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ORIGINAL ARTICLE

Development and validation of a multidimensional mental health screening questionnaire for pregnant women: A preliminary report

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Abstract

Background: Mental health problems during pregnancy are multifaceted major health issues.

Aim: To develop and validate a short screening questionnaire that covers important domains including antenatal depression, tokophobia, fetal bonding disorder, suicidality, and emesis.

Methods: A total of 321 pregnant women who were less than 36 weeks gestation responded to a cross-sectional web survey and filled in the 33-item Dimensional Assessment of Mother Baby Organization Questionnaire (DAMBO Q33, available as an e-book). Out of these women, 111 (35%) responded to our invitation to an online research interview (Dimensional Assessment of Mother Baby Organization-Research Version). Using theory-driven or cluster analysis-driven categories of the five mental health domains as a gold standard, we identified the most powerful DAMBO Q33 questionnaire items for each domain and calculated psychometric properties of cut-off points of the domain scores for the questionnaire, including sensitivity, specificity, and positive and negative predictive values. We proposed the best cut-off value for each domain.

Results: We identified 11 DAMBO Q33 items as the best predictors for five mental health domains. The psychometric properties of the best cut-off points were acceptable for each domain. By these cut-off points, we could identify 57%, 19%, 100%, 46%, and 46% of true cases of antenatal depression, tokophobia, fetal bonding disorder, suicidality, and emesis, respectively. Positive cases of the five domains substantially coexisted with each other.

Conclusion: The final 11-item questionnaire (DAMBO Q11) may be a useful screening tool for the five major mental health problems among pregnant women.

KEYWORDS

depression, emesis, fetal bonding disorder, pregnancy, suicidality, tokophobia

INTRODUCTION

Mental health problems during pregnancy have been attracting clinicians and researchers for more than half a century.[1] They may include antenatal depression, tokophobia (fear of childbirth), fetal bonding disorder, and suicidal ideation, to name just a few.[2] Emesis has also been viewed from the perspective of its association with mental illnesses.[3–14] However, in busy antenatal clinics where mental health professionals are not available or are difficult to approach, patient-reported measures (self-rating questionnaires) may be a promising alternative for assessing the mental status of patients and detecting those who need specialist care. For example, the Edinburgh Postnatal Depression Scale (EPDS),[15] which was originally developed as a screening tool for postnatal depression, is used for detection of antenatal depression.[16–18] Many devices have been developed for the assessment of tokophobia[19–21] and fetal bonding (also known as maternal prenatal attachment)[22–25] as well as suicidal ideation.[26–28]

Nevertheless, these devices are not without drawbacks. Such devices were developed as a specific assessment or screening tool for single mental health domains (e.g., the EPDS for depression, the Wijma Delivery Expectancy/Experience Questionnaire[W-DEQ][21] for tokophobia). There are few instruments that tap diverse mental health domains frequently observed among expectant women. Second, many of the previous devices have many items for assessment (e.g., 33 items for the W-DEQ) and are thus time-consuming and often burdensome for pregnant women. Hence what clinicians and researchers need is an instrument that is sufficiently short and covers a wide area of pregnancy-related mental health domains. In addition, psychological tools are subjected to cultural and linguistic influences.[29] For example, the EPDS has been used worldwide[30] but its factor structure is still a topic of scientific debate[31] and its cut-off points (to detect clinical depression) vary between countries. Instruments that have robust psychometric properties may not be suitable in other cultures. Culture-specific biases should be considered carefully when developing a psychological measure.[32–35]

This study aimed to develop a short and psychometrically sound screening instrument for five main pregnancy-related mental health domains: antenatal depression, tokophobia (fear of childbirth), fetal bonding disorder, suicidal ideation, and emesis among Japanese women. We selected these five domains because, as noted previously, they are serious health issues for pregnant women.

