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Changes in paternal perinatal depression and its predictors from third trimester of pregnancy to one-year post-partum: a longitudinal study

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ABSTRACT

Introduction: Paternal depression is not as widely recognized as maternal depression. Studies in Japan have examined the factors associated with paternal depression, but these have been limited to specific regions rather than conducted on a nationwide scale. This study aimed to examine changes in paternal perinatal depression from the last trimester of pregnancy to one year postpartum. Additionally, we explored the relationship between paternal perinatal depression and fathers' feelings toward their infants.

Methods: This study used a longitudinal design. We initially planned to collect data from over 384 cases based on sample size calculations, and successfully collected data from 494 men in the first survey. However, more than half of the participants dropped out in the second and subsequent surveys, resulting in 201 men completing the longitudinal survey over a one-year period.

Results: The mean Edinburgh Postnatal Depression Scale, Japanese version (EPDS-J) score in the last trimester of pregnancy was 9.274 (95% confidence interval [CI] 8.413-10.134), which was the highest throughout the study period. The mean EPDS-J score was lowest at 3-5 months postpartum, with a score of 7.682 (95% CI 6.816-8.547). At all time points, occupational stress and partner relationships were associated with EPDS-J scores.

Conclusions: Reducing paternal perinatal depression requires controlling for occupational stress and maintaining good marital relationships. The findings suggest that addressing work-life balance is crucial for Japanese fathers to enhance their whole-family well-being.

Keywords: fathers, marital relationship, occupational stress, perinatal depression

Introduction

Japanese society is now transitioning from a traditional division of roles, with fathers supporting the family economically and mothers doing housework and raising children, to fathers becoming more involved in parenting. Japan has amended the "Act on Childcare Leave, Caregiver Leave, and Other Measures for the Welfare of Workers Caring for Children or Other Family Members" and launched the *Ikumen Project* to eliminate traditional gender role divisions to promote the idea of parents sharing childcare responsibilities (Japan Ministry of Health, Labour and Welfare, 2020; Tatsumi, 2022). These efforts have been underpinned by the idea that increasing fathers' role in parenting could reduce the childcare burden borne by mothers, improve mothers' mental well-being, and create the best possible childcare environment. However, while the active involvement of fathers in parenting has helped stabilize mothers' mental health (Ikeda & Saeki, 2018), it is now being addressed that fathers, in a supportive position, also suffer from depression (Nishimura et al., 2015; Nishimura & Ohashi, 2010; Suto et al., 2016;

Takehara et al., 2017, 2020). However, screening and intervention for paternal depression have been insufficient (Kido et al., 2022), although screening and intervention for maternal depression have been conducted by municipalities and medical facilities since the 2000s (Suzumiya et al., 2008).

It is common for fathers to be involved proactively in childcare. However, similar to working women, working men have a greater childcare burden, which negatively affects their health (Glasser & Lerner-Geva, 2019). In particular, in the period between their partner's pregnancy and the year after birth, men struggle to reconcile their personal and work needs with the demands of their new families (Genesoni & Tallandini, 2009). Consequently, fathers might experience depression during the perinatal period. This depression in fathers is referred to as paternal depression. Chen et al (2023) conducted a conceptual analysis of paternal perinatal depression and defined it as depression in fathers whose partner is pregnant or in the first year postpartum, lasting at least two weeks and including 'masked' symptoms such as emotional symptoms, physical symptoms, negative parenting behavior, risk-taking behavior, substance abuse, irritability and emotional rigidity.

Currently, men face a struggle to balance work and raise children in Japan. This can cause stress, hamper mental health, and increase the risk of depression among fathers. Several studies have examined the effects of paternal perinatal depression on children's subsequent development and mental health (Fletcher et al., 2011; Ip et al., 2018; Pietikäinen et al., 2020; Tichovolsky et al., 2018). Although the prevalence of paternal perinatal depression is lower than maternal depression rates, a focus on fathers' mental health during the perinatal period is crucial not only for their spouses and children, but also because of the negative impact on the fathers themselves (Chen et al., 2023). For example, the effect of paternal depression on fathers themselves includes loss of working and short-term memory (Pio de Almeida et al., 2012) and an impact on their ability to perform tasks at their place of work (Melrose, 2010).

