This study investigated the effects of the Japanese Early Promotion Program (JEPP), which is based on the Infant Mental Health (IMH) program. The JEPP aims to promote mother-infant interactions by enhancing the mother’s ability to respond appropriately her child. Mothers in the JEPP group (n = 15) received support from IMH nurses in a pediatric clinic until their infants reached 12 months of age. The nurses provided positive feedback that emphasized strength of parenting, and assisted the mothers in understanding the construct of their infants. Mother-infant interactions and mother’s mental health status were assessed at intake (1–3 months), and at 6, 9, and 12 months of infants’ age. The JEPP group data were compared with cross-sectional data of the control group (n = 120). Although JEPP dyads were not found to be significantly different from the control group in general dyadic synchrony, both before and after intervention, JEPP mothers significantly improved their ability to understand their infant’s cues and to respond promptly. In the JEPP group, unresponsiveness to infants was reduced in mothers, while infants showed reduced passiveness and enhanced responsiveness to the mother. Furthermore, the intervention reduced the mothers’ parenting stress and negative emotions, thereby enhancing their self-esteem.

Key Words: early intervention, Infant Mental Health, maternal sensitivity, mother-infant interaction, NCATS

Introduction

No infants are independent. They gradually learn about themselves via the actions of their mother. Infants and their caregivers have a close relationship. Mothers are absolutely indispensable to the growth of babies, and the mother-child dyad is the basic unit. The children of highly sensitive mothers, who observe their children carefully and are able to provide appropriate stimulation, are able to interact with the outside world through their mothers, and eventually follow a better developmental trajectory. In contrast, a mother with low sensitivity, who is not aware of the indicating need of the child, does not accurately interpret the child cue, or inappropriately respond to the child, causes severe stress on the mother and child relationship. Maternal stress is one of the main reasons for infant abuse, and there exists a strong causal relationship between feeling the difficulties of parenting and abuse. In Japan, many infant deaths due to abuse have been reported, and abuse has become a serious social issue. Childcare support aimed to prevent abuse is an emergent need. Because of such backgrounds, this study focused on the relationship and interaction of mother and child. We provided support to promote mothers’ correct understanding of infants’ feelings and needs as well as appropriate responses. The effect of this support program was measured.

Infant Mental Health (IMH)

The brain grows the fastest in the first three years of
a person’s life, and since cognition / emotions and social functions are all closely linked to the development, early experience in infancy is important. Early experiences play a crucial role in the cognitive development of children. Highly stressful experiences in interactions with the main caregiver, usually the mother, where the mother is poorly attuned to the child or does not return an appropriate response, influence cerebral plasticity, and trigger permanent changes in brain tissue. Studies to date have emphasized the importance of synchrony in the formation of attachment between the mother and infant in their interactions. The findings of recent studies suggest that the quality of early stage mother-infant relationships, especially the mother’s response to her child, influence the cognitive and behavioral outcomes of children. IMH, the basis of the intervention used in this study, places great importance on early mother-infant interactions and the parent-child relationship because these influence the growth and life of children. IMH is synonymous with healthy social and emotional development. “Infant” referred to children less than three years of age. “Mental” included social, emotional and cognitive domains. “Health” referred to the well-being of young children and families. The practice Infant Mental Health is an extraordinary approach to strengthening the development and well-being of infants and young children within secure and stable parent-child relationships. Aiming to build a good mother-infant relationship, early promotion programs are carried out widely, mainly in Europe and the U.S., and some achieve good results. Some representative programs include the European Early Promotion Project, a research project held in five European countries, the Family Partnership Model carried out mainly in London, and the Nurse Family Partnership Project held all over the U.S. Focusing on providing support to the mother-infant dyad, these projects provide enthusiastic childcare support to high-risk cases, as well as contribute to the prevention of child abuse. An IMH specialist describes that the provider (intervener) must pay attention to the emotions and behavior of the mother and infant, while focusing on the parent-child interaction. They emphasize support for mothers and support for the working alliance. It is important to reduce parental stress and induce a sense of optimism towards parenting, so that mothers are better able to understand their child’s responses, and in turn help their child achieve stable actions based on this understanding. In Japan, awareness of IMH is still poor among specialists (i.e., public health nurses, midwives, nurses, etc.). Despite the many opportunities to address early-stage mother-infant relationships, and there are very few specialists who are familiar with mother-infant relationships. For this reason, we believe that projects focusing on building the confidence and competence of mothers and acquiring more extensive knowledge and understanding of children are useful for parents and children at risk in Japan.