METHODS

Study procedures and participants

This internet study solicited pregnant women (less than 36 weeks gestation) to participate in a questionnaire survey, conducted between August 29 and September 7, 2022, via internet application by Luna Luna Baby (MTI Ltd). No exclusion criteria were used other than a lack of sufficient command of Japanese. A total 321 women entered the study. The participants in this study came from almost all prefectures in Japan. Participation was anonymous (except for their mailing address) and was voluntary. The questionnaire contained an information page, which described the aims of the study, affiliations, information about informed consent, and the address of the consultation desk for the research. At the end of the questionnaire, all the participants were invited to a net interview. A total of 111 (35%) women agreed to be interviewed. Their mean (SD) age was 32.3 (4.3) years with a range between 23 and 42 years. Participants received an incentive with electronic money which could be used for Amazon shopping. Consent was obtained electronically from each participant.

Measurements

Net questionnaire: We used the 33-item Dimensional Assessment of Mother Baby Organization Questionnaire (DAMBO Q33),[36] available as an e-book. This consisted of (a) demographic features (age, education, area of residence, occupation, and marital status), (b) obstetric features (gestational week, number of past pregnancies, and deliveries [term, immature, and stillbirth], termination of pregnancies, abortions, and neonatal deaths), (c) depression (16 including three items that were also used for suicidality) (abbreviations of antenatal depression items in Table 1 represent DSM Major Depressive Episode [MDE] diagnostic criteria: e.g., A1 for "depressed mood"), (d) tokophobia (four items), (e) fetal bonding disorder (nine items), (f) suicidality (three items), (g) emesis (two items), and (h) social dysfunction (two items). Depression, tokophobia, fetal bonding disorder, suicidality, emesis and social dysfunction were all rated with a seven-point scale being rated from 1 = not at all to 7 = very much so.

Web interview: This was conducted following a structured interview: Dimensional Assessment of Mother and Baby Organization-Research Version (DAMBO-RV).[37] This covers (a) demographic features (age), (b) obstetric features (gestational week, fetal movement, and number of past pregnancies and deliveries [term, immature, and still birth], termination of pregnancies, abortions, and neonatal deaths), (c) psychological response to the current pregnancy (five-point scale), (d) desirability of pregnancy (five-point scale) and the duration and contents of infertility treatment, (e) preferred model of delivery (vaginal, neuraxial anaesthesia, Caesarean section, and others), (f) depression (22 dichotomous items with a dichotomous (yes/no) scale, including seven items that were also used for suicidality), (g) tokophobia (six items with a five-point scale), (h) fetal bonding disorder (nine items with a five-point scale), (i) suicidality (two essential and five sequential dichotomous items), and (j) emesis (two items with a five-point scale). All the five-point scales were rated from 1 = not at all to 5 = very much so.

The interviews were performed by seven trained interviewers, including one psychiatrist, two obstetricians, and four midwives. The average time spent for interview was about 30 min. Raters' interrater reliability of all the items was rated by intraclass correlation (ICC)[38–40] where all the interviewers viewed randomly selected 15 recoded interviews and rated the items independently. The ICC ranged between 0.90 and 1.00.

TABLE 1 Comparison of the questionnaire items between those with and without each mental domain problem ($n = 111$).

