Research Paper

Brief screening for maternal mental health in Vietnam: Measures of positive wellbeing and perceived stress predict prenatal and postnatal depression

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ABSTRACT

Background: In many countries, there is limited consideration of the psychological wellbeing of women during antenatal and postnatal care. Among a range of contributing factors, one practical reason is that brief, valid and reliable screening tools are not widely used to guide clinical interviews. The present study evaluated psychometric properties of three brief scales that measure recent wellbeing (the WHO-5 index), perceived stress (the PSS-10) and depression (PHQ-9).

Methods: A prospective birth cohort study was completed in Hue City, central Vietnam with 148 pregnant women in the third trimester of pregnancy, with follow-up 3–5 months after childbirth. Moderate-to-severe antenatal depressive symptoms were used as the reference standard to validate the WHO-5 and PSS-10.

Results: Approximately one-third of the women indicated significant stress and 12% reported moderate to severe depressive symptoms during pregnancy. The WHO-5 and PSS had good internal consistency (Cronbach's alpha=0.76–0.81) and good discriminant properties against prenatal depression. Area under the Curve (AUC) values showed good predictive validity to detect postpartum depressive symptoms for the WHO-5 [AUC=0.73, 95% CI (0.60 - 0.86)] and the PSS-10 [AUC=0.69, 95% CI (0.45 – 0.92)]. WHO-5 scores ≤ 60/100 and PSS-10 scores ≥ 20/40 provided good sensitivity (approx.83%) and fair specificity (approx.61%) to detect depression pre- and post-natally.

Conclusions: Given these satisfactory psychometric properties, brief but broad screening that includes questions about positive wellbeing and recent stress in addition to depressive symptoms should be integrated into routine psychosocial care for pregnant women in Vietnam and similar cultural contexts.

1. Background

Many women experience mental distress during pregnancy and the effects can be profound (Liou et al., 2016; Prady et al., 2013; Mughal et al., 2019). Despite its importance in primary care, establishing an open dialogue between pregnant women and health professionals is often challenging. This is especially the case in societies with a relatively short history of attention to psychological wellbeing by health professionals, and where mental health literacy is not yet optimal in the general population (Kelly et al., 2007).

In East Asian countries, many cultural, social, health service and individual factors can limit open discussion about depression, anxiety and other emotional problems during and after pregnancy (Fisher et al., 2012; Petersen et al., 2017). One important practical factor is that clinicians in many settings lack the training and tools to initiate conversation to briefly and validly assess their clients' wellbeing (Rathod et al., 2017; Baron et al., 2016). Mental health is a sensitive topic and may lead to shame or stigma during clinical interviews (Barney et al., 2009; Rössler, 2016). This sensitivity about mental health may be comparatively higher among pregnant women in Asian countries like Vietnam than for women in western and high-income countries, who generally have better mental health literacy (Bambridge et al., 2017). Thus, important questions emerge about how best to discuss mental health problems during antenatal care (Bambridge et al., 2017). Prior research suggests that women are more comfortable if they are asked some questions about their general wellbeing and coping at the beginning of clinical interviews (Melville and Hincks, 2016).

In Vietnam, screening maternal wellbeing and distress using standardised validated screening tools especially during antenatal care is rarely performed in routine practice (Van Ngo et al., 2018; Gammeltoft, 2018). Systematic reviews have described a range of scales used to screen for maternal mental distress and illness in Asian countries (Koirala and Chuemchit, 2020) and Vietnam (Do et al., 2019). Frequently used tools include the SCID- Structured Clinical Interview for DSM-IV, the EPDS Edinburgh Postnatal Depression Scale, the General Health Questionnaire 12 items (GHQ-12), Zung's Self-rated Anxiety Scale (Zung SAS), and the HADS – Hospital Anxiety and Depression Scale. However, these tools primarily focus on negative mental states and some are long and unsuitable for routine primary care settings where clinicians typically have short consultation times.

The 5-item Well-Being Index was developed by the World Health Organization in 1998 to assess perceived psychological well-being. This brief and non-invasive 5-item scale is used in many cultures and languages. The scale has been validated in clinical contexts and is a useful addition to screening for depression, quality of life and psychological distress (Torchalla et al., 2015). To date, however, there is limited information about sensitivity and specificity of WHO-5 scores in relation to mental health disorders during pregnancy (Sischka et al., 2020).

