

A STUDY OF CORRELATIONS BETWEEN NEWBORN CHILDREN OUTCOMES AND EMOTIONAL STATES AND ATTACHMENT TO A FETUS IN WOMEN PREGNANT USING IN-VITRO FERTILIZATION

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Взаимосвязь эмоционального состояния и привязанности к плоду у женщин, забеременевших с помощью ЭКО, с перинатальными исходами их детей

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Abstract

Children's development in the early years is significantly linked to further well-being. Among many factors involved in

Резюме

Развитие детей в раннем возрасте в значительной степени связано с их дальнейшим благополучием. Среди многих факторов, влияющих

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early development are mother's attachment to the fetus and her emotional state during pregnancy. The current study prospectively explores mothers' characteristics during the third trimester of pregnancy and their newborn children outcomes. The sample included 300 women with natural conception (NC) and 127 women with in-vitro fertilization (IVF), and their newborn children. For mothers, the following instruments were used: the Maternal Fetal Attachment Scale, the Clinical Scale for Self-assessment of Irritability, Depression and Anxiety. For newborns, the following parameters of newborn children outcomes were assessed: gestational period; the length and weight; the Apgar score in the first and fifth minutes after birth. All components of maternal attachment to the fetus were in the normal range for most women in both groups. All aspects of maternal attachment to the fetus were significantly greater in the IVF group. In both groups, more than 35% of women experienced depression and 43% of women experienced moderate/severe levels of anxiety. In the NC group, greater scores on giving of self and enjoying of watching tummy jiggle as the baby kicks inside were associated with less irritation in mothers. In the IVF group, the indicators of women's attachment to their fetus were not associated with emotional states. Neither mothers' attachment to their fetus nor their emotional states during pregnancy predicted newborn children outcomes. Children born from IVF had a statistically lower gestational period than in the NC group.

Keywords: pregnant women's emotional states, attachment to fetus, newborn children outcomes, in-vitro fertilization, natural conception.

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на раннее развитие, выделяются привязанность матери к плоду и эмоциональное состояние матери во время беременности. В настоящем исследовании проспективно изучаются особенности матерей в третьем триместре беременности и перинатальные исходы новорожденных детей. Выборка включала 300 женщин с естественным зачатием (ЕЗ) и 127 женщин с экстракорпоральным оплодотворением (ЭКО), а также их новорожденных детей. Для матерей использовались следующие инструменты: Шкала привязанности матери к плоду, Клиническая шкала для самооценки раздражительности, депрессии и тревоги. У новорожденных оценивались следующие параметры перинатальных исходов: гестационный срок; длина и вес; оценки по шкале Апгар на первой и пятой минутах после рождения. Все компоненты материнской привязанности к плоду находились в пределах нормы у большинства женщин в обеих группах. Все аспекты материнской привязанности к плоду были значительно сильнее в группе ЭКО. В обеих группах более 35% женщин испытывали депрессию, а 43% женщин испытывали умеренный/выраженный уровень тревожности. В группе ЕЗ более высокие баллы за самопожертвование и удовольствие от наблюдения за покачиванием животика, когда ребенок шевелится внутри, были связаны с меньшим раздражением у матерей. В группе ЭКО показатели привязанности женщин к своему плоду не были связаны с эмоциональными состояниями. Ни привязанность матерей к своему плоду, ни их эмоциональное состояние во время беременности не предсказывали перинатальные исходы у новорожденных. У детей, рожденных в результате ЭКО, гестационный срок был статистически ниже, чем в группе ЕЗ.

Ключевые слова: эмоциональные состояния беременных женщин, привязанность к плоду, перинатальные исходы новорожденных, экстракорпоральное оплодотворение, естественное зачатие.

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Introduction

Children's mental development and health in the early years are significantly linked to further well-being. The complex system of factors contributing to children's outcomes remains poorly understood. Whereas some factors have already been suggested as potential targets for early intervention and prevention programs (Keshishian et al., 2014; Solovyeva, 2014; Britto et al., 2017; World Health Organization, 2018), many factors are still unclear.

Psychological readiness of a woman for motherhood, including mother's attachment to the fetus, is one of such factors (Muntaziri Niyya, 2011; Alhusen et al., 2013; Solovyeva, 2014; Yakupova & Zakharova, 2016; Savenysheva, 2018; Cildir et al., 2020; Hruschak et al., 2022). Specifically, an increasing number of studies have shown that a mother's attachment to the fetus can affect the relationship between mother and child, the formation of parental identity and the child's future social, emotional and cognitive development (Ranson & Urichuk, 2008; Talykova, 2008; Gracka-Tomaszewska, 2010; Vasilenko & Vorobeva, 2016; Foley & Hughes, 2018).

The emotional connection of the mother with the fetus is manifested in parental care for the child already during pregnancy when the mother engages in well-being promoting behaviors. These include proper nutrition, sleep and exercise, abstinence from substance use, as well as the developing mindfulness skills during pregnancy and desire to get acquainted with the fetus during pregnancy (Lindgren, 2001; Eastwood et al., 2017; Yang et al., 2017; Nyklíček et al., 2018).