Perinatal paternal depression is the tendency of fathers to show depressive symptoms during their partner's pregnancy and postpartum period, with a reported worldwide prevalence of 8.4 % (95% confidence interval, 7.2–9.6 %)(Cameron et al., 2016). In Japan, the prevalence of prenatal depression in fathers is 8.5%;the prevalence of postpartum depression in fathers is 9.7% in the first month after delivery, 8.6% in the first-3 months after delivery, 13.2% in the 3-6 months after delivery, and 8.2% in the 6-12 months after delivery (Tokumitsu et al., 2020). This meta-analysis analyzed articles published from 2006-2017, with no reports from the last five years; the included longitudinal studies are from a limited region and there are no recent reports from the last five years. The symptoms of depression specific to men include alcohol and drug misuse, risk-taking, and decreased impulse control (Hyde & Mezulis, 2020). There are no reported symptoms of perinatal paternal depression specific to male depression (Kido et al., 2022). The Gotland Male Depression Scale was developed; however, its ability to detect perinatal depression is questionable (Carlberg et al., 2018).Therefore, the EPDS is often used to examine fathers' risk of perinatal depression (Shafian et al., 2022).

Perinatal paternal depression is related to perinatal paternal depression and includes a history of psychiatric illnesses (Matthey et al., 2003; Skari, 2002; Zelkowitz & Milet, 2001). Furthermore, relationships with partners have been identified as an important risk factor for perinatal paternal depression(Chhabra et al., 2020; Gawlik et al., 2014). In addition, we hypothesized that work stress might be related to perinatal paternal depression in Japanese fathers because of their history of a strong belief in the role of men in working hard after having a child and supporting the family financially. However, there are no studies that have found an association with work stress as a factor related to perinatal paternal depression. In summary, the results of previous studies indicate that perinatal paternal depression is an important adverse occurrence that negatively affects fathers, as well as their children and mothers. However, updated data are needed to determine at what point and how support should be provided to fathers.

This study aimed to examine changes in paternal perinatal depression from the last trimester of pregnancy to one year after childbirth. To do this, we monitored paternal perinatal depression from before childbirth (the final trimester of pregnancy or gestational age of 32–40 weeks) to one year after childbirth. The goal was to determine when mental health declines, and whether work stress and relationships with partners affect mental health.

Materials and Methods

Study design

This longitudinal study with a predictive design aimed to examine changes in paternal perinatal

depression from the last trimester of pregnancy to one year postpartum and to identify its predictors from the last trimester of pregnancy to one year postpartum. In the present study, paternal perinatal depression was repeatedly examined five times, starting in the last trimester of pregnancy and continuing for one year postpartum.

Operational definition

Paternal perinatal depression was defined as depression in fathers when their partner is pregnant or in the first year postpartum, lasting at least two weeks and including 'masked' symptoms such as emotional symptoms, physical symptoms, negative parenting behavior, risk-taking behavior, substance abuse, irritability and emotional rigidity (Chen et al., 2023).

This study was initiated before this definition was presented. In this study, we did not strictly follow the definition proposed by Chen et al. (2023). In this study, paternal perinatal depression was defined as a state of deteriorating mental health in the father from his partner's pregnancy to one year postpartum. No specific scale has been dedicated to measuring paternal perinatal depression. Therefore, the Edinburgh Postnatal Depression Scale (EPDS), a scale measuring maternal postpartum depression, was used in the present study to measure paternal perinatal depression. The EPDS was developed to screen for maternal depression, but it is also a reliable measure for detecting paternal depression (Rigmor Cet al., 2022). Furthermore, referring to previous studies (Nishigori et al., 2020; Nishimura et al., 2015; Nishimura & Ohashi, 2010), the present study hypothesized that paternal perinatal depression is also associated with work stress and relationships with partners.

Participants and data collection

Data were collected by conducting a nationwide web-based survey via Macromill, a marketing research company with monitors across Japan. The target population comprised men whose partners were pregnant and registered as macromill monitors. Participants were informed that participation was voluntary, that the survey would be anonymous, and that it would take approximately 15 minutes to complete the survey. They were asked to complete a web-based survey if they agreed to its purpose. Furthermore, they explained that by answering the questionnaire, they would receive points that could be used for online shopping. Foreigners residing in Japan were excluded because they might not have been able to fully understand the questions owing to their language ability. As this was a longitudinal study, the survey was conducted five times: at the gestational age of 32–40 weeks, 0–2 months after birth, 3–5 months after birth, 6–9 months after birth, and 10–13 months after birth. These surveys were conducted between June 2019 and August 2020.