Measure of mother-infant interactions

Mother-infant interaction is a complicated concept composed of the behaviors of the mother and infant, and their relationship, and is thus not easy to assess. In this study, the Japanese version of the Nursing Child Assessment Teaching Scale (JNCATS) and the Child-Adult Relationship Experimental Index for infants (CARE-Index) were used. These two scales have different emphasis in the evaluation of interactions. The former focuses on the specific behaviors of dyads, while the latter prioritizes the relationship between mother and infant.

1) JNCATS

JNCATS is an assessment instrument used to quantify the quality of mother-infant interactions for children from birth to 36 months of age. JNCATS is the Japanese version of the NCATS, the original version of which was developed by Barnard. The scale has 4 subscales for the mother and 2 subscales for the infant. There are also subsets of contingency items. When contingent responses are positive, they tend to create adaptive behavioral patterns since they provide a mechanism by which the child begins to understand the relationship between behavior and environment. Barnard described adaptive parent-child interactions as a “dance.” Each member of the pair responds and reacts to the other, adapting their behavior to accommodate or modify the behavior of the other during the interaction. In Barnard’s working theory, both parent and child are assumed to play important roles or have responsibilities.

2) CARE-Index for infants

The Child-Adult Relationship Experimental Index (CARE-Index) was developed by Crittenden. The infant version can be used with children from birth to 15 months. It is a play-based system, designed to assess dyadic synchrony. Therefore it does not evaluate the attachment. In the CARE-Index, sensitive mother is any pattern of behavior that pleases the infant, increases the infant’s comfort and attentiveness, and reduces its distress and disengagement. Coding is conducted
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in two steps. First, the coder assesses the mother’s sensitivity to infant signals using three maternal scales (sensitivity, control, and unresponsiveness). Infants’ responses are coded along four scales (cooperation, compulsivity, difficulty, and passivity). Then, based on the evaluations, the coder assesses dyadic synchrony as a comprehensive index. Scoring of dyadic synchrony suggests different potential types of intervention (23, 24).

3) The mother’s parenting stress and emotions that affect mother-infant interactions

A survey on stress after childbirth and parenting revealed that mothers who feel especially burdened by parenting go through long periods of not being able to understand why their children are crying (25). According to the 2010 Ministry of Health, Labour and Welfare, for babies younger than one year old, the percentage of deaths by abuse increases as their ages in months decrease. The two most common motives for abuse are “Refusal/denial of the existence of the child” and “Feeling of irritation with the child who does not stop crying,” followed by “Experiencing the difficulties of parenting and parenting anxiety” (26). In addition, mothers who feel especially burdened by parenting tend to have negative feelings towards their children (27). Comparisons with other countries indicate that mothers in Japan spend longer hours on child-rearing (28) and have less positive feelings about parenting (29). In order to meet mothers’ needs for an environment where they can honestly express their feelings and talk about their lives, the “Healthy Parents and Children 21” is providing support in Japan, focusing on emotions (30). This study aimed to investigate the effects of early intervention for support in dyads with risk. Support was provided based on the IMH. The aims of the intervention included promoting: (a) the mother’s reading of and sensitivity to her child’s cues; (b) the child’s responsiveness; (c) the mother-infant relationship; (d) self-esteem of the mother; and, decreasing (e) the mother’s parenting stress and negative emotions. The following three hypotheses were consequently established:

H1. Mother-infant interactions in the JEPP group before undergoing the early intervention support program would have lower than the control group.
H2. After intervention, the mother’s score for contingency on the JNCATS and the score for dyadic synchrony on the CARE-Index would be improved in the JEPP group.
H3. Support based on IMH would reduce parenting stress and maternal depression, and would help mothers to maintaining the mother’s mental health and self-esteem.