Screening questionnaire items	Comparison between absent and present groups			
	Absent	Present		
Antenatal depression	Without antenatal depression ($n = 104$)	With antenatal depression ($n = 7$)	*T* test (Mann–Whitney *U*)	AUC
A1: depressed mood #	2.09 (1.22)	3.29 (1.50)	2.5* (*)	0.755
A2: lack of interest #	2.07 (1.37)	4.00 (1.63)	3.6** (**)	0.810
A3a: decreased appetite	2.52 (1.72)	4.00 (1.73)	2.2 (*)	0.751
A3b: increased appetite	2.92 (1.89)	2.57 (1.81)	0.5 (ns)	0.455
A4a: insomnia	3.58 (1.80)	4.71 (2.14)	1.4 (ns)	0.661
A4b: hypersomnia	4.39 (1.66)	5.00 (2.16)	0.9 (ns)	0.618
A5a: psychomotor retardation	4.76 (1.89)	6.29 (0.76)	4.5** (*)	0.740
A5b: agitation	1.62 (1.19)	2.43 (1.90)	1.7 (ns)	0.638
A6: fatigability	4.25 (1.75)	5.86 (1.22)	2.4* (*)	0.757
A7a: lowered self-esteem	2.32 (1.71)	4.14 (2.73)	1.7 (ns)	0.688
A7b: guilt feeling	1.61 (1.00)	2.86 (2.27)	1.5 (*)	0.694
A8a: poor concentration #	3.25 (1.84)	6.14 (0.90)	7.5*** (***)	0.902
A8b: indecisiveness	2.38 (1.71)	3.71 (2.43)	1.9 (ns)	0.658
Tokophobia	Without tokophobia ($n = 62$)	With tokophobia ($n = 48$)		
Fear of pain #	5.59 (1.36)	6.27 (0.92)	3.0** (**)	0.654
Fear of medical procedure	4.40 (2.05)	5.35 (1.48)	2.7** (*)	0.622
Fear of risk to baby's life #	4.35 (1.72)	5.23 (1.68)	2.70** (**)	0.649
Fear of risk of own life	4.14 (1.49)	4.67 (1.45)	1.86 (ns)	0.590
Fetal bonding disorder	Without fetal bonding disorder ($n = 109$)	With fetal bonding disorder ($n = 2$)		
Happiness	1.97 (1.10)	3.50 (2.12)	1.9 (ns)	0.775
Alpha pride	4.20 (1.13)	5.00 (2.83)	0.4 (ns)	0.539
Beta pride	4.24 (1.19)	4.50 (3.54)	0.1 (ns)	0.500
Shame	2.71 (1.58)	4.50 (2.12)	1.6 (ns)	0.789
Guilt #	2.52 (1.75)	6.50 (0.71)	3.2** (**)	0.986
Fear #	3.43 (1.95)	5.50 (0.71)	3.9 (ns)	0.817
Anger #	2.14 (1.59)	6.00 (1.41)	3.4*** (*)	0.956
Sadness	1.92 (1.44)	4.00 (4.24)	0.7 (ns)	0.651
Disgust	1.63 (1.33)	2.00 (1.41)	0.4 (ns)	0.619
Suicidality	Without suicidality ($n = 100$)	With suicidality ($n = 11$)		
A9a: no meaning in life	1.16 (0.56)	2.91 (2.07)	2.8* (***)	0.745
A9b: wish to die #	1.15 (0.44)	2.64 (1.86)	2.6* (***)	0.780
A9c: wish to harm oneself	1.04 (0.20)	1.73 (1.79)	1.3 (***)	0.618
Emesis	Without emesis ($n = 100$)	With emesis ($n = 11$)		
Nausea #	2.19 (1.26)	4.00 (1.79)	3.3** (**)	0.792
Vomiting #	1.26 (0.68)	3.00 (1.41)	4.0** (***)	0.857

Note: # items that remain for DAMBO Q11.

*$p < 0.05$; **$p < 0.01$; ***$p < 0.001$.

Data analysis

Of the 321 women who entered the website, 27 did not complete the answers to all of the questions, resulting in 294 women remaining, therefore we performed Little's Missing Completely at Random Test.[41–43]

The main aim of the present study was to develop a short and valid screening instrument for five pregnancy-related mental health domains. Interviewer's assessment was used as a "gold standard" for each mental health domain. Then, we compared the mean (with SD) of each DAMBO Q33 questionnaire item between those with and without the mental health domain of question. Here we used a *T* test but because categories of some domains were very small in number, we also used the Mann–Whitney *U* test. For example, all the interviewed women were assigned either with or without antenatal depression using the interviewer's assessment (see below). The mean of a questionnaire item that was related to antenatal depression (e.g., lowered self-esteem) was compared between the two group with *t*-test. Receiver operating characteristics (ROC)[44] analysis was performed to calculate the area under curve (AUC) for each item to identify the best selection of DAMBO Q33 items to predict the mental health domain in question. We hoped to achieve a relatively small number of questionnaire items to predict five mental health domains. We posited that approximately 10 items might be sufficiently short for a busy clinical setting. We thought that repeated use of a 10-item questionnaire might not be too burdensome for pregnant women.