Sample size

In 2019, there were 864,000 births in Japan in 2019 (Japan Ministry of Health, Labour and Welfare,2019). Based on these births, to have an accuracy of 5% and a confidence rate of 95% for the number of births per year, it was necessary to have at least 384 cases for each study period (five times: at a gestational age of 32–40 weeks, 0–2 months after birth, 3–5 months after birth, 6–9 months after birth, and 10–13 months after birth). However, the number of dropouts increased after the third survey, resulting in fewer than 384 dropouts.

Measurement of perinatal depression

There is no appropriate tool for assessing depression in men with a perinatal partner. The Japanese version of the Edinburgh Postnatal Depression Scale (EPDS-J) is used to assess maternal depression during the postpartum period (Kubota et al., 2014) and pregnancy period (Usuda et al., 2017); and has also been administered to fathers (Nishimura et al., 2015; Suto et al., 2016; Takehara et al., 2017). Therefore, we used the EPDS-J to assess paternal perinatal depression in this study. The EPDS-J consists of 10 items, each rated on a 4-point Likert scale ranging from 0 to 3. The maximum score on the scale was 30. The cut-off score for fathers varied among the studies. Three studies suggested a cutoff score of 13 points (Ballard et al., 1994; Lane et al., 1997; Pio de Almeida et al., 2012), two suggested eight points (Nishigori et al., 2020; Nishimura et al.2015), while one study each suggested 10 (Da Costa et al., 2019),11 (Dudley et al., 2001), and 12 points (Clavenna et al., 2017). The cut-off values for using the EPDS for fathers have not been determined, and researchers have used different cut-off values. We decided to calculate prevalence rates using cutoff scores from 8 to 13, which have been reported so far.

Factors related to paternal perinatal depression

The sociodemographic characteristics and other factors related to postpartum depression among fathers identified in previous studies were as follows: whether it was the first child, whether it was an unexpected

Tabel 1 Basic attributes of the fathers (during pregnancy of their partners through one year after birth)