Methods

Participants

The recruitment period was from July 2012 to February 2015. Dyads consisting of 1- to 3-month-old infants and their mothers, who visited a pediatric clinic in a suburban area of Japan and whom pediatrician deemed as requiring continued childcare support, were enrolled as the intervention group receiving JEPP support (JEPP group). The JEPP group included a total of 15 infants, 5 infants each group of 1, 2, and 3 months of age, consisting of 6 males and 9 females. The control group consisted of patients visiting the same clinic for vaccinations or health checkups. The control group consisted of 120 infants: 20 infants each group of 1, 2, and 3 months of age (the baseline of the JEPP group), and 20 infants each group at 6, 9, and 12 months of age, which were coincident with the time of outcome evaluation. As shown in Figure 1, our intervention data for the control group was cross-sectional, while that for the JEPP group is longitudinal. However, the assignment of subjects in this study was heterogeneous because high risk cases were included in the JEPP group, suggesting a quasi-experimental design. The dyads of both groups fulfill the following criteria: (a) Japanese nationality, (b) biological mother and infant, (c) no severe disease, (d) living together, and (e) consented to participate in the study.

Procedure

Dyads deemed as requiring continued childcare support by physicians were asked to visit us to be briefed about the purpose of the study, the need for intervention, and were provided with details of the study. We assigned dyads who consented to cooperate in the study as the JEPP group and started providing support. Taking the first interview as the baseline, outcomes were assessed when the children became at 6, 9, and 12 months of age, regardless of the time at which intervention support was started. For the assessment, playing situations of mother and child were recorded (3 to 5 minutes per encounter). In addition, mothers were asked to fill out self-report questionnaires that included
items such as parenting stress, depressive tendencies, self-esteem, mental health, and development of children. The recorded data was coded by two researchers, each whom had reliability license. These coders were blind to the participants’ personal data and group assignment.

**Intervention**

The interveners were members of a team that included nurses with expertise and clinical experience of IMH, public health nurses, clinical psychotherapists, and specialists from Europe and the U.S., the latter of whom participated as advisors or coder.

JEPP-dyad interventions took place in a counseling room in the clinic. The room ensured the privacy of the subjects, and the interior resembled a living room so that the dyads could relax. Breast-feeding and eating were permitted in the room. Toys were also made available, suitable for each age group. Thereafter, the same intervener (an IMH nurse) continued to provide support. Each session lasted 60 to 90 minutes, generally in the presence of the dyadic pair. If a mother felt insecure, counseling was carried out only for the mother. In each session, efforts were made to build and foster a good relationship with the mother based on the partnership model14, 15, 31. During conversation with mothers, interveners avoided judgmental or intrusive expressions to respect the mother. The timing was decided according to the dyadic needs. To enable JEPP mothers to contact interveners easily, a special support e-mail address was provided.

**Variables and Measures**

It should be noted that reliability and validity have been established in the scales used in this study: the Nursing Child Assessment Teaching Scale (JNCATS), Child-Adult Relationship Experimental Index for Infants (CARE-Index), Japanese Parenting Stress Index (JPSI), Subjective Well-Being (SUBI), Center for Epidemiologic Studies Depression Scale (CES-D), and the Rosenberg’s Self-Esteem Scale (RSES).

1) **Demographic data**

Before each pre-intervention assessment, we obtained from the mother the (a) maternal age, (b) maternal educational background, (c) structure of the family, (d) annual family income, (e) infant’s birth weight, (f) infant’s gender, and (g) development of children. In addition, we measured the child’s weight in every session through the pre-post intervention.

2) **Mother-infant interaction**

(i) **JNCATS**

The JNCATS scale has 4 subscales for the mother: Sensitivity to Cues (maximal score: 11), Response to Child Distress (11), Social Emotional Growth Fostering (11), and Cognitive-Growth Fostering (17). There are 2
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subscales for the infant: Clarity of Cues (10) and Responsiveness to Caregiver (13). Each item is scored as yes (1) or no (0), and the maximum possible score is 73. Higher JNCATS scores indicate better mother-infant interactions. There are also subsets of contingency items for the mother (20) and the infant (12). This coding generated more than 90.0% inter-rater reliability on a randomly selected 20% of the videos.

(2) CARE-Index for infants

We prepared toys, which are different from the JNCATS kit. The mother was asked to “play with your baby as you would usually do” and the interaction was videotaped for approximately three minutes. The coder was an instructor for Care-Index for infants. This coding generated more than 90.0% inter-rater reliability on a randomly selected 20% of the videos. The coder scored synchrony (maximal score: 14), the three maternal subscales (sensitive, control, unresponsive; 14), and the four infant scales (cooperation, compulsive, difficult, and passive; 14).