MDE[45] is often used as diagnostic criteria of depression regardless of the patient's demographic and clinical conditions but we thought this would be inaccurate. This is because although in the original DSM-5, diagnostic criteria for MDE require (a) either depressed mood or lack of interest for the past 2 weeks and (b) at least five of the nine diagnostic items, a factor analysis of the MDE symptoms identified by the Patient Health Questionnaire-9[46] demonstrated that three items (sleep disturbances [insomnia or hypersomnia], appetite disturbances [decrease or increase of appetite or body weight], and fatigability [lack of energy]) constructed an independent factor,[47] and these physical symptoms are usually seen as accompanying emesis among pregnant women. A recent study of antenatal women[48] showed that only four MDE items ("depressed mood," "lack of interest," "poor concentration," and "lowered self-esteem") showed a high AUC in predicting antenatal depression in ROC analysis, therefore, in this study, we defined antenatal depression as a case with at least three items out of the above four depression items. It is of note that the definition of antenatal depression as at least two items of the four depression items resulted in a prevalence of antenatal depression >0.50 and we thought this was clinically unpractical.

Tokophobia (fear of childbirth), fetal bonding disorder, suicidality, and emesis were rated by items with a five-point scale in the DAMBO-RV interview. They were thus regarded as continuous variables. Since there are no explicit diagnostic criteria for these conditions thus far, we performed a two-step cluster analysis. Case groups identified by cluster analysis are homogenous within themselves and heterogenous from the other cluster based on the characteristics of the symptoms in question.[49]

There are quite a few cluster techniques, including *k*-mean and hierarchical cluster analyses. However, two-step cluster analysis is superior to the others in that it creates clusters based on both categorical and continuous variables.[50] In this clustering procedure, the number of clusters was selected automatically, thus avoiding the idiosyncrasies of researchers as much as possible. Two-step clustering begins with the construction of a cluster features tree that creates "nodes" containing multiple cases. Next, agglomerative clustering is used to produce a range of solutions. Two-step clustering automatically confirms the possible maximum number of clusters. This is followed by determination of the best cluster model in terms of the highest distance increase (measured by Schwarz's Bayesian criterion) between the two closest cluster models during each stage of the hierarchical clustering.[51] To assess the discreteness of clusters, silhouette coefficients were calculated. Clusters indicating the presence of more severe symptoms were defined as tokophobia, fetal bonding disorder, suicidality or emesis.

After identifying a cluster (or a group in the cases of antenatal depression) with the mental health domains defined above, the mean scores of the DAMBO Q33 questionnaire items were compared between those with and without each mental health domain among the interviewed cases ($n = 111$). Then, to identify the best DAMBO Q33 questionnaire item(s) for each mental health domain, we performed ROC and searched the items with the highest AUC values. Accuracy of prediction based of the selected items for each mental health domain was examined in terms of specificity, sensitivity, and positive and negative predictive values with a range of cut-off points. The best cut-off point was determined in the balance of psychometric properties and clinical utility. Overlap of each mental health domain thus identified was calculated.

RESULTS

Characteristics of the population and missing value pattern

The participants' mean (standard deviation [SD]) gestational week was 19.4 (9.3), with a range between 5 and 35 weeks. There were 88 nulliparae and 23 multiparae women. Their mean (SD) age was 32.4 (4.3) years. The mean (SD) number of pregnancies was 1.6 (1.0). About 98% of the participants had high-school educational level or higher and 61% had college educational level or higher. Ten (9%) women were housewives, while 91% had jobs. There were seven (6%) unmarried women. Little's missing completly at random test showed that the present data derived from the net-questionnaire survey were missing completely at random, χ^2 (23) = 10.377, $p = 0.989$, therefore we deleted data with missing values on a casewise basis.