The final trimester	Pre birth	After birth (months)				longitudinal
parameter	N=494	0-2 N=385	3-5 N=352	6-9 N=300	10-13 N=224	study case N=201
Area						
Hokkaidō	21(4.3)	15(3.7)	15(4.3)	11(3.7)	7(3.1)	6(3.0)
Tōhoku	19(3.8)	16(3.9)	12(3.4)	12(4.0)	8(3.6)	4(2.0)
Kantō	179(36.2)	152(37.1)	131(37.2)	115(38.3)	84(37.5)	79(39.3)
Chūbu	91(18.4)	74(18.0)	65(18.5)	59(19.7)	45(20.1)	44(21.9)
Kinki	91(18.4)	75(18.3)	65(18.5)	53(17.7)	40(17.9)	34(16.9)
Chūgoku	24(4.9)	17(4.1)	12(3.4)	10(3.3)	10(4.5)	9(4.5)
Shikoku	17(3.4)	12(2.9)	10(2.8)	8(2.7)	5(2.2)	3(1.5)
Kyūshū	52(10.5)	49(12.0)	42(11.9)	32(10.7)	25(11.2)	22(10.9)
Age of father						
20 to 24 years	8(1.6)	3(0.8)	3(0.9)	2(0.7)	2(0.9)	1(0.5)
25 to 29	83(16.8)	58(15.1)	44(12.5)	34(11.3)	24(10.7)	31(15.4)
30 to 34	128(25.9)	98(25.5)	85(24.1)	75(25.0)	50(22.3)	55(27.4)
35 to 39	122(24.7)	98(25.5)	85(24.1)	68(22.7)	53(23.7)	49(24.4)
40 to 44	90(18.2)	83(21.6)	87(24.7)	79(26.3)	60(26.8)	42(20.9)
45 to 49	63(12.8)	43(11.2)	41(11.6)	34(11.3)	29(12.9)	23(11.4)
50 to 54	0(0.0)	2(0.5)	7(2.0)	8(2.7)	6(2.7)	0(0.0)
Family structure	428(86.6)	332(86.2)	287(81.5)	238(79.3)	190(84.8)	173(86.1)
Nuclear families(lives with his wife and child(ren))	57(11.5)	47(12.2)	36(10.2)	36(12.0)	25(11.2)	24(11.9)
Extended families(with his/her parents and others)	9(1.8)	4(1.0)	6(1.7)	7(2.3)	9(4.0)	3(1.5)
Alone(lives away from his wife and(or) child(ren))	0(0.0)	2(0.5)	23(6.5)	19(6.3)	0(0.0)	1(0.5)
No answer	428(86.6)	332(86.2)	287(81.5)	238(79.3)	190(84.8)	173(86.1)
Income						
<2,000,000yen	6(1.2)	5(1.3)	4(1.1)	3(1.0)	3(1.3)	1(0.5)
2,000,000<4,000,000	57(11.5)	49(12.7)	44(12.5)	38(12.7)	34(15.2)	22(10.9)
4,000,000<6,000,000	110(22.3)	105(27.3)	77(21.9)	74(24.7)	58(25.9)	37(18.4)
6000000<8000000	94(19.0)	89(23.1)	71(20.2)	66(22.0)	47(21.0)	35(17.4)
8000000-10000000	47(9.5)	46(11.9)	33(9.4)	30(10.0)	26(11.6)	22(10.9)
>10000000	57(11.5)	65(16.9)	54(15.3)	49(16.3)	40(17.9)	22(10.9)
No answer	123(25.0)	26(6.8)	69(19.6)	40(13.3)	16(7.1)	62(30.8)
Birth experience /Number of children						
First time baby	236(47.8)	181(47.0)	166(47.2)	145(48.3)	113(50.4)	101(50.2)
Second and more	258(52.2)	204(53.0)	186(52.8)	155(51.7)	111(49.6)	100(49.8)
Marriage						
Yes	481(97.4)	374(97.1)	322(91.5)	271(90.3)	212(94.6)	199(99.0)
No	13(2.6)	11(2.9)	7(2.0)	11(3.7)	12(5.3)	2(1.0)
No answer	0(0.0)	0(0.0)	23(6.5)	18(6.0)	0(0.0)	0(0.0)
Live together with partner(and child)						
Yes	451(91.3)	369(95.8)	320(90.9)	271(90.3)	211(94.2)	184(91.5)
No	43(8.7)	16(4.2)	9(2.6)	11(3.7)	13(5.8)	17(8.5)
No answer	0(0.0)	0(0.0)	23(6.5)	18(6.0)	0(0.0)	0(0.0)
Unexpected pregnancy						
No	396(80.2)	308(80.0)	279(79.3)	235(78.3)	214(95.5)	157(78.1)
Yes	98(19.8)	77(20.0)	73(20.7)	65(21.7)	10(4.5)	44(21.9)
Children health						
Good	447(90.5)	369(90.0)	315(89.5)	265(88.3)	214(95.5)	176(87.6)
Poor	47(9.5)	16(3.9)	14(4.0)	17(5.7)	10(4.5)	25(12.4)
No answer	0(0.0)	0(0.0)	23(6.5)	18(6.0)	0(0.0)	0(0.0)
Family bereavement						
No	362(73.3)	291(75.6)	252(71.6)	219(73.0)	173(77.2)	141(70.1)
Yes	132(26.7)	94(24.4)	77(21.9)	63(21.0)	51(22.8)	60(29.9)
No answer	0(0.0)	0(0.0)	23(6.5)	18(6.0)	0(0.0)	0(0.0)
History of mental health problems(himself)						
No	427(86.4)	340(88.3)	291(82.7)	248(82.7)	202(90.2)	176(87.6)
Yes	67(13.6)	45(11.7)	38(10.8)	34(11.3)	22(9.8)	25(12.4)
No answer	0(0.0)	0(0.0)	23(6.5)	18(6.0)	0(0.0)	0(0.0)
History of mental helath problems(partner)						
No	444(89.9)	350(90.9)	300(85.2)	252(84.0)	206(92.0)	185(92.0)
Yes	50(10.1)	35(9.1)	29(8.2)	30(10.0)	18(8.0)	16(8.0)
No answer	0(0.0)	0(0.0)	23(6.5)	18(6.0)	0(0.0)	0(0.0)
Anxiety about economic status(subjective)						
No	188(38.1)	256(66.5)	206(58.5)	185(61.7)	79(35.3)	75(37.3)
Yes	306(61.9)	129(33.5)	123(34.9)	97(32.3)	145(64.7)	126(62.7)
No answer	0(0.0)	0(0.0)	23(6.5)	18(6.0)	0(0.0)	0(0.0)