3) Parenting stress

Parenting stress was measured with the Japanese Parenting Stress Index (JPSI), whose reliability and validity have already been verified. The JPSI is a parent self-report questionnaire, which includes 78 items, each of which is rated on a 5-point Likert scale. Scores from the child domain indicate the degree of parental stress caused by characteristics of the child. The scores from the parent domain indicate the degree to which the parent’s stress is due to the parent’s own characteristics. Higher scores indicate higher levels of parenting stress.

4) Subjective well-being

Using the Japanese version of Subjective well-being (SUBI) developed by the World Health Organization (WHO), we measured the subjective well-being of mothers. The SUBI is a self-report questionnaire of 40 items that assesses mental health state. Subjective well-being is analyzed according to two scales: positive feelings (19 questions) and negative feelings (21 questions). The cutoff scores were 31 points for positive feelings and 43 for negative feelings. Lower score indicate lower levels of subjective well-being. There exists no balanced correlation in mental health whereby positive emotions weaken as negative emotions become stronger and vice versa.

5) Maternal depressive symptoms

The Japanese version of the Center for Epidemiologic Studies Depression Scale (CES-D) was used to measure parental depressive symptoms. The CES-D is 20-item self-report scale for depression screening. Scores on the CES-D range from 0 to 60; a higher score indicates more evidence of depression. The cutoff score is 16; it is assumed that a person who scores 16 points or more is depressed.

6) Maternal self-esteem

In this study self-esteem included the mother’s sense of her own worth and her parenting ability. Self-esteem was measured via a version of Rosenberg’s Self-Esteem Scale; RSES that has been translated into Japanese and revised. The scale, which has proven reliability and validity, consists of 10 items, each of which is rated on a 5-point Likert scale. Mothers’ negative feelings toward themselves are associated with lower maternal responsiveness to their babies.

Statistical Analysis

Basic attribute data consisted of maternal age, maternal educational background, child’s birth weight and gender, and birth order, structure of family, and family income. Statistical differences from the control group were analyzed by chi-square tests for structure of family, family income, birth order, and child’s gender, and by independent t-tests for maternal age, maternal educational background, and child’s birth weight. JNCATS and CARE-Index scores were used as mother-infant interaction indices, while PSI, CES-D, SUBI, and RSES scores were used to analyze maternal mental health state. For the pre-intervention assessment, 60 infants between 1–3 months of age were set as the control groups for comparison with the 15 JEPP infants (1–3 months of age). Inter-group differences were analyzed via independent groups t-tests. For the post-intervention assessment, three age groups (6, 9, and 12 months), each consisting of 20 infants, were set as the control groups corresponding to the assessment time of the JEPP infants. Intervention effects could not be compared between the two groups since JEPP data were longitudinal and control data were cross-sectional. Indices relative to normal mother-child states were calculated by subtracting the JEPP score from the mean score of the control for each age group. The relative scores were compared before and after the intervention using paired t-tests to assess the intervention effects. Statistical analyses were carried out using IBM SPSS (22.0 J) software for Windows.
Ethical Considerations
The study protocol was approved by the ethics committee of Tokyo Medical and Dental University (receipt No: 1121, date of approval: 2012.6.21). Written informed consent was obtained from all enrolled parents when a principal investigator started data collection and intervention. Before the parents gave informed consent, they were informed orally and in written form about the study, including the study content, privacy protection, and the freedom to withdraw from the study.

Results
Attributes and number of interventions
Table 1 summarizes the demographic data for JEPP and control groups. Inter-group differences were insignificant for all attributes, including maternal age, education, family income, and child’s birth weight. Many of the factors for which physicians deemed childcare support necessary are related to the mother, such as parenting concerns and parenting stress felt by the mother. Factors related to the child include poor weight gain.

<table>
<thead>
<tr>
<th>Table 1. Summary of Demographic Data</th>
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<th>Table 2. Timing of Intervention to JEPP</th>
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| Note. | Values are based on data collected at the first assessment (1-3 months old for JEPP group and 1-12 months old for Control group). ns = not statistically significant (p > .05) |
| Mean and SD. | t test. | n and percentage. | Chi-square test. | Most frequent income class. |
The number of times support was received by the parent-child dyad in the JEPP group between the start of support and when the child was 12 months old was 11.3 on average (SD: 5.64), and varied according to the case, ranging from a minimum of 4 times to a maximum of 27 times. Intervals gradually increased as the mother’s worries decreased, with the child’s growth and increased weight (Table 2).