Antenatal depression

Seven cases (6.3%) were identified as meeting the criteria of antenatal depression (Table 1). Five DAMBO Q33 questionnaire items

showed significant ($p < 0.05$) mean differences between those with and without antenatal depression: A1 ("depressed mood"), A2 ("lack of interest"), A5a ("psychomotor retardation"), A6 ("fatiguability"), and A8a ("poor concentration"). It is of note that prefixes represent DSM MDE diagnostic criteria. Three items showed AUC > 0.75 in the ROC analysis. They include A1, A2, and A8a. Although A3a (decreased appetite) and A6 (fatiguability) showed AUCs slightly less than 0.75, we did not use them as predictor items because they were reported to reflect emesis rather than depression.[48]

We calculated the total score of the above three questionnaire items by adding their raw scores. Balancing specificity, sensitivity, and positive and negative predictive values, we thought that the best clinical cut-off point was 13/14 (Table S1). This means that among a population of pregnant women similar to the present one, approximately one out of 10 women might be detected as positive and more than 50% of true cases of antenatal depression would be identified.

Tokophobia

Two-step cluster analysis identified two clusters (silhouette coefficient = 0.4) (Table 1). Compared to women in cluster 1 ($n = 62$), women in cluster 2 ($n = 48$) scored higher in all the DAMBO-RV tokophobia interview items. Three DAMBO Q33 tokophobia items showed significant ($p < 0.01$) mean differences between those with and without (cluster analysis-derived) tokophobia: "fear of pain," "fear of medical procedure," and "fear of risk of baby's life" (Table 1). ROC analysis revealed that two DAMBO Q33 items ("fear of pain" and "fear of risk of baby's life") had an AUC > 0.63. We should note that AUC > 0.75 was used as a criterios to select the best items in the other domians, and we used AUC > 0.63 only for tokophobia. This is because all the tokophobia items showed relatively low ROC. This suggets that the concept measured by tokophoba items is not very homogeneous. We calculated the total score of the two questionnaire items ("fear of pain" and "fear of risk of baby's life") by adding their raw scores. We considered the best clinical cut-off point was 13/14 taking into account psychometric properties (Table S2). Among pregnant women, we expected that approximately one in 10 women might be detected as positive and 19% of true cases of tokophobia would be identified.

Fetal bonding disorder

Two-step cluster analysis identified two clusters (silhouette coeficient = 0.7) (Table 1). Compared to women in cluster 1 ($n = 109$), women in cluster 2 ($n = 2$) scored lower in positive fetal bonding (qustionnaire) items (e.g., "happiness") and higher in negative bonding (questionnaire) items (e.g., "guilt"). Significant ($p < 0.01$) mean differences between those with and without fetal bonding disorder were found in "guilt" and "anger." ROC analysis revealed AUC > 0.8 was obtained by three questionnaire items: "guilt," "fear," and "anger." Thus, the scores of these three DAMBO Q33 items were added to make a total score. The best clinical cut-off was judged as 16/17 after considering specificity, sensitivity, and positive and negative predictive values (Table S3). About 5% of pregnant women might be detected as positive with all true cases of fetal bonding disorder being detected.

Suicidality

Two-step cluster analysis identified two clusters (silhouette coefficient = 0.9) (Table 1). Compared to women in cluster 1 ($n = 100$), women in cluster 2 ($n = 11$) scored lower in all the three questionnaire items but significant ($p < 0.05$) mean differences between those with and without Suicidality were found in A9a ("no meaning in life") and A9b ("wish to die") only. ROC analysis revealed AUC > 0.75 was only obtained by A9b ("wish to die"). Thus, the scores of A9b (DAMBO Q33 item) were used as the scores of sucidality. The best clinical cut-off point was 2/3 (Table S4). This means that among a population of pregnant women similar to the present one, approximately one in 10 women might be detected as positive and about half of true cases of sucidality would be identified.

Emesis

A two-step cluster analysis identified two clusters (silhouette coefficient = 0.7) (Table 1). Compared to women in cluster 1 ($n = 100$), women in cluster 2 ($n = 11$) scored higher in the two DAMBO Q33 emesis items. Significant ($p < 0.01$) mean differences between those with and without emesis were found in both the two DAMBO Q33 questionnaire items. Only one of the two ("vomiting") had AUC > 0.80 in a ROC analysis. Nevertheless, the sum of the scores of the two questionnaire items was used as a composite variable because we thought that a single questionnaire item for a category might be too fragile as a measurement model (and because the AUC of "nausea" was almost 0.8). The best clinical cut-off point was found at 6/7 (Table S5). This means that among a population of pregnant woman similar to the present one, approximately one in 10 women might be detected as positive. The rate of true cases of emesis identification was about 46%.