Prenatal attachment can contribute to the child's positive development, which has been shown in a number of studies describing the effectiveness of maternity protection programs (Hompes et al., 2012; Dokuhaki et al., 2019). These programs were aimed at strengthening prenatal attachment through raising awareness and improving interaction with the fetus. In the intervention group, educating the women on fetal-maternal attachment skills was associated with the infants' earlier achievement of some gross and fine motor skills, such as the equal hand movement, with modest to moderate effects at one and three months of age (Dokuhaki et al., 2017). In another study, attachment skills of mothers were related to greater children's height and weight, compared to the control group at birth, and one month and three months after birth (Maddahi et al., 2016).

Many studies found that pregnant women on average report higher rates of depression, irritability, anxiety, and high mood instability than non-pregnant women (Bowen et al., 2012; Yazici et al., 2018; Bahadırılı et al., 2019). Several studies demonstrated that depression during pregnancy may lead to maternal behaviors that present a risk for low birth weight, and poor physical and mental health of the child (Vasilenko & Vorobeva, 2016; Eastwood et al., 2017; Robbins, 2003; Petrova et al., 2013). For example, the association between depression and birth weight was found in a retrospective study of mothers (N = 17564) of all infants born in public health facilities of New South Wales (NSW). Children of mothers with higher scores for antenatal depressive symptoms, measured with Edinburgh Postnatal Depression Scale, had higher odds of low birth weight [OR = 1.7] and of a shorter gestational age at birth of < 37 weeks [OR = 1.3], compared to children of women with lower depression scores (Eastwood et al., 2017). Thus, in a prospective cohort study of 681 women in France were found that the rate of spontaneous preterm birth was significantly higher among women with higher depression scores (9.7%), as opposed to other women (4.0%), even after adjustment for potential confounding factors (Dayan et al., 2006). In a study from New Zealand, women at increased risk of spontaneous preterm birth have higher levels of anxiety (Dawes et al., 2022). Some studies have demonstrated that anxiety, bad mood and stress in early and late pregnancy can affect the fetus' development and somatic well-being (Punamaki et al., 2006; Qiao et al., 2012; Brunton, 2013).

Research suggests that attachment to the fetus may mediate the links between mothers' emotional states and newborn children outcomes. However, results of previous studies are inconsistent regarding these links during pregnancy, as well as the directions of causation (Della Vedova & Burro, 2017). Several studies reported that attachment to the fetus was negatively related to anxiety and depression (Hart & McMahon, 2006; Hjelmstedt et al., 2006; Della Vedova & Burro, 2017). Other studies found no link between attachment and mental health (Hjelmstedt et

al., 2006; McFarland et al., 2011). Yet, other research suggests that anxiety about an abnormality of the fetus or the risk of premature birth strengthens attachment, leading to positive correlation between them (Abazari et al., 2017). For example, a study found that pregnant women with mild depressive symptoms paid more attention to fetal movements than women without depression (Seimyr et al., 2009).

Currently, parental attitudes and emotional states of women participating the IVF program are actively studied, suggesting that these women require psychological support both during the pregnancy and after childbirth (Malenova & Kytкова, 2015; Yakupova & Zakharova, 2016). Research has suggested that women with IVF show on average greater attachment to the baby. For example, a study found that women in the IVF group on average had higher rates of attachment to the fetus and subsequently to the baby than women in the group with natural conception (Chen et al., 2011). However, some studies did not find average differences in mothers' attachment to their unborn children regardless of the type of conception (Hopkins et al., 2018).

Some research found that emotional states of women participating in the in-vitro fertilization procedure are characterized by a significant frequency of affective disorders, comorbidity of anxiety and depression, such as predominant disorders of the anxiety spectrum, as well as lower indicators of well-being, activity, and mood, compared to women with a physiologically natural pregnancy (Petrova, Podolkhov, 2011; Petrova et al., 2013). For example, it was shown in a study that almost a third of women with IVF have symptoms of mild, moderate, and, in a few cases, severe depression (Naku et al., 2016). Another study found that women using IVF reported significantly greater anxiety about losing a pregnancy than about the baby's possible health, compared to women having a natural conception (Hjelmstedt et al., 2003). The elevated rate of psychological problems in women who use in-vitro fertilization may be partly related to their history of infertility (Hjelmstedt et al., 2003; Petrova, Podolkhov, 2011; Petrova et al., 2013). However, other research did not find differences between IVF and natural conception groups. For example, most women participating in an IVF program were found to have an average level of anxiety (Naku et al., 2016).

Overall, the gaps in the existing literature underline the need for research investigating the association between maternal factors, such as prenatal attachment to the fetus and emotional states, and newborn children outcomes.

Aim

The current study prospectively explores mothers' psychological characteristics during the third trimester of pregnancy and their newborn children outcomes. The study has the following three aims:

1. To investigate potential differences between the NC and IVF groups in:
 - 1.1 maternal attachment during pregnancy;
 - 1.2 emotional states of women during pregnancy;
 - 1.3 newborn children outcomes.
2. To investigate links among groups of variables in the NC and IVF groups:
 - 2.1 attachment characteristics;

- 2.2 mothers' emotional states;
 - 2.3 maternal attachment and mothers' emotional states;
 - 2.4 newborn children outcomes.
3. To explore the links between mothers' psychological characteristics in pregnancy and newborn outcomes in the NC and IVF groups:
- 3.1 maternal attachment and mothers' emotional states with newborn children outcomes;
 - 3.2 a potential mediating role of maternal attachment in the links between mothers' emotional states and newborn children outcomes.