### Intervention effects on mother-infant interactions assessed via two scales

Table 3 includes the scores of the JEPP group for each index at each assessed point in time, the mean score of each age group of the control group, and standard deviations. On the JNCATS, the maternal subscale scores were 8.27 for Sensitivity to Cues, 10.13 for Response to Child Distress, 8.33 for Social Emotional Growth Fostering, 11.67 for Cognitive-Growth Fostering, 14.13 for Contingency, and 38.40 for Mother Total in the pre-intervention JEPP group (1–3 months). Compared to the mean score of the appropriate control age group (1–3 months), the maternal scores for Sensitivity to Cues, Social Emotional Growth Fostering, and Contingency, and the child’s scores for Response to Caregiver were significantly lower than the control. Similarly, the Mother/Infant Total (52.13) was also low (p < .05). The mean JNCATS scores of the post-intervention JEPP group at 12 months of age were 10.07 for Sensitivity to Cues, 9.60 for Social Emotional Growth Fostering, 11.67 for Cognitive-Growth Fostering, 14.13 for Contingency, and 38.40 for Mother Total.

#### Table 3. Mean Scores of Dependent Variables

<table>
<thead>
<tr>
<th>JNCATS Subscale</th>
<th>JEPP group (N = 15)</th>
<th>Test of intervention effect</th>
<th>Control group (N = 120)</th>
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<tbody>
<tr>
<td></td>
<td>Pre (1-3m)</td>
<td>6m</td>
<td>9m</td>
</tr>
<tr>
<td><strong>Mother</strong></td>
<td></td>
<td></td>
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<tr>
<td>Sensitivity to Cues</td>
<td>8.27 (0.96)</td>
<td>9.40 (1.06)</td>
<td>9.53 (0.74)</td>
</tr>
<tr>
<td>Response to Child Distress</td>
<td>10.13 (0.83)</td>
<td>9.67 (0.98)</td>
<td>9.67 (0.82)</td>
</tr>
<tr>
<td>Social Emotional Growth Fostering</td>
<td>8.33 (0.82)</td>
<td>8.60 (0.74)</td>
<td>8.67 (0.98)</td>
</tr>
<tr>
<td>Cognitive-Growth Fostering</td>
<td>11.67 (1.63)</td>
<td>12.40 (1.24)</td>
<td>11.87 (1.68)</td>
</tr>
<tr>
<td>Contingency</td>
<td>14.13 (2.85)</td>
<td>16.13 (1.55)</td>
<td>16.93 (1.13)</td>
</tr>
<tr>
<td><strong>Infant</strong></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Clarity of Cues</td>
<td>6.40 (1.68)</td>
<td>7.93 (0.96)</td>
<td>8.13 (1.19)</td>
</tr>
<tr>
<td>Response to Caregiver</td>
<td>7.33 (1.95)</td>
<td>8.20 (1.30)</td>
<td>9.13 (1.73)</td>
</tr>
<tr>
<td>Mother Total</td>
<td>38.40 (2.95)</td>
<td>40.07 (2.25)</td>
<td>39.73 (2.49)</td>
</tr>
<tr>
<td>Infant Total</td>
<td>13.73 (3.35)</td>
<td>16.13 (2.61)</td>
<td>17.27 (2.58)</td>
</tr>
<tr>
<td>Total JNCATS Scores</td>
<td>52.13 (5.34)</td>
<td>56.20 (3.45)</td>
<td>57.13 (3.52)</td>
</tr>
</tbody>
</table>