Comorbidity and positive cases

The five mental health domains were not mutually exclusive and somehow comorbid (Table 2). More than 40% of the antenatal depression cases also had tokophobia and emesis. Half of the fetal bonding disorder cases also had antenatal depression, tokophobia, suicidality, and emesis. More than 40% of suicidality cases also had tokophobia. Similarly, more than 40% of emesis cases also had tokophobia.

Three antenatal sepression items ("depressed mood," "lack of interest," and "poor concentration"), two tokophobia items ("fear of pain" and "fear of risk of baby's life"), three fetal bonding disorder items ("guilt," "fear," and "anger"), one suicidality item ("wish to die"),

TABLE 2 Comorbidity of antenatal depression, tokophobia, fetal bonding disorder, sucidality, and emesis.

Mental health domain	Antenatal depression	Tokophobia	Fetal bonding disorder	Suicidality	Emesis
Antenatal depression ($n = 7$)	-	3 (43%)	1 (14%)	2 (29%)	4 (57%)
Tokophobia ($n = 48$)	3 (6%)	-	1 (2%)	5 (10%)	5 (10%)
Fetal bonding disorder ($n = 2$)	1 (50%)	1 (50%)	-	1 (50%)	1 (50%)
Suicidality ($n = 11$)	2 (18%)	5 (45%)	1 (20%)	-	2 (18%)
Emesis ($n = 11$)	4 (36%)	5 (46%)	1 (9%)	2 (18%)	-

Note: For example, that three (43%) of seven cases with antenatal depression met the criteria of Tokophobia.

TABLE 3 Patterns of questionnaire-positive cases.

Number of positives	Antenatal depression	Tokophobia	Fetal bonding disorder	Suicidality	Emesis	*n*
0	0	0	0	0	0	82
1	X	0	0	0	0	2
1	0	X	0	0	0	5
1	0	0	X	0	0	2
1	0	0	0	X	0	3
1	0	0	0	0	X	4
2	X	0	X	0	0	1
2	X	0	0	0	X	2
2	0	X	0	X	0	1
2	0	X	0	0	X	4
3	X	0	0	X	X	2
3	X	0	X	X	0	1
3	X	X	0	X	0	1

Note: X, present; 0, absent.

and two emesis items ("nausea" and "vomiting") remained as predictors of positive cases of antenatal mental health problems. Using the aforementioned cut-off points, 82 cases were judged negative for all of the five domains (Table 3). There were two, five, two, three, and four cases who were judged positive only for antenatal depression, tokophobia, fetal bonding disorder, suicidality, and emesis, respectively. There were one, two, one, and four cases who were judged positive for antenatal depression and fetal bonding disorder, antenatal depression and emesis, tokophobia and suicidality, and tokophobia and emesis, respectively. A few cases met positive criteria for three domains: One case was positive for antenatal depression, fetal bonding disorder, and suicidality, one for antenatal depression, tokophobia, and suicidality, while two cases were positive for antenatal depression, suicidality, and emesis, therefore mental health problems during pregnancy often were intermingled with each other. It is of note that there were four cases of suicidality with antenatal depression (with or without other mental health domains) whereas there were five other cases with suicidality without antenatal depression.

Case presentation

A few case vignettes illustrate the clinical pictures of pregnant women that the present screening instrument positively identified.

Ms. A. was positive for antenatal depression, fetal bonding disorder, and suicidality. She was 31 years old with history of miscarriage. She had a plan to kill herself before the child's birth. This was accompanied by severely depressed mood, lack of interest, insomnia, lack of energy, reduced self-esteem, and poor concentration. This was a long-lasting depression episode that was enhanced by an incident of severe abuse towards her mother by her father

followed by an escape to the house of the partner's parents. She had a long history of physical and psychological abuse by her father. She was once nearly strangled to death by her father. She had poor bonding with the fetus (anger). Psychiatric past history included borderline personality disorder, dissociation disorder, several episodes of depression, and drug use disorder together with several suicide attempts. She was referred to psychiatric consultation.

