conceived through assisted pregnancy have not been included in our review. Although three studies included a qualitative component (Bernstein et al., 1994; Fisher et al., 2008; McMahon et al., 1997), the method of analysing the information obtained from the interviews was not fully explained, and these data were not included in our review.

Implications for care and research

The number of ART-pregnancies is growing, placing additional and changing demands on the competence and knowledge of maternity care professionals. The results of this review can provide starting points for policymakers and health professionals to better meet the needs of ART clients.

A key clinical implication of the findings of the review is that health-care providers are needed to help ART couples adjust to the changes related to the transition to parenthood (Cowan & Cowan, 1995). Special support groups in ART-pregnancies are proposed, in prenatal education (Chen et al., 2011; Kuo et al., 2013). Counselling on women's anxiety and relaxation training are also recommended.

Further studies should aim to control demographic variables, and explore the roles of reproductive history, infertility-related factors, the measurement instruments selected, timing and the frequency of measurement, with appropriately increased sample sizes. Additional research is specifically needed on the relationship between maternal mental representations and psychological morbidity in ART pregnancies and on the father-fetus relationship and parent-child attachment.

Conclusion

This review provides insights into prenatal attachment in pregnancy following ART. The review revealed that regardless of the trimester of pregnancy, in ART-conceived couples, the level of attachment was either similar to or higher than that of spontaneously conceived couples, and they did not appear to be at risk for attachment difficulties. However, ART women may be more susceptible to anxiety due to pregnancy loss and it would seem that support might be better focused on the pregnancy-related anxiety in these women rather than any attachment intervention.

Acknowledgments

We gratefully acknowledge Dr Helen Allan and Dr Esther Crespo for their assistance and contributions to this work.

Authors' contributions

FR conceptualized the study and prepared the draft proposal. FR and MG conducted the searches and selected the studies together and abstracted the data independently. Disagreements between FR and MG resolved through discussion with CW who had experience in this field. All authors contributed to the reviewed draft version of the manuscript and approved the final version.

Disclosure statement

No potential conflict of interest was reported by the authors.

Funding

This work has not been funded.

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