**Note.** Standard deviations are in parentheses.

- Test of intervention effect
- **p**<.05
- Effect size: \( r \) was calculated by the square of root of \( t^2 \) divided by \( (t^2 + df) \) (degrees of freedom).
for Response to Child Distress, 8.73 for Social Emotional Growth Fostering, 12.93 for Cognitive-Growth Fostering, 16.60 for Contingency, and 41.33 for Mother Total. The score for Response to Child Distress suggests a reduced frequency of mothers calming down their children as the children grow. The scores of the JEPP group decreased with infant age, a tendency shared with the JNCATS19. Although all scores showed a sharp improvement as compared with pre-intervention, these increases cannot be completely attributed to intervention effects because differences were observed even control groups. We therefore compared the pre-intervention scores with scores at 12 months, using adjusted relative scores calculated by subtracting the JEPP group scores from the mean scores of the corresponding control age group. The JNCATS subscale scores showed significant increases (p < .05) for maternal domain attributes (Sensitivity to Cues, Response to Child Distress, Social Emotional Growth Fostering, Contingency), suggesting the scores changed due to the effects of the intervention. In particular, at 6 months, the scores exceeded the mean scores of age-matched control groups for Sensitivity to Cues and Response to Child Distress (Fig.2A-B). The maternal contingency score was higher than the control group at 9 months (Fig.2C). In contrast, the child's JNCATS relative scores did not show any significant difference before intervention versus at 12 months, for both the general scales and subscales. This was the same change as the improvements engendered by growth per se in the control children; that is, no intervention effects were found.

For the CARE-Index, the scores of the most important index, Dyadic Synchrony, were as follows: the mean score of the JEPP group before intervention was 4.20, which did not significantly differ from the mean score of the corresponding control age group (p > .05). At 12 months after intervention, the mean score of the JEPP group increased significantly to 7.47. Scores also increased to 7.15 in the control age group around the same time. For this reason, the relative scores were not adjusted (p = .434) and no intervention effects were seen (Fig.3A). In contrast, when each behavior score was analyzed, the parent-domain Unresponsive and child-domain Passive showed significant improvement.

![Figure 2. Score transition of mother's domain of JNCATS](image)

Calculation and comparison were performed using a relative score that was corrected by subtracting the mean score of the control group corresponding to the score of the JEPP group’s evaluation time (pre, 6, 9, and 12 months). This corresponds to the mother’s score on the JNCATS subscale in Table 3.
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in the relative score ($p < .05$). Such improvements in the behavior of both mother and infant were stronger than in the control group at before intervention. However, this tendency decreased at 6 months. After that, values were lower than the control group (Fig. 3B-C). In addition, there were no significant changes in the parent domain Controlling and child domain Difficult. Further, child-domain Compulsive did not exist in the JEPP group throughout the whole period.

**Intervention results for parenting stress and mother’s feelings**

Table 3 shows the scores (mean, standard deviation and the transition) for JEPP and control groups on parenting stress and feelings of the mother. The subscale scores for SUBI in the pre-intervention JEPP group were 42.13 for Positive affectivity and 48.73 for Negative affectivity. The mean scores of the corresponding control age group (1-3 months) were 42.97 for Positive affectivity and 52.23 for Negative affectivity (Table 3). Comparing the two groups, the Negative affectivity score was significantly lower in the pre-intervention group than the control group ($p = .021$), indicating that before intervention, mental fatigue was strong in the JEPP group. In contrast, other variables indicating maternal mental state did not significantly differ between the pre-intervention JEPP group and control group (PSI, CES-D, and RSES; $p > .05$). In the post-intervention analysis, we discovered that the characteristics of the JEPP group could broadly be divided into positive tendencies and negative tendencies. Factors which enhanced these tendencies were subjective well-being and self-esteem. As mentioned earlier, negative affectivity, which already differed from the control group pre-intervention, increased greatly from 48.73 (before intervention) to 54.87 (at 12 months). Positive affectivity also increased from 42.13 to 45.13, indicating a tendency for mental health to improve with the age of the children. In contrast, the control group’s negative affectivity decreased from 52.53 (1-3 months) to 49.55 (12 months), while positive affectivity decreased from 42.97 to 41.45. The decrease in these scores indicates considerable mental fatigue of the children as their ages increased. The mean RSES score of the JEPP group increased from 35.40 (before
intervention) to 38.27 (at 12 months), while that of mothers in the control group dropped from 36.70 (1–3 months) to 32.00 (at 12 months), indicating that the older her children, the lower the mother’s self-esteem. Factors that offset this tendency were parenting stress and the tendency toward depression in mothers. Mothers in the JEPP group showed less stress with the growth of their children. The mean parent-domain stress score of PSI dropped from 95.40 (before intervention) to 88.60 (12 months), the child-domain stress dropped from 85.90 to 72.20, and the general score also dropped significantly from 181.30 to 161.30. In the control group, the parent-domain stress increased from 95.77 (1–3 months) to 99.00 (12 months) but the child-domain stress dropped from 83.18 to 74.70, and the general score from 178.95 to 173.30, indicating that only the parent-domain stress increased with the age of the children. In particular, the parent-domain stress of the control group was highest (104.10) and that of the JEPP group lowest at 9 months (86.20), confirming that in the same period, the stress of the JEPP group was significantly lower ($p = .033$). Regarding the tendency toward depression in mothers, the mean CES-D score of the JEPP group before intervention was 9.73, which decreased sharply to 5.73 at 12 months. In contrast, the tendency toward depression in the control group increased from 7.67 to 10.30. While it was demonstrated that in general, the mother’s mental health tended to decrease as the children aged in the control group, improvements were seen in the JEPP group. To review intervention results based on this, the adjusted relative scores, obtained by subtracting the changes in the values from the mean score of the corresponding control age group, were compared with before intervention and at 12 months. Positive changes ($p < .05$) were seen in the following items: PSI: maternal and total score; CES-D; SUBI: positive affectivity, negative affectivity; and RSES, except for the child domain which is a subscale of parenting stress. Although these results cannot be definitively attributed to intervention effects, they nevertheless confirm that the JEPP group showed a tendency for improvement compared to the control group.