Ms. B. was positive for antenatal depression, suicidality, and emesis. She was a 23-year-old student and was at 35 weeks gestation. She did not plan her pregnancy and felt perplexed when she realized her pregnancy. She still felt nauseous every day. She felt shame towards the fetus. She had an extreme fear of labor pain, medical procedures, and life risk to the baby and herself. Although she denied depressed mood and loss of interest most of the day for the last 2 weeks, she had recurrent short periods of despondent mood and crying spells, and occasionally thought of killing herself. This was because she had difficulties communicating with her partner, who lived apart from her; in addition, she felt she was a burden on her parents. She had an argument with her partner over the fact that he was in debt, after which he stopped responding to her e-mails. She searched the internet regarding methods of suicide.

Ms. C was positive for antenatal depression, suicidality, and emesis. She was 25 years old and was at 7 weeks gestation. When she realized the unexpected pregnancy, she felt strong anxiety, complaining of lack of confidence to look after the baby. She complained of severe nausea (but no vomiting). She had an extreme fear of labor pain and possible anomalies of the baby. She had short periods of depressed mood, lack of interest, difficulty going to sleep, hypersomnia, lack of energy, and occasional wish to die.

DISCUSSION

The present preliminary study used the data derived from the DAMBO-RV interview to validate the algorithm of five domains of mental health problems during pregnancy: antenatal depression, tokophobia, fetal bonding disorder, suicidality, and emesis from the DAMBO Q33 questionnaire items. Although the cut-off points that we proposed were tentative, we could identify 57% of true cases of antenatal depression, 17% of true cases of tokophobia, all true cases of fetal bonding disorder, 46% of true cases of suicidality, and 46% of true cases of emesis. Because cases of positive results for five domains coexisted to some extent, approximately one-quarter of the participants were positive for any of the domains. Only one out of 10 participants showed positive results for two or more domains. The number of items necessary for identifying positive cases was reduced from 33 to 11. Hence, we think that the short version of the DAMBO Q33 (DAMBO Q11) may be used as a screening instrument to identify women who need specific assessment and care for their mental health problems. We should, however, be cautious in selecting the best items for antenatal depression. As A3a ("decreased appetite") and A6 ("fatiguability") showed AUCs > 0.75, they have the ability to predict cluster antenatal depression (like flags or ad-balloons). Is it exactly all right to delete those items? The AUC is the index indicating discriminate power between two groups (i.e., with vs. without each mental health domain). At the same time, we wonder whether items with high AUCs truly represent domains of symptoms. In a future study, performance of discrimination of a dimension of symptoms may depend on discrimination parameters in item response theory.

The prevalence of antenatal depression was 6% in the present interviewed sample. This is in line with a Japanese epidemiological study that used a structured diagnostic interview based on the DSM-IV.[52] The positive predictive rate of 0.5 possibly meant that the cut-off detected cases in which severity might be below the threshold of major depression. This may be advantageous because clinical depression that needs assessment and care during pregnancy is often minor depression. Kitamura et al.[53,54] reported 16% of pregnant women experienced depression which included minor depression, showing significant association with obstetric, accommodational, and personality variables.

Just less than half of the interviewed women met the definition of tokophobia. Interestingly, all the tokophobia items of the questionnaire showed AUC < 0.75. We may have included women who (normally) feared the forthcoming childbirth. Women with pathological fear should be identified in a future study. Fear of childbirth has been neglected for a long time as a perinatal health issue, but in reality, it has a grave impact on pregnant women's mental state.[55–57] Much more clinical attention should be paid to this. Further refinement of symptomatology and assessment methods of tokophobia may give proper guidance for the care for such women.

Fetal bonding disorder, although consisting of a very small proportion of the participants in the present study, is very important as a strong indicator of postnatal poor bonding towards a neonate.[58–68] Effective intervention to fetal bonding disorder[69–72] may be useful as a tool not only to support such women but also to prevent neonatal bonding disorder after childbirth.