Participants

The sample included 300 women with natural conception (NC) and 127 women with in-vitro fertilization (IVF), and their newborn children. All of them are participants in the Prospective Longitudinal Interdisciplinary Study (PLIS). The study included women with a single (not multiple) pregnancy. The average age of women in the NC group was 29.3 ± 4.0 years; in the IVF group, 33.2 ± 4.6 years. The average gestation period in the NC group was 39.89 ± 1.26 ; in the IVF group, 38.57 ± 2.04 . In the NC group, 16.7% of women noted that their pregnancy was unplanned. In each group, a certain number of women already had children (it was not their first pregnancy and childbirth): one child, 27.3% in the NC group and 22.0% in the IVF group; two children, 4.0% in the NC group and 3.9% in the IVF group; three children, 1.0% in the NC group and .9% in the IVF group.

Procedure

Data collection was carried out at obstetric clinics and assisted reproductive technology centers in Siberian region (Russia). The study was approved by the Ethical Committee for Interdisciplinary Research at Tomsk State University. Written informed consent was obtained from all participants in the study, including for accessing their medical records. Data were collected from participants in the third trimester of pregnancy, as well as from perinatal and postnatal medical records (in medical centers where pregnancy monitoring and delivery were conducted).

Measures

Mothers' Psychological Characteristics

Two instruments were used to evaluate psychological characteristics of pregnant women: the Maternal Fetal Attachment Scale (Cranley, 1981) and the Clinical Scale for Self-assessment of Irritability, Depression and Anxiety (IDA-Scale; Snaith, 1978). The instruments are based on the materials of a large-scale longitudinal study of child development, the C-IVF (Cardiff Study of IVF Children, UK). The measures were adapted to Russian using the following procedure: two independent translators, whose first language is Russian and the second

English, conducted the translation of the test from English to Russian following the ITC guidelines for test translations (International Test Commission, 2017).

Table 1 provides a description and reliability information (Cronbach's alpha) for each subscale. As can be seen from Table 1, low reliability was found for the Differentiation of self from fetus subscale of the attachment scale. We explored the poor reliability of this subscale. Two items (Decision on the name for a baby girl; Decision on the name for a baby boy) had low loading on the subscale. We removed these items from the subscale and used the remaining two items of the subscale as separate independent variables.

For emotional states, low reliability was found for two subscales: Depression and Inward irritation (see Table 1). The IDA was originally created for self-assessment of emotional states in a clinical context and showed high reliability. For example, Cronbach's alpha among patients with Huntington's disease was between .87 and .90 for Depression, Anxiety, Outward and Inward irritation. Some studies with non-clinical populations used modified versions of the IDA scale, for example excluding self-harm items, leading to better reliability (.71–.81) (Wilson et al., 2019). We decided to keep the original subscales, despite the poor internal consistency of times, because the summed up total scores provide a reasonable measure of individual differences for this research purpose.

Newborn Children Outcomes

Table 2 presents the description for the five parameters of newborn children outcomes obtained from mothers' medical records, as well as normative values for these parameters.

Statistical Analysis

We used the following methods: descriptive statistics, Mann-Whitney U test, Chi squared analysis, Spearman nonparametric correlation criterion, regression analysis, and mediation analysis (in the IBM SPSS Statistics 26 application package).

Results

Statistically significant differences in the age of the study participants were revealed: women of the IVF group are older than women with natural conception ($U = 9350.5; p < .01$).

Group comparisons

Maternal attachment to the fetus in the NC and IVF groups

The NC and IVF groups were compared for indicators of maternal attachment to the fetus in the third trimester of pregnancy. As the distributions differed from normal, the nonparametric Mann-Whitney U test was used. The results presented

Table 1

A List of Measures of Mothers' Psychological Characteristics in Pregnancy

Title	Subscales (Max. scores)	Cronbach's α (NC/IVF)	Items №	Scoring
<i>Maternal attachment in pregnancy</i>				
Maternal Fetal Attachment Scale (Cranley, 1981)	Interaction with the fetus (25)	.81/.74	5	A 5-point scale from 1 ("Always no") to 5 ("Always yes"). According to Item 22, "Feeling that my body is ugly", an inverted count is assumed. Points are summed for each subscale, which is the total indicator of attachment to the fetus. High indicators for subscales indicate a favorable prognosis for the formation of attachment to the fetus; low indicators indicate a risk of problem maternal behavior. The total maternal affection of 120 points is high, 24 points — low.
	Giving of self (25)	.79/.78	5	
	Differentiation of self from fetus (20)	.40/.63	4	
	Role taking (20)	.87/.86	4	
	Attribution of characteristics and intentions to the fetus (30)	.74/.74	6	
	Total attachment to the fetus (120)	.91/.91	24	
Independent items from Differentiation of Self scale*	Enjoying of watching my tummy jiggle (5)		1	A 5-point scale from 1 ("Always no") to 5 ("Always yes").
	Looking forward to seeing the baby (5)		1	
<i>Emotional states of women during pregnancy</i>				
The Clinical scale for self-assessment of irritability, depression and anxiety (IDA-Scafe; Snaith, 1978)	Depression (15)	.44/.48	5	A 4-point scale from 0 ("No, not at all") to 3 ("Yes, definitely"). When calculating the scales, some questions are reversed, so that a higher score meant a more pronounced negative state. Then points are summed for each subscale. A risk of negative emotional states is indicated by the following scores (borderline levels): from 4 to 6 points for Depression and Inward irritation; from 5 to 7 points for Outward irritation; and from 6 to 8 for Anxiety. Scores lower than these ranges indicate the normal range. Scores higher than these ranges (elevated levels) indicate a problem and an urgent need for help.
	Anxiety (15)	.64/.66	5	
	Outward irritation (12)	.68/.61	4	
	Inward irritation (12)	.38/.39	4	

*Items extracted from "Differentiation of self from fetus" scale as the scale had low reliability.