Discussion

Intervention effects on mother-infant interactions and maternal sensitivity

Early intervention based on IMH that promotes mother-infant relationships contributes about positive changes in the JNCATS parent domain subscales of Sensitivity to Infant’s Cues, Response to Child Distress, and Mother’s Contingency. As shown in Figure 2(A-C), the intervention increased scores of the JEPP group and reduced the difference from the control group at 6 months. The intervention gave advice to ensure the mothers understood their children better from the perspectives of their children, and focused on working with the mothers to determine appropriate responses to their children based on evidence-based understanding of child growth, including neuroscience aspects. As a result, the JEPP group mothers improved their ability to read the cues of their children more accurately, and respond with appropriate timing. The maternal subscales of the JNCATS scores, which tended to show improvement following JEPP, match the components of the sensitivity of mothers emphasized by Ainsworth. These consist of 1) mother’s awareness of her infant’s signals, 2) accurate interpretation of such signals, 3) appropriate responses to the signals, and 4) prompt responses to the signals. Sensitivity toward the children’s cues increased with the intervention.

CARE-Index dyadic synchrony, another subscale pertaining to mother-infant relationships, did not signal significant intervention effects when comparing the JEPP and control groups at 12 months (Table 3). There are two possible reasons for this. One is that dyadic synchrony could be maintained because the child complemented the mother’s weak responsiveness. The JEPP group’s synchrony did not significantly differ from the control group in the pre-intervention comparison. Regarding the responsiveness of children, the clarity of the children’s cues and responses to caregivers did not significantly differ from the control group before intervention. As shown in Figure 3A, the CARE-Index synchrony score increases with time due to the influence of child maturation. That is, children with the ability to respond before intervention are able to provide clear cues, which mothers can read easily as the child grows. That is, the child responds to the mother. If synchrony is considered as interactions based on turn-taking and if the interactions in the Barnard model measure whether the mother and infant fulfill their responsibilities to dyadic synchrony, it can be understood that synchrony does not differ between the JEPP and control groups. The second perspective is that intervention enhances the mother’s sensitivity and the quality of interactions, allowing synchrony to be maintained at the same level as the control group. This may be posited from the significant decrease in the “unresponsive” score of the mothers in the JEPP group (Fig. 3B). “Unresponsive” also includes the mother’s inability to realize the distress and discomfort of her
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child, and a lack of response to her child’s emotions. As the “unresponsiveness” of the mothers in the JEPP group improved, their affection for their children increased, and they were able to provide more attention to their children. That is, the mothers’ sensitivity had increased. Accordingly, the tendency towards “passiveness” in the children also decreased (Fig. 3C). Consequently, this decrease in mutual negative actions between mother and infant eliminated the difference in dyadic synchrony between the control group and JEPP group (Fig. 3A). Of the JNCATS subscales, only Cognitive Growth Fostering did not differ significantly between the two groups at 12 months (Table 3). This may suggest that our intervention focuses more on social and emotional development than cognitive development. However, the words spoken by the mother and the cognitive stimulation provided may have a significant impact on the words spoken by children and their cognitive ability. Interventions for mothers and infants should therefore be provided from the perspective of infant development and neuroscience, and incorporated in future childcare support methods.