The Perceived Stress Scale (PSS) was originally designed by Cohen, Kamarck and Mermelstein (1983) to measure perceived stress over the previous month. The original version had 14 items but 10-item and 4-item short forms have been used (Lee, 2012). The ten-item version has been found to be superior to the 14-item version (Cohen, 1994). In Vietnam, the PSS-10 was validated among elderly women (Dao-Tran et al., 2017) with regard to face and construct validity but predictive validity was not examined. The present study explores the psychometric properties of these brief measures of maternal wellbeing, perceived stress and depressive symptoms. We examined internal consistency, convergent and discriminant validity, and concurrent and predictive validity to estimate optimal cut-off points and acceptable sensitivity and specificity. The purpose was to assess brief screening tools that measure both positive and negative mental states that can be readily used to facilitate discussion of parental well-being during primary care.

2. Methods

2.1. Study setting

A birth cohort study was implemented in Hue city, the main population centre of Thua Thien Hue province in central Vietnam. This site was one of eight medium-sized cities in middle-income countries included in the Evidence for Better Lives Study (Evidence for Better Lives Consortium 2019; Valdebenito et al., 2020). In Hue City, stratified multi-stage cluster sampling was applied to recruit 150 pregnant women selected from approximately 1500 women who registered for antenatal check-up in Hue city during the study period. Eight out of 27 city wards were randomly selected using a coin toss to select four wards in the South and four in the North-side of the city. Each ward has a commune health centre (CHC), and all pregnant women are expected to register for antenatal check-up. The population of the selected wards ranged between 7500 and 22,000 persons and approx. 1.500 pregnant women registered for antenatal check-up at health facilities. Women were included if they met the following criteria: (i) they were within the third trimester of pregnancy (i.e. weeks 29–40); (ii) 18 years of age or older; (iii) a resident of Hue city; and (iv) agree to participate and give signed informed consent. Women were recruited consecutively at each site following presentation at the CHC (Martínez-Mesa et al., 2016). At baseline (Wave 1) 150 women completed audio-computer assisted interviews, and 148 women completed follow up interviews three to five months after delivery. Two women whose babies died in utero or after delivery were not re-interviewed.

The sample size was calculated based on a previous study which estimated 12.6% of women experience prenatal intimate partner violence (P-IPV) (Le et al., 2014). A sample size of 151 patients (rounded to 150) is sufficient to detect 18 positive results, with a two-sided 0.05 significance level and power of 0.8. In anticipation of incomplete interviews and failure to provide consent, the target sample size was increased by 30% (45 cases), yielding an optimal study sample size of 195 pregnant women. In the data collection, among 195 pregnant women approached, 150 women were successfully recruited (mean age 29.9 ± 5.0), with a 76% response rate at Wave 1.

2.2. Data collection

The questionnaire was initially designed in English by the EBLS consortium. It was forward translated into Vietnamese by two independent bilingual experts and semantic equivalence was harmonised by a panel of four bilingual health professionals. Backward translation was optional and only focused on sensitive items, as recommended in the World Health Organization guidelines (WHO 2017). To assess the culturally adapted Vietnamese questionnaire, we initially conducted a pre-pilot interview with five prospective mothers. Participants completed face-to-face interviews and on average the interviews took approximately 60 min.

To ensure privacy and confidentiality, interviews were conducted in separate rooms within the commune health centre. The interview questionnaire was administered using computer-aided personal interview (CAPI). Some sensitive questions (e.g. adverse childhood experiences and substance use) were administered via audio-supported self-completion interview (A-CASI). The research protocol and details of interview methods have been reported elsewhere (Valdebenito et al., 2020).

A brief follow-up interview was conducted with 148 women between three to five months after birth (Wave 2). The follow-up interview of just 22 questions included a subset of the baseline measures focusing on the baby's and mother's health (e.g., child weight and height, type of delivery, breastfeeding, and maternal postnatal depressive symptoms).

2.3. Measurement

Of the 209-item baseline interview, 24 items measured maternal wellbeing (WHO-5), perceived stress (PSS-10) and recent depressive symptoms (PHQ-9) and 33 items measured victimization of violence [see Additional file 1: English questionnaire and Vietnamese versions]. The brief interview at follow-up included 22 questions about self-reported newborn health problems, mode delivery and maternal well-being.

The WHO-5 (5 items) is widely used to determine subjective wellbeing during the previous two weeks (Topp et al., 2015). The five plain language questions are answered on a 6-point Likert scale ("all of the time −0″, "most of the time-1″, "more than half of the time-2″, "less than half of the time-3″, "some of the time-4″ and "at no time-5″), ranging from 0 to 25. Raw scores are multiplied by 4 to generate a total score ranging from 0-absent wellbeing to 100-maximal well-being. A cut-off score <50 (or raw score <13) indicates low wellbeing (Topp et al., 2015).