Table 2

Measures of Newborn Children Outcomes

Parameters of newborn children outcomes	Normative indicators of parameters of newborn children outcomes (norms for Russia)
Gestation period (at time of birth)	38-41 weeks
Newborn weight (grams)	more than 2500 g
Newborn body length (cm)	over 40 cm
Apgar score in the first minute of a newborn's life	7 and up to 10 points
Apgar score in the fifth minute of a newborn's life	7 and up to 10 points

in Table 3 showed significant statistical differences between the NC and IVF groups. The IVF group showed on average greater maternal attachment on all subscales compared to the NC group. The effect size of the differences was weak, but remained significant after correction for multiple comparisons ($p = .05/7 = .007$), with the exception for Parameter 7, Enjoying of watching my tummy jiggle.

Table 3

Descriptive Statistics for Indicators of Maternal Attachment to the Fetus

Indicators	Groups	Mean	SD	Me	Min	Max	U	p	η^2	d_{Cohen}
Interaction with the fetus	NC	20.75	4.12	22	5	25	8062.50	< 0.01	0.037	0.394
	IVF	22.34	2.80	23	11	25				
Giving of self	NC	20.61	4.37	22	5	25	7932.50	< 0.01	0.041	0.412
	IVF	23.07	2.72	24	7	25				
Role taking	NC	16.39	3.73	17	4	20	6746.00	< 0.01	0.079	0.587
	IVF	17.89	2.81	19	5	20				
Attribution of characteristics and intentions to the fetus	NC	23.18	4.78	24	7	30	6377.00	< 0.01	0.094	0.643
	IVF	25.94	3.20	27	14	30				
Total attachment to the fetus	NC	95.49	18.28	99	30	120	2531.50	< 0.01	0.318	1.365
	IVF	104.74	13.40	108	43	118				
Enjoying of watching my tummy jiggle	NC	4.62	1.05	5	1	5	10431.50	0.01	0.001	0.069
	IVF	4.92	0.47	5	1	5				
Looking forward to seeing the baby	NC	4.47	1.10	5	1	5	9969.00	< 0.01	0.012	0.222
	IVF	4.82	0.66	5	1	5				

Note. The number of participants differed for different items: N(NC) = 289–300; N(IVF) = 120–127.

Emotional states among women in the NC and IVF groups

Table 4 presents descriptive statistics for women's emotional states in the third trimester of pregnancy in the NC and IVF groups. Regardless of the type of conception, more than 35% of women experienced borderline or elevated levels of depression and more than 43% of women experienced moderate/severe levels of anxiety. More women experienced outward irritation (20.7–30.7%) than inward irritation (1.2–4.1%).

The Mann-Whitney U test between the NC and IVF groups showed no significant differences for any indicators of emotional states, with the exception of Outward irritation, which was more pronounced in the NC group ($U = 9645.50$, $p = .05$). The effect size (Eta squared (η^2) = .011, $d_{\text{Cohen}} = 0.207$) was negligible and significance did not survive correction for multiple comparisons ($p = .05/4 = .013$).

Newborn children outcomes in the NC and IVF groups

Table 5 presents descriptive statistics for newborn children outcomes. According to the Kolmogorov-Smirnov criterion, in both groups, the distribution of all indicators differed from normal, with the exception of the weight of newborns in the NC group. The gestation period results indicated that for most children, birth occurred in a standard time frame. However, about one in six of the IVF children had a gestational period below normal. Indices on the Apgar scale in the first and fifth minutes of a child's life, newborn weight and body length were within the norm for most children.

Comparative analysis using the Mann-Whitney and Chi squared tests is presented in Table 6. The results of the Mann-Whitney U test indicate that children born from IVF have a statistically lower gestational period than children in the NC

Table 4

Descriptive Statistics for Indicators of Emotional States

Indicators	Borderline level	Elevated level	Groups	Mean	SD	Me	Min	Max	% of women with borderline level	% of women with elevated level
Depression	4–6	7–15	NC	3.13	2.16	3	0	10	32.5	7.4
			IVF	3.01	2.06	3	0	10	32.1	3.7
Anxiety	6–8	9–15	NC	5.58	1.92	5	2	12	33.2	18.8
			IVF	5.36	1.90	5	3	11	29.5	13.5
Outward irritation	5–7	8–12	NC	3.44	2.21	3	0	11	25.2	5.5
			IVF	2.89	1.99	2	0	8	18.3	2.4
Inward irritation	4–6	7–12	NC	1.20	1.27	1	0	7	3.7	0.4
			IVF	0.98	1.12	1	0	5	1.2	0

Note. The number of participants differed for different items: N(NC) = 289–300; N(IVF) = 120–127.