Note. *32-40 weeks of pregnancy
Note. **A total of 201 cases could be followed through the final trimester of pregnancy until one year postpartum.

pregnancy, whether one lived with their partner, whether one had experienced the death of a family member, whether one was anxious about one's economic condition, the mental health history of the father, the mental health history of the partner, the family as a life event (e.g., death in the family member), and the health status of the child (Nishigori et al., 2020;

Tabel 2 Changes in the prevalence of paternal perinatal depression during pregnancy through one year after birth-percentage by the EPDS-J cut-off level-

N=201*		EPDS≥8	EPDS≥9	EPDS≥10	EPDS≥11	EPDS≥12	EPDS≥13
*longitudinal study case		n (%)	n (%)	n (%)	n (%)	n (%)	n (%)
The final trimester (32-40 weeks of pregnancy)		108(53.7)	99(49.3)	91(45.3)	87(43.3)	77(38.3)	67(33.3)
	0-2	97(48.3)	87(43.3)	79(39.3)	70(34.8)	63(31.3)	54(26.9)
	3-5	60(29.9)	52(25.9)	81(40.3)	70(34.8)	59(29.4)	54(26.9)
After birth (months)	6-9	54(26.9)	52(25.9)	78(38.8)	71(35.3)	58(28.9)	65(32.3)
	10-13	45(22.4)	43(21.4)	79(39.3)	75(37.3)	66(32.8)	59(29.4)

Nishimura et al., 2015; Kido et al., 2020). All these items were used in this study.

The survey items for marital relationships (6 items) and work stress (11 items), which have been reported to be related to men's mental health, were based on the Survey on the Current Status of Working Styles and Attitudes (Japan Ministry of Health, Labour and Welfare, 2015). The survey can be used for research purposes without permission. The items for work stress were about "heavy responsibility" "having no one talking with me at workplace" "working long hours" "not fit for the job" "difficulty responding to informatization and technological innovation" "anxiety of the company's future" "anxiety of being fired/going bankrupt" "too many expectations on work performance" "heavy workload" "Uncomfortable working environment" "distressing relationships at work place." The items were rated on a 4-point Likert scale, with 3 denoting "strongly," 2 = "slightly," 1 = "not so much, " and 0 = "not at all." The total score ranged from 0 to 30, with higher scores indicating higher stress at work.

The items for marital relationship were about "my wife (partner) can count on me," "my wife (partner) understands me," "I have enough time for my wife (partner)," "I often talk to my wife," "my wife (partner) respects my hobbies and behavior," and "I try to be good at housework and parenting." The items were rated on a 4-point Likert scale, with 3 denoting "strongly agree," 2 denoting "slightly agree," 1 denoting "slightly disagree," and 0 denoting "strongly disagree." The total score ranges from 0 to 24, with higher scores indicating better marital relationships.

The items for work stress and satisfaction were about "having heavy responsibilities," "having no one to talk to at the workplace," "working long hours," "not being fit for the job," "having difficulty adapting to informatization and technological innovations," "being anxious about the company's future," "being anxious about getting fired or going bankrupt," "experiencing extreme stress regarding work performance," "having a heavy workload," "having an uncomfortable working environment," and "having distressing relationships at the workplace." All items were rated on a 4-point Likert scale ranging from "completely disagree" to "completely agree."

Data analysis

The 201 cases used for analysis in the longitudinal study had complete data, excluding missing data. First, we calculated descriptive statistics. We then performed repeated one-way analysis of variance to investigate changes in the EPDS-J scores from the last trimester of pregnancy to one year after childbirth. Multiple comparisons were performed when the changes were statistically significant. Next, we calculated the prevalence of paternal perinatal depression using different cutoff scores of the EPDS-J. Finally, we performed general linear and multiple regression analyses to determine the factors predicting paternal perinatal depression. All statistical analyses were performed using IBM SPSS Statistics version 28.0. Statistical significance was set at $p < 0.05$.