The adapted 10-item PSS was designed to assess the perception of stress over the past month included six negatively-phrased items related to called "perceived helplessness" and four positively phased items regarding "perceived self-efficacy" (Maroufizadeh et al., 2018; Taylor, 2015). The original PSS-10 items utilized a 5-point Likert scale for responses ("never"−0, "almost never"−1, "sometimes"−2; "fairly often" – 3 and "very often") (Cohen et al., 1983). We adapted this to a 4-point Likert scale by merging "never" and "almost never" response anchors, so the four options were "not at all/ never- almost never-1″, "several days/ sometimes-2″, "more than half the days/ fairly often-3″, "nearly every day/ very often-4″. Based on evidence from literature and pre-test interviews with five pregnant women, the EBLS scientific advisory panel decided to modify the PSS-10 Likert scale to make it similar to the four PHQ-9 response anchors. Our goal was to limit vague linguistic frequency expressions (e.g. sometimes) (Bocklisch, 2019) and reduce the variety of response formats, especially in situations where the response anchors are comparable in the way they capture intensity or frequency of a given stimulus (Cameron et al., 2008). Varying response formats can be confusing to respondents, especially in middle income country settings where some participants have limited education.

The PHQ-9 measures depressive symptoms experienced during the preceding two weeks. The items cover the nine DSM-IV criteria for depression (Kroenke et al., 2001). Responses are given on a 4-point Likert scale ("not at all-0″, "several days-1″, "more than half the days-2″, and "nearly every day-3″). The possible total score ranges from 0 to 27. Cut-points of 5, 10, 15, and 20 represent "mild", "moderate", "moderately severe" and "severe depression" (Kroenke et al., 2001). The PHQ-9 has been validated globally (Cameron et al., 2008; Martin et al., 2006) and in Vietnam (Nguyen et al., 2016).

Prenatal intimate partner violence (P-IPV) victimisation was measured using an adapted 13-item scale from the WHO Multi-Country Study on Women Health and Domestic Violence against Women (WHO, 2005). The self-reported scale measures lifetime IPV and how often abuse was experienced in the past 6 months on 4-point Likert scale ranging from "never" = 0 to "many times" = 3. Women who experienced at least one type of P-IPV were categorised dichotomously (1/ Yes, 0/ No).

Suicidality: The Suicide Behaviors Questionnaire-Revised (SBQ-R) is used to indicate lifetime suicidal risk (Supraja et al., 2016). We included one item of the SBQ-R: "*Have you ever thought about or attempted to kill yourself?*" with responses on 5-point Likert scale from 0-never to 4-suicidal and really hoped to die.

Birth outcomes were measured by several variables. The delivery mode was based on the question: "How was your baby delivered?" (C-section or vaginal delivery). Breastfeeding was estimated with the question: "How are you feeding your baby?" and breastfeeding behaviour at 3 to 5 months was coded as Yes (exclusive) or No (Not exclusive). Baby sickness was indicated by the mother's response to the question: "*Has your baby suffered from any of the following problems (diarrhoea, vomiting, infection, thrush, constipation, weight problem or other sickness?*" (Yes/No).

Childhood adversity – We used 19 out of the 31 items in the Adverse Childhood Experiences International Questionnaire (ACE-IQ) to measure the severity of adverse experiences up to the age of 18 years (WHO, 2009). This tool has been tested in international comparative studies including among Vietnamese students (Tran et al., 2015). A subset of 6 items that focused only on childhood abuse was used to identify women with physical or sexual abuse experiences as a child. Respondents were categorised as having child abuse if they responded 'Yes' to at least one of the 6 items on physical and sexual abuse (Yes/ No).

2.4. Statistical analysis

Statistical analysis was conducted using Stata Version 15.1 (Stata Corp. LP, TX, USA). Cronbach's alpha coefficients were used to indicate internal consistency, with an acceptable value > 0.7 (Taber, 2018).

Convergent and discriminant validity: Internal convergent and discriminant validity were assessed from the correlation matrix which shows correlation coefficients for 24 items with the total scores of three scales (Perrot et al., 2014; Campbell and Fiske, 1959). Items with a factor loading with their own scale any lower than 0.4 were considered to lack convergent validity. In contrast, items having a correlation with their theoretical scale (e.g. WHO-5 item) lower than the coefficient computed against other scores' scales (e.g. item coefficient with PSS-10 or PHQ-9) were deemed to lack divergent validity.