Table 5

Descriptive Statistics of Newborn Children Outcomes

Indicators	Groups	Mean	SD	Median	Min	Max	% of children with below the norm levels
Gestation period	NC	39.89	1.26	40	35	42	5.5
	IVF	38.57	2.04	39	29	41	16.5
Newborn weight (grams)	NC	3492.75	490.92	3500	2340	5060	3.2
	IVF	3373.52	574.83	3375	1300	4470	5.2
Newborn body length (cm)	NC	52.95	2.60	53	45	59	0
	IVF	52.67	3.39	53	39	58	2.6
Apgar score in the first minute of a newborn's life	NC	8.06	0.63	8	3	9	0.9
	IVF	8.30	0.74	8	5	10	1.7
Apgar score in the fifth minute of a newborn's life	NC	8.77	0.62	9	5	10	0.5
	IVF	8.94	0.86	9	7	10	0

Note. N(NC) = 218; N(IVF) = 115.

Table 6

Comparison of Newborn Children Outcomes in NC Vs. IVF Groups

Indicators	Comparison with U Mann-Whitney				χ^2 analyses	
	U	<i>p</i>	η^2	d_{Cohen}	χ^2	<i>p</i>
Gestation period	2985.50	< 0.01	0.397	1.624	39.31	< 0.01
Newborn weight (grams)	4810.50	0.218	0.298	1.304	35.17	0.198
Newborn body length (cm)	5395.50	0.992	0.270	1.215	3.34	0.698
Apgar score in the first minute of a newborn's life	4275.00	0.083	0.326	1.391	3.46	0.170
Apgar score in the fifth minute of a newborn's life	4817.50	0.168	0.298	1.303	0.60	0.457

group (after correction for multiple comparisons: $p = .05/5 = .01$). Sizes were moderate to large. There were no significant differences for the newborn weights and length, and the Apgar scale indicators. Chi squared analyses performed on categorical data (frequencies below norm levels) showed significant differences in the gestation period.

*Links among the Variables***Maternal attachment characteristics in the NC and IVF groups**

In both groups, most correlations among different indicators of maternal attachment to the fetus were significant (ranging from .24 to .60). Out of 15 pairwise correlations,

when adjusted for multiple comparisons ($p = .05/20 = .003$), six were not significant in the IVF group (see Table 7). Five of the 15 correlations were stronger in the NC group (Fisher-Z transformation).

Mothers’ emotional states in the NC and IVF groups

All indicators of emotional states were significantly correlated in the NC group (ranging from .22 to .35), including after multiple testing ($p = .05/6 = .008$) correction (Table 8). In the IVF group, three significant correlations were found after multiple testing. Anxiety was not significantly associated with other emotional

Table 7

The Results of the Correlation Analysis for Characteristics of Maternal Attachment to the Fetus in the NC and IVF Groups

Indicators	Groups	Giving of self	Role taking	Attribution of characteristics and intentions to the fetus	Enjoying of watching my tummy jiggle	Looking forward to seeing the baby
Interaction with the fetus	NC	.475***	.500***	.588***	.455***	.470***
	IVF	.237***	.399***	.513***	.166	.395***
Giving of self	NC		.387***	.375***	.462***	.388***
	IVF		.235***	.301**	.146	.310***
Role taking	NC			.584***	.401***	.603***
	IVF			.493***	.164	.438***
Attribution of characteristics and intentions to the fetus	NC				.441***	.508***
	IVF				.187	.336***
Enjoying of watching my tummy jiggle	NC					.499***
	IVF					.126

** $p < .01$, *** $p < .003$. Pairs of correlations with significantly different coefficients ($Z = 1.86-2.71, p < .05$) are highlighted in bold.

Table 8

The Results of the Correlation Analysis for Mothers’ Emotional States in the NC and IVF Groups

Indicators	Groups	Anxiety	Outward irritation	Inward irritation
Depression	NC	.309***	.256***	.255***
	IVF	.271*	.313***	.295***
Anxiety	NC		.220***	.236***
	IVF		.138	.165
Outward irritation	NC			.354***
	IVF			.332***

* $p < .05$, *** $p < .008$.

states. No significant differences were found between the two groups in the correlation coefficients.

Maternal attachment and mothers' emotional states in the NC and IVF groups

Spearman nonparametric correlations did not differ significantly between the NC and IVF groups (Table 9). In both groups, Giving of self was weakly but significantly negatively correlated with Depression and Anxiety; in the IVF group, Role taking had a significant negative correlation with Inward irritation; in the NC group, Enjoying of watching my tummy jiggle had a significant negative correlation with Depression and Outward irritation, but these correlations did not survive the multiple testing correction ($p = .05/33 = .002$). The results showed three significant correlations (after multiple correction adjustment) in the NC group: Giving of self negatively correlated with Outward and Inward Irritation; Enjoying of watching my tummy jiggle negatively correlated with Inward irritation.