Ethical considerations

The rationale, aims, and methods of the study were explained to all the participants through the Macromill webpage. Participants were also informed that there would be no negative consequences if they refused to

Tabel 3 Multiple regression analysis of paternal perinatal depression (EPDS-J) and the sociodemographics of participants - 201 cases followed during the final trimester of pregnancy through one year postpartum-

		A	B	C	D	E	F	G	H	I	J
		First time:1 Second or more:0		Yes:1 No:0	Yes:1 No:0	Yes:1 No:0	Poor:1 Good: 0	Yes:1 No:0	Poor:1 Good:0	Poor:1 Good:0	Yes:1 No:0
The final trimester**		-0.244*	-0.047	0.060	-0.283*	0.021	-0.053	0.159*	0.107	-0.003	0.107
After birth (months)	0-2	-0.151*	0.015	0.055	-0.281*	0.033	-0.040	0.121	-0.015	0.112	0.150*
	3-5	-0.070	0.090	0.059	0.071	0.085	0.005	0.002	0.081	-0.014	0.075
	6-9	-0.182*	0.093	0.101	-0.195*	0.044	-0.107	0.193*	-0.024	0.150	0.061
	10-13	-0.174*	-0.028	0.053	-0.257*	0.052	-0.032	0.136	0.035	0.067	0.049

Note. All numbers in the table indicate the standardized partial regression coefficient. B: standardized partial regression coefficient *<0.05;**32-40 weeks of pregnancy; Variables; A: birth experience; B: age; C: marriage; D: living together with partner; E: unexpected pregnancy; F: children's health; G: family bereavement; H: history of mental health problems (himself); I: history of mental health problems (partner); J: anxiety about economic status (subjective).

Tabel 4 Linear regression analysis between Paternal perinatal depression and work stress and marital relationship-201 cases followed during the final trimester of pregnancy through one year postpartum

	N=201	Occupational stress	Marital relationship
		Standardized partial regression coefficient (B)	
The final trimester (32-40 weeks of pregnancy)		0.483*	-0.254*
	0-2	0.435*	-0.332*
	3-5	0.421*	-0.263*
After birth (months)	6-9	0.465*	-0.332*
	10-13	0.429*	-0.295*

Note. Dependent variable: Edinburgh Postnatal Depression Scale (EPDS); independent variable:work stress, marital relationship * p <0.05

participate in the survey. Consent was then obtained, and the survey was administered. The survey was completed anonymously. This study was approved by the ethics committee of Kagawa Prefectural University of Health Sciences (approval number 279, Approval Date: July 8, 2019).

Results

Characteristics of the participants

Table 1 present the characteristics of the participants. The largest number of participants were from the Kanto area, followed by the Chubu and Kinki areas. There were only a few participants from the Shikoku, Tohoku, and Hokkaido areas. Most participants were in their 30s and had a nuclear family. The number of participants having their first child at the time was approximately the same as the number of participants having their second or more babies. Most participants were married and lived with their partners.

Changes in paternal perinatal depression from the final trimester of pregnancy to one year after childbirth

Table 2 presents the results of analyzing changes in the prevalence of perinatal depression in fathers from the last trimester of pregnancy to one year after birth using different cut-off scores on the EPDS-J. Changes in the mean values of paternal perinatal depression (EPDS-J) over a one-year period are shown in Figure 1. The mean scores for the five survey periods differed significantly ($F = 6.253$, $p < 0.001$). Bonferroni's multiple comparison test showed significant differences in the mean scores in the last trimester of pregnancy, 0–2 months postpartum, and 3–5 months postpartum. The mean score on the EPDS-J was 9.274 (95% CI = 8.413–10.134) during the final trimester of pregnancy. The mean score was the highest among all survey periods. The lowest mean score was 7.682 (95% CI] = 6.816–8.547) at 3–5 months postpartum. After this, The mean score was 8.284 (95% CI] = 7.355–9.212) at 6–9 months after birth. At 10–13 months postpartum, the mean score increased to 8.373 (95% CI] = 7.473–9.273) and remained unchanged.