**Intervention effects on parenting stress and maternal emotions**

Before intervention, negative feelings on the SUBI are stronger in the JEPP group than the control group. Pediatricians’ assessments that are the need for childcare were related to the mother’s fatigue. In Japan, the government has launched a program where nurses visit the homes of newborns up to the 28th day from birth, and all homes with infants up to 4 months from birth. The implementation rate is high at 94.1%. Of these cases, only 11% require repeated support in the form of re-visits, and continued support may not be sufficiently provided. The 15 parent-child pairs of the JEPP group in this study were also visited by public health nurses, but continued support was not provided. However, mother-infant interactions were poorer than the control group, the mother’s sensitivity towards their children’s cues, and responsiveness of the children toward caregivers were both low. These results suggest that it is important to note the physical state and minor comments made by mothers visiting pediatric clinics for their children’s medical checkups or medical consultations. In the control group, the mother’s mental fatigue, parenting stress and the tendency toward depression increased with the children’s age. This parallels the tendency for parenting stress felt by mothers to increase as their children grow. The results of a previous study showed that with respect to parenting stress felt by mothers, dissatisfaction toward being confined by childcare and the lack of freedom following childcare are not affected by the development of their children. However, mother’s confidence regarding parenting and concerns about their children’s behavior are affected over time, and early parenting stress affects the mother’s parenting stress six months or one year later. In this respect, the tendency toward depression and parenting stress of mothers in the JEPP group continued to gradually decrease over time due to the intervention, while self-esteem and positive affect increased over time. The PSI scale was developed as a tool for studying parenting stress. Abidin et al. reported that self-acknowledgment by the parent affects parenting stress. In addition, pessimism and negative self-evaluations of capability in mothers are closely related to stress. There have also been suggestions that the mother’s image of her roles and how she succeeds in those roles affects stress levels. In the intervention, the tendency toward depression in the JEPP group improved dramatically compared to the control group, which in turn sharply enhanced the self-esteem of the former. The intervention thus not only simply resolved the difficulties of parenting, but also contributed to enhancing the parent’s affirmative perception and capability.

**Early intervention approach by IMH nurses**

IMH nurses provided consistent support to the JEPP group from the start of the project. The nurses constantly observed the relationship between mother and infant, showed deep respect for them, and listened carefully and shared the mothers’ views, feelings, and parenting experiences. The nurses listened patiently to the worries expressed about parenting, and the negative emotions and irritation mothers felt when unable to carry out childcare properly. When mothers in the JEPP group were noted as suffering from mental fatigue, parents and child were supported carefully and warmly. Providing counseling to mothers with such receptive, enthusiastic attentiveness, and providing assessments from an early stage contributes greatly to the improvement of depression. In this study, these efforts contributed significantly to improving depression and parenting stress in JEPP group mothers. Listening carefully to the words spoken by mothers, and carefully observing mothers and infants are useful for clarifying dyadic advantages, shortcomings, and potential problems. The building of a close trust relationship with dyads by the health care provider is a strong source of protection to the mother and infant. However, in a Japan, there are few opportunities for mother and infant to receive continued support from specialists in IMH. For this reason, we must
review ways of providing continuing support to promote mother-infant relationships and maternal sensitivity.

Limitations and future directions

Because this study recruited a small number of participants, the results need to be interpreted carefully. Moreover, cross-sectional data was used for the JEPP group and longitudinal data for the control group; because we could not standardize these data conditions, we need to take care in generalizing intervention effects. We need to improve the uniformity of the intervention group data to the control group data. Further, this study should be replicated with a larger sample size and should be performed as a randomized controlled trial. However, despite the limitations, we demonstrated that the intervention carried out on the JEPP group was beneficial to childcare situations accompanied by a high risk of problems. We plan to increase the sample size and carry out detailed analyses to early interventions based on IMH, and thus contribute to the wider adoption of such methods.

Acknowledgments

The authors sincerely thank participants, physicians, and nurses at the pediatric clinic. We would also like to express our gratitude to the graduate students and staff members at Child and Family Nursing, Graduate School of Healthcare Sciences, Tokyo Medical and Dental University. This study was made possible with grants from Grants-in-aid for scientific research by the Ministry of Education, Culture, Sports, Science, and Technology in Japan (No. 23249091, PI: Taiko Hirose).

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