Newborn children outcomes in the NC and IVF groups

The results of the Spearman's test presented in Table 10 revealed expected positive significant correlations between the majority of indicators of development in

Table 9

The Results of the Correlation Analysis for Indicators of Maternal Attachment to the Fetus and Emotional States in the NC and IVF Groups

Indicators	Groups	Depression	Anxiety	Outward irritation	Inward irritation
Interaction with the fetus	NC	-0.060	0.018	-0.082	-0.059
	IVF	-0.172	-0.167	-0.006	-0.073
Giving of self	NC	-0.140*	-0.147*	-0.223***	-0.194***
	IVF	-0.211*	-0.203*	-0.169	-0.095
Role taking	NC	-0.033	-0.040	-0.005	0.087
	IVF	-0.028	-0.032	-0.038	-0.233*
Attribution of characteristics and intentions to the fetus	NC	0.011	0.052	-0.081	-0.013
	IVF	-0.067	-0.074	-0.009	0.013
Total attachment to the fetus	NC	-0.098	-0.042	-0.106*	-0.067
	IVF	-0.114	0.049	-0.010	0.028
Enjoying of watching my tummy jiggle	NC	-0.135*	-0.112	-0.157**	-0.207***
	IVF	-0.023	0.123	0.039	-0.141
Looking forward to seeing the baby	NC	-0.095	-0.045	-0.086	-0.112
	IVF	-0.053	0.016	0.024	0.057

* $p < .05$, ** $p < .01$, *** $p < .002$.

Table 10

The Results of the Correlation Analysis for Newborn Children Outcomes in the NC and IVF Groups

Indicators	Groups	Newborn weight	Newborn body length	Apgar score in the first minute of a newborn`s life	Apgar score in the fifth minute of a newborn`s life
Gestation period	NC	.404***	.306***	-.047	.052
	IVF	.697***	.679***	.317***	.192*
Newborn weight	NC		.862***	.087	.106
	IVF		.895***	.281***	.184*
Newborn body length	NC			.112	.122
	IVF			.323***	.268***
Apgar score in the first minute of a newborn`s life	NC				.623***
	IVF				.784***

* $p < .05$, *** $p < .005$. Pairs of correlations with significantly different coefficients ($Z = -4.65 - -2.96, p \leq .05$) are highlighted in bold.

both groups (including after correction for multiple comparisons ($p = .05/10 = .005$)). In several cases, the correlations were statistically higher in the IVF group than in the NC group.

Mothers' Emotional States and Attachment to the Fetus during Pregnancy and Newborn Children Outcomes

We performed regression analyses (the Enter method) to assess the links between mothers' measures (emotional states and attachment during pregnancy) and the newborn children outcomes. There were a series of regressions with five newborn children outcomes as criterion variables: body length, weight, gestational period, and Apgar score in the first and fifth minutes. In all five models, mothers' emotional states and attachment to the fetus were simultaneously entered into the regression as 11 predictor variables. Tables 11 and 12 present the results of these regressions for both groups. None of the models were significant.

We further explored the hypothesized mediating role of attachment in the links between mothers' emotional states and newborn children outcomes. We performed the analysis of mediation using the PROCESS Procedure for SPSS Release 2.16.1. We found no evidence for a mediating role of attachment between emotional states and newborn children outcomes in both groups.

Discussion

The present study is part of a large-scale longitudinal project following groups with in-vitro fertilization and natural conception (from the period of pregnancy to

Table 11

**Regression Models of the Relationship of Emotional States and Attachment Indicators
as Predictors of Newborn Children Outcomes in the NC Group**

Predictors (Sub-scales)	Gestation period		Newborn weight		Newborn body length		Apgar score in the first minute		Apgar score in the fifth minute	
	β	<i>p</i>	β	<i>p</i>	β	<i>p</i>	β	<i>p</i>	β	<i>p</i>
Depression	-.193	.074	.163	.137	.104	.345	.110	.305	-.221	.388
Anxiety	-.051	.649	-.082	.472	-.040	.728	.006	.958	.090	.688
Outward irritation	.178	.107	.030	.790	-.009	.938	.155	.162	.116	.686
Inward irritation	-.043	.712	.004	.975	.063	.599	-.060	.606	.068	.813
Interaction with the fetus	-.005	.981	-.082	.701	-.069	.748	-.052	.802	-.094	.771
Giving of self	-.005	.980	-.320	.116	-.235	.253	-.164	.413	.475	.076
Role taking	-.292	.217	.277	.251	.215	.376	-.035	.883	-.039	.873
Attribution of characteristics and intentions to the fetus	-.079	.682	-.120	.542	-.051	.799	-.123	.524	.432	.270
Total attachment to the fetus	.494	.229	.151	.654	.105	.759	.545	.177	.466	.195
Enjoying of watching my tummy jiggle	-.143	.584	-.006	.983	.093	.729	-.092	.727	-.125	.569
Looking forward to seeing the baby	.318	.179	.052	.827	.017	.943	.271	.252	-.453	.046
Adjusted R ²	.099		.068		.046		.095		.163	
<i>p</i> for a model	.452		.774		.938		.497		.231	
F	1.000		0.659		0.434		0.950		1.479	

children's admission to school). The revealed statistically significant differences in the age of the study participants repeat the established conclusion about the average greater age of mothers with IVF in comparison with women with NC. The analyses explored maternal emotional states in the third trimester of pregnancy as they relate to newborn children outcomes.