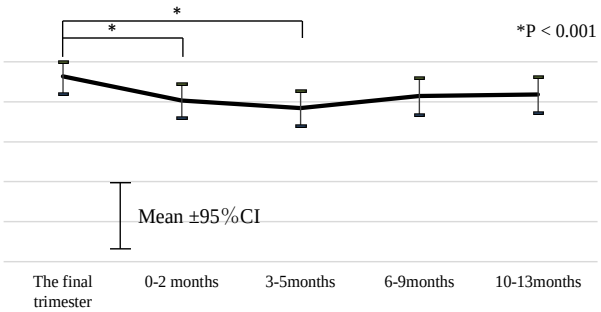

Figure 1. Changes in paternal perinatal depression measured by EPDS-J

Multiple regression analysis of EPDS-J scores and participants' sociodemographic characteristics

Multiple regression analysis was conducted with EPDS-J scores in the five survey periods as dependent variables and participants' sociodemographic characteristics as independent variables. The results are presented in Table 3. Birth experience and whether one lived with their partner were significantly associated with EPDS-J scores at all time points, except for the score at 3–5 months postpartum. Family bereavement was significantly associated with EPDS-J scores in the last trimester of pregnancy and 6–9 months postpartum. Anxiety regarding economic status was significantly associated with the EPDS-J score at 0–2 months after birth.

Linear regression analyses of EPDS-J scores, work stress, marital relationship

We conducted a linear regression analysis with EPDS-J scores as dependent variables, and all items of work stress were independent variables. The results showed significant correlations in all survey periods (Table 4). Then, a linear regression analysis was performed with EPDS-J scores as the dependent variable and all items measuring marital relationships as the independent variable. A significant correlation was found for all survey periods (Table 4).

Discussions

Changes in paternal perinatal depression scores among fathers from the last trimester of pregnancy to one year postpartum

The EPDS-J scores of fathers in Japan were highest in the last trimester of pregnancy and lowest at 3–5 months postpartum. According to a meta-analysis conducted by Paulson and Bazemore (2010), the prevalence of depression among fathers was 11% in the first and second trimesters of pregnancy, 12% in the third trimester, 7.7% in the first three months after childbirth, 25.6% (and the highest) in the first three–six months postpartum, 9% in the first six–twelve months postpartum, and 10.4% from gestation to one year postpartum. Our results were quite different from those of Paulson and Bazemore (2010), but their meta-analysis was more than a decade old and was possibly affected by different social conditions today. Moreover, it examined paternal depression in Western countries but did not include Japanese cases. Suto et al. (2016) conducted a survey in Japan and found that 17% of fathers exhibited depressive symptoms at three months postpartum, but our results showed a higher prevalence of depression. The reason for this discrepancy could be that we conducted an online nationwide survey and the participants may have made exaggerated declarations. Nonetheless, it is important to identify other reasons for the highest prevalence of paternal depression in the third trimester of pregnancy. In this study, fathers were most depressed in the last trimester of pregnancy and the first year after childbirth. The characteristics associated with EPDS-J scores in the last trimester of pregnancy were whether it was the first child, whether the father lived with their partner, and whether the father had experienced the death of a family member. Work stress and relationship with the partner were also related to the EPDS-J scores. Although the number of children did not increase physically because of gestational stage, fathers may have experienced an emotional burden. Overlapping emotional burdens such as work stress and family misfortune can exacerbate mental health problems. Furthermore, the findings of the present study show that fathers' mental health changed during their partner's last trimester of pregnancy and in the first year postpartum. Mental health levels were the lowest in the last trimester of pregnancy and recovered thereafter. However, they did not recover dramatically and remained stable. Paternal mental health status possibly suffered the most in the last trimester of pregnancy due to expectations anxiety about the increased burden of raising a child. Although the situation has somewhat recovered, the level of the situation has remained unchanged. This may be partly related to the constant exposure to work stress that fathers continue to experience throughout their child-rearing phase. However, there is no conclusive data to support these findings, and further studies are required.