It is of note that suicidality was seen among not only antenatal depression positive women but also those with tokophobia, fetal bonding disorder, or emesis. There were as many cases with suicidality without antenatal depression as those with suicidality together with antenatal depression. Although this is a preliminary small sample study, we think that it is premature to think that suicidality is a part of depression only. Clinicians should be cautious about pregnant women's suicidality among women who do not have depression.

Emesis may be a physical expression of psychological problems such as tokophobia. What may be important is the distinction between cases of only gastrointestinal symptoms ($n = 4$ in the present study) and cases with psychological maladjustment ($n = 5$ in the present study). Antenatal depression, tokophobia, and fetal bonding disorder are such conditions clinicians should be alert for when identifying emesis cases.

Although antenatal depression, tokophobia, fetal bonding disorder, and suicidality are major perinatal health issues, women with such conditions rarely seek professional support spontaneously. Expectant women may believe that obstetricians and midwives can only be consulted about physical issues. It is of vital importance for perinatal health professionals to screen and identify expectant women who need mental health care. A brief and accurate screening

questionnaire to identify a wide range of mental health issues is a robust means by which perinatal health professionals can conduct a detailed assessment interview. When such women are identified, supportive intervention should be commenced immediately.

There are several drawbacks to this study. First, the participants were solicited via an internet website. Expectant women who had mental health problems might be more likely to be motivated in taking part in this study. We were unaware of details of their background such as life history, including rearing environment and current marital adjustments. Future studies should include such information. A second crucial limitation is that only a third of the questionnaire responders participated in the online interview. This may be a source of biases. Third, an important weakness of the present study was that the number of interviewed participants was very small ($n = 111$) and categories of some domains were extremely small. This may be a source of bias and makes the interpretation of the results difficult. We could not emphasize more the preliminary nature of the study. Fourth, the structured interview, the DAMBO-RV, usually took half an hour, thus it focused on limited areas of interest. When conducting an interview in clinical settings, professionals should cover not only psychopathological domains but also life history, personality, and social domains that are important for making a support and treatment plan. Fifth, we used a two-step cluster analysis, as a practical means, to categorize problem cases of fetal bonding disorder, tokophobia, suicidality, and emesis. These phenomena may be likely to be dimensional rather than categorical.[73,74] Further studies should be more vigorous to set a cut-off point to identify pathological categories. We selected the best set of questionnaire items for each domain by the means of AUC but it may be arbitrary. Such a procedure could make better use of item response theory if we had much larger samples. Finally, because the present study was a cross-sectional one, we were unaware of variances in psychometric properties if conducted repeatedly with a certain interval. A question that remains is the factor structures of the psychological problems discussed in the present study. Do they have several factors? If so, we have to create subscales of which internal reliability should be calculated. These are issues of great research and clinical importance but they will be discussed elsewhere because the main aim of the present study was to develop and validate a short screening questionnaire that covers important domains such as antenatal depression, tokophobia, fetal bonding disorder, suicidality, and emesis.

Although this is a preliminary report, the DAMBO Q11 may be a promising screening instrument to identify expectant women who need specific assessment and care in a wide range of mental health issues.

AUTHOR CONTRIBUTIONS

Toshinori Kitamura: Conceptualization, methodology, formal analysis, writing. **Mami Yamamoto, Tomomi Saito, Ayako Hada, Ayumi Tanke, Yuriko Usui, Hiroko Ishida,** and **Toshinori Kitamura**: Data curation. All authors have read and agreed to the published version of the manuscript.

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CONFLICT OF INTEREST STATEMENT

The authors declare no conflicts of interests.

DATA AVAILABILITY STATEMENT

All the data will be available upon reasonable request to the corresponding author.

ETHICS APPROVAL STATEMENT

This study was approved by the Institutional Review Board of the Kitamura Institute of Mental Health Tokyo (number 2022063001).

PATIENT CONSENT STATEMENT

Informed consent was electrically obtained from all participants involved in this study.

CLINICAL TRIAL REGISTRATION

N/A.

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SUPPORTING INFORMATION

Additional supporting information can be found online in the Supporting Information section at the end of this article.

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