First, we explored absolute levels of maternal attachment to the fetus (as the extent to which women engage in behaviors that represent an affiliation and interaction with their unborn child) and found that most women showed attachment levels in the normal range. The results were consistent with previous literature on samples from other populations (Hjelmstedt et al., 2006; Karatas et al., 2011; Lingeswaran & Bindu, 2012; Alhusen et al., 2012). We then investigated potential differences in maternal attachment in pregnancy between the NC and IVF groups. We found that attachment was significantly higher in women in the IVF group. Thus, women in the IVF group are more likely than women with a natural conception to talk to their unborn child, refer to the baby by a nickname, stroke the baby's tummy to quiet them when there is too much kicking. Women with IVF feel

Table 12

Regression Models of the Relationship of Emotional States and Attachment Indicators as Predictors of Newborn Children Outcomes in the IVF Group

Predictors (Sub-scales)	Gestation period		Newborn weight		Newborn body length		Apgar score in the first minute		Apgar score in the fifth minute	
	β	<i>p</i>	β	<i>p</i>	β	<i>p</i>	β	<i>p</i>	β	<i>p</i>
Depression	-.014	.964	.059	.837	-.037	.884	-.230	.368	.043	.685
Anxiety	.008	.976	-.086	.733	.046	.835	.022	.920	-.103	.357
Outward irritation	-.189	.596	.209	.521	.345	.234	.267	.355	.173	.117
Inward irritation	.275	.442	.101	.755	.130	.649	-.023	.936	.026	.821
Interaction with the fetus	.047	.907	.401	.282	.346	.290	.023	.943	.278	.185
Giving of self	.189	.551	.550	.070	.584	.032	-.285	.150	-.090	.652
Role taking	-.102	.735	-.346	.217	-.280	.252	.081	.738	-.418	.179
Attribution of characteristics and intentions to the fetus	.044	.926	-.443	.316	-.219	.568	.352	.365	.018	.924
Total attachment to the fetus	-.580	.116	-.649	.177	-.699	.311	-.442	.472	-.780	.461
Enjoying of watching my tummy jiggle	-.151	.578	-.048	.847	-.223	.311	.004	.985	-.189	.470
Looking forward to seeing the baby	-.140	.598	.035	.884	-.111	.603	-.448	.048	.099	.674
Adjusted R ²	.238		.164		.099		.095		.163	
<i>p</i> for a model	.905		.103		.454		.497		.231	
F	0.455		1.765		0.998		0.950		1.479	

stronger that all the trouble of being pregnant is worth it, try to do things to stay healthy that they would not do if they were not pregnant, give up doing certain things (alcohol consumption, smoking, etc.). Also, the following is more characteristic for women of this group, compared with women with natural conception: they imagine themselves feeding and taking care of the baby, can hardly wait to hold the baby, look forward to seeing what the baby looks like. Women with IVF are more likely to attribute characteristics and intentions to their unborn child: to wonder if the baby feels cramped in there, can almost guess what the baby's personality will be from the way they move around, wonder if the baby can hear, can tell that the baby has the hiccoughs. This is consistent with a study of Chen et al. (2011). However, other studies did not find greater attachment in the IVF groups (Hjelmstedt et al., 2006; Hammarberg et al., 2008; Hopkins et al., 2018). These inconsistencies may be explained by differences across the studies in the sample size; pregnancy trimester of assessment and measures used to assess prenatal attachment.

In both groups, almost all indicators of maternal attachment to the fetus were related to each other, with some stronger correlations and with more correlations in the NC group (with stronger intensity of this indicators in the IVF group described above). This may define a lower consistency of the components of maternal attachment to the fetus in the IVF group compared with women with natural conception due to the presence of unpleasant symptoms during pregnancy, and tap into complex feelings during pregnancy: fears of the upcoming birth; doubting one's parenting abilities; worry about child's health; experience of one's bodily metamorphosis and the associated feeling of one's unattractiveness, as well as necessary changes in one's lifestyle. Unlike in the NC group, the correlation between Enjoying of watching my tummy jiggle with other indicators of maternal attachment was not significant in the IVF group. Enjoying of watching my tummy jiggle is focused on enjoying experiencing the baby's activity in the womb and imagining the baby's feelings and thoughts as it is developing in the womb, but probably for a woman with IVF, it does not define engaging in behaviors that represent an affiliation and interaction with the unborn child. Also, Giving of self, which means that pregnant women feel that all the trouble of being pregnant is worth it, because she is pregnant and she does things to improve her well-being and wellbeing of the baby inside, is not significantly associated with Attributing characteristics and intentions to the fetus. The results indicating the difference in the levels of severity and interrelationships of indicators of maternal attachment to the unborn child in the IVF group (as opposed to the NC group) have prognostic significance and can be considered as indicators of maternal attitude to the child after childbirth in the process of care, upbringing and interaction with them.