Factors influencing fathers' scores on the Paternal perinatal depression

A large Italian study reported that an EPDS-J cutoff score of 12 or higher increases the risk of maternal perinatal depression to 6.4% during pregnancy and 19.9% postpartum (Cena et al., 2021). Economic status was also found to be associated with depression during pregnancy and the postpartum period (Cena et al., 2021). The incidence of depression in mothers is higher during the postpartum period than during the gestational period. This result differs from our findings, which show that the incidence of depression in fathers is higher during the gestational period and lower during the postpartum period. Fathers' mental health during the parenting period may be affected by work stress and their relationship with their partner, which may differ from the background of mothers' depression. In this study, work stress was identified as a risk factor for depression among fathers. Similarly observed for mothers, a German study showed that precarious working conditions and psychosocial work stress increase the risk of perinatal depression (Karl et al., 2020). We also found that marital relationships were associated with depression in fathers. When couples have poor relationships, they are unable to work collaboratively to raise their children (Schoppe-Sullivan et al., 2007; Van Egeren, 2004). This may cause stress and negatively impact mental health, although there is insufficient evidence. Regarding marital relationships, studies have shown an association between marital satisfaction and depression among fathers during childrearing (Wang et al., 2021). Similar results have been obtained in a previous study. Japanese society is currently experiencing a very low fertility rate, and it may be argued that having a good marital relationship not only maintains good mental health for both spouses, but also influences their hopes for the next pregnancy and childbirth. Mothers who have reported greater involvement and indirect care from their child's father have been found to be more likely to have another child from the same father and less likely to have another child from a different father. In other words, if the father is heavily involved in childcare, their partner is likely to be willing to have another child with them (Kotila & Kamp Dush, 2012). In contrast, if the father is not involved in childcare, their partner is likely to choose not to have another child with them. Therefore, it is necessary to emphasize the maintenance of a good

marital relationship, not only to improve mental health but also to combat declining birth rates.

Paternal perinatal depression and the risk of maltreatment

Our results revealed that father–infant bonding can be predicted using the EPDS-J. Paternal perinatal depression of fathers has been shown to be directly related to father–infant bonding (Wells & Jeon, 2023). Symptoms of postpartum blues in fathers are associated with impaired father–infant bonding (Baldy et al., 2023). Parent–child bonding promotes cognitive neurodevelopment in children (Winston & Chicot, 2016). Improving the mental health of fathers during the child-rearing period is extremely critical, as the formation of the father–child bond influences the child's development. The questionnaire we used to assess the father–child bond is a simple 10-item scale that Japanese healthcare institutions use to assess the risk of abuse. Thus, it can be inferred that fathers' mental health can predict the risk of abuse. Although the focus tends to be on the mother–child bond, it is necessary to examine the mental health of fathers to form a good father–child bond (Nakić Radoš, 2021).

The study design was longitudinal, and the changes in paternal perinatal depression and relevant factors were examined. However, this study has several limitations. First, the number of dropouts increased after the third study, and the number of cases was less than 384. Only 201 patients were included in the longitudinal study. It is difficult to obtain a sufficient sample size in longitudinal studies. Owing to the insufficient sample size required for this study, it is possible that it was difficult to obtain significant differences as an effect on the results, and we cannot generalize our results. Second, we did not examine the mothers' mental status; thus, we could not determine the impact of their partners. The next survey should be conducted with the fathers and mothers. Third, diagnostic interviews were not used to assess depression. The possibility of perinatal depression in fathers should be rigorously assessed. Nonetheless, there are no recent studies in Japan examining changes in fathers' mental health status during the one-year prenatal and postpartum periods, and the present study provides important data for supporting fathers during the perinatal period.

Conclusion

Measuring paternal perinatal depression, the mean score on the EPDS-J was the highest during the final trimester of pregnancy and the lowest at 3–5 months postpartum. Subsequently, it increased slightly in the first 6–9 months postpartum and remained unchanged at 10–13 months. Whether one lived with their partner and whether it was the first child was associated with EPDS-J scores in all survey periods, except for the scores at 3–5 months postpartum. Anxiety about economic status was associated with EPDS-J scores at 0–2 months after birth. Whether one had experienced The death of a family member was associated with EPDS-J scores in the last trimester of pregnancy and at 6–9 months after birth. Work stress and relationship with the partner were associated with EPDS-J scores in all survey periods. These results suggest that reducing paternal depression requires controlling for work stress and maintaining a good marital relationship. Screening mothers for maternal perinatal depression should include questions about the fathers' mental health status. Additionally, this study suggests that to reduce paternal perinatal depression, healthcare providers need to identify specific factors associated with paternal perinatal depression at each time point between the last trimester of the partner's pregnancy and the first year postpartum and provide individualized interventions for fathers.

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Author contribution statement

KK conceived the study and performed the statistical analysis. AM and YU supervised the study design and performed the statistical analyses. KK, AM, and YU contributed to writing the manuscript, and all authors read and approved the submitted version of the manuscript.

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Conflicts of Interest

We have no conflicts of interest to declare.

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