Next, we explored mothers' levels on the four dimensions: depression, anxiety, and outward and inward irritation. In both groups, more than 35% of women experienced borderline or elevated levels of depression and more than 43% of women experienced moderate/severe levels of anxiety. These women don't feel cheerful, have poor appetite, can't laugh or feel amused, haven't kept up their old interests, wake up ahead of time, get scared or panicky for no good reason, can't sit down and relax quite easily, feel tense or "wound up", can't go out on their own without feeling anxious, so might require psychological support to alleviate the symptoms and buffer the potential negative effect on their infants. Inward irritation was low in women of both groups; it means that it is not typical for the overwhelming majority of the study participants to get angry with themselves or call themselves names, feel like harming themselves, be getting annoyed with themselves. There were increased levels of outward irritation in 20.7-30.7% of women: they could lose temper, yell and snap at others, lose control and hit or hurt someone, and be less patient with other people. Overall, these results are consistent with findings of several previous studies that showed higher levels of irritability and mood instability in pregnant as compared to non-pregnant women (Hjelmstedt et al., 2006; McMahan et al., 2007; Yazici et al., 2018). The multiple comparisons in our study showed that the groups did not statistically differ for depression, anxiety, and outward and inward irritation. As described in the introduction, previous research into the group difference is inconsistent (Hjelmstedt et al., 2003; McMahan et al., 2007;

Chen et al., 2011; Hopkins et al., 2018). Our results suggest that women regardless of the type of conception show very similar emotional states during pregnancy. In the IVF group (compared to the NC group) anxiety was not significantly associated with other emotional states, which may reflect certain specifics about the weak interrelationship and interdependence of negative emotional states of this group of pregnant women in the last trimester of pregnancy and reflect the need to search for factors causing such specifics.

The results of the correlation analysis for indicators of maternal attachment to the fetus and indicators of emotional states showed that in the IVF group, unlike in the NC group, there are no significant relationships. In the NC group, Giving of self showed significant negative relationships with Outward and Inward irritation, Enjoying of watching my tummy jiggle showed significant negative correlation with Outward and Inward irritation. Women who are more irritated with themselves and the world around them are less responsible for the child's life, and are less willing to sacrifice their comfort and pleasure for the sake of strengthening the child's health. Also, women who are more irritated with themselves are less able to enjoy watching their tummy jiggle. Similarly to the group with NC, in the IVF group, depression and anxiety, for which more than a third of women in each group have borderline and elevated levels, are in no way related to indicators of maternal attachment to the fetus. These data differ from the results of some other studies in which correlations were found, for example in Hart & McMahon, 2006; Hjelmstedt et al., 2006; Della Vedova & Burro, 2017; Seimyr et al., 2009; Abazari et al., 2017. Further research is needed to clarify the possible factors that determine the presence/absence of such relationships and their causal mechanisms.

Our analyses of the potential differences in newborn children outcomes showed that, on average, infants in the IVF group had a shorter gestation period than in the NC group, in compliance with norms for the gestational period. Only 16.5% of the IVF group children had gestational period indicators below the norm. There are also studies showing differences in newborn children outcomes, depending on the type of conception. For example, Stojnic et al. (2013) showed that the mean gestational age at delivery of the IVF group was 38.13 ± 1.72 weeks, slightly shorter than 38.65 ± 1.79 weeks in spontaneously conceived singletons. In general, it can be concluded that pregnancy with IVF can potentially increase the perinatal risk of premature birth for some of the women who have used this method. Despite this, there were no significant group differences between NC and IVF children in newborn weight and length, and health as measured by the Apgar scores, which is similar to the results of some studies, for example Belva et al. (2007) and Tomic (2011). For child characteristics, in the IVF group, all newborn children outcomes were linked to each other. Fewer associations were observed in the NC group: the child gestational period was associated with body length and weight; two Apgar scales were associated with each other, but not with other newborn children outcomes. Overall, in the IVF group, the associations among the newborn children outcomes were stronger than in the NC group.

We found that in both NC and IVF groups none of the maternal emotional states or attachment characteristics were significantly associated with newborn

children outcomes. This result is inconsistent with some previous research that found such associations. This inconsistency may stem from the fact that most previous research considered overall mother-fetus attachment, rather than specific components of attachment to the fetus (Alhusen et al., 2012; Stojnic et al., 2013; Wilson et al., 2019; Simpson et al., 2019). Studies that examined individual components of prenatal attachment found that only some of them were weakly correlated with newborn children outcomes (Wilson et al., 2019). Moreover, the links between prenatal attachment and newborn children outcomes may be mediated by health practices during pregnancy (Alhusen et al., 2012). This should be further investigated. Finally, the mediation analysis performed in the present study did not find evidence that prenatal attachment mediates the links between mothers' emotional states and newborn children outcomes. Given that these factors can be associated with child's later development and maternal postpartum parental attitudes (Shreffler et al., 2021; Savenysheva et al., 2022), the observed results could be implemented in a complex system of psychological support for women with IVF. So, the data presented in the article complement the available scientific data obtained from various socio-cultural samples and serve as a basis for further research, since the problem under study has not received an unambiguous solution, and an expanded search for factors that may directly or indirectly affect the studied relationships is required.

Conclusion

The study found that maternal attachment to the fetus is more pronounced in the IVF group compared to the NC group of mothers. In contrast, no group differences were found in mothers' depression, anxiety, outward and inward irritation during the third trimester of pregnancy. In the IVF group, no significant correlations of indicators of maternal attachment and emotional states were found. In the NC group, higher scores on giving of self and greater enjoying of watching tummy jiggle as the baby kicks inside were associated with less irritation of pregnant women. Children born from IVF had statistically a lower gestational period; however, these groups did not differ in body weight and length, and the Apgar scores, as compared to children in the NC group. No associations were found between mothers' prenatal attachment, emotional states and newborn children outcomes.

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