Internal structure of the instrument: The structure of WHO-5 and PSS-10 was tested separately using Horn's Parallel Analysis to determine the number of factors based on principal component analysis (PCA) and factor analysis (O'Connor, 2000), and Structural Equation Modelling (SEM) where the three latent factors (PHQ-9, WHO-5 and PSS-10) were computed in the multiple-factor measurement model. The fit of the SEM was assessed through RMSEA (acceptable fit of <0.06) and CFI, with acceptable fit if > 0.95 (Hu and Bentler, 1999) and when relative Chi-square values were less than 5 (Baldwin, 2019). A bootstrapping technique was used with 100 replications to obtain a robust standard error in the SEM model.

Concurrent and predictive validity: The total score of the WHO-5 Wellbeing Index was reversed (WHO-5-R). The sensitivity and specificity of the WHO-5 and PSS-10 to detect moderate-to-severe depressive symptoms was assessed by comparing scores with those of the PHQ-9 collected at Wave 1 and Wave 2 as a proxy reference standard. A case definition was that a woman who has a PHQ-9 score greater than 10 is considered to have at least moderate prenatal depression (Wave 1) or postpartum depression (Wave 2). A total of 19 women (12.67%) were found to have moderate prenatal depression and 6 women (4.1%) reported postpartum depression. WHO-5-R and PSS-10 scales were compared to the reference standard via the Receiver Operating Characteristic (ROC) curve to generate the Area under the Curve (AUC). A cut-off of AUC less than 0.5 indicates that the test was unable to detect cases, and when the AUC value approaches 1 it indicates an excellent classifier (Habibzadeh et al., 2016). The optimal cut-point was determined by the optimal level of sensitivity and specificity, as well as scale efficiency (i.e. the proportion of the sample correctly classified by the scale) at that cut-point (McFall and Treat, 1999).

Fagan's Nomogram, a convenient graphical calculator (Caraguel and Vanderstichel, 2013), was applied to quantify the post-test probability for positive and negative test results using a pre-test probability (assumed prevalence of women who felt unhappy and crying during pregnancy) at 32%, based on a study of 1260 pregnant women in Vietnam (Hue et al., 2020). The clinical utility was assessed using the pre-test probability and likelihood ratios of each test (Tugwell et al., 1997a,b P. Tugwell et al., 1997).

Clinical application of three scales: To generate individual mental health profiles based on combined measures, distributions of scores from the WHO-5 and PSS-10- were dichotomized based on ROC curves that suggest cut-offs or ≤ 60 for the WHO-5 and ≥ 20 for the PSS-10. Then, we generated an ordinal variable based on whether women had poor

Table 1
Demographic characteristics and antenatal history of the participating mothers (N = 148).

Variables	N (%)	Variables	N (%)
Mean age in years (SD)	29.9 (5.0)	**Family structure**	
Age groups (in years)		Nuclear family	50 (33.8)
18–24	20 (13.3)	Extended family	98 (60.2)
25–34	107 (71.3)	**Employment**	
≥35	23 (15.3)	Unemployed	42 (28.4)
Ethnicity		Manual labour	47 (31.8)
Kinh	146 (98.6)	Professional, or administrative worker	59 (39.8)
Minority groups	2 (1.3)	**Antenatal history**	
Educational attainment		Nulliparous	42 (28.4)
Primary school or lower	28 (18.9)	Multiparous	106 (71.6)
Secondary school	29 (19.6)	**Present unplanned pregnancy (Yes vs. No)**	47 (31.3)
High school	23 (15.5)	**Low well-being (WHO-5 raw score <13)**	44 (29.7)
Vocational training or higher	68 (45.9)	**Maternal distress**	
Residence		Low distress	33 (22)
Urban	73 (49.3)	Moderate distress	75 (50)
Peri-urban	75 (50.7)	High distress	42 (28)
Family economic status		**Prenatal depression**	
Poor	20 (13.5)	None to minimal depression	72 (48)
Near poor	20 (13.5)	Mild depression	59 (33.3)
Medium	79 (53.4)	Moderate to severe depression	19 (12.7)
Better-off	29 (19.6)	**Postpartum depression**	
		None to minimal depression	110 (74.32)
		Mild depression	32 (21.62)
		Moderate to severe depression	6 (4.05)

mental health on both PSS-10 and WHO-5, (n = 31), poor on any one or two measures (n = 44), or whether they had good mental health on both measures (n = 72). Women who scored poor on both measures were labelled as a high risk of mental disorder. Chi-square tests were used to assess the associations between 'high risk of mental disorder' and various factors measured during or after pregnancy (e.g. P-IPV, childhood abuse, C-section).

Finally, the predictive capacity of the WHO-5, PHQ-9 and PSS-10 was evaluated by hierarchical multiple regression analysis to test the strength of prediction of postpartum depression scores (PHQ-9 score). These three scales and six other variables (i.e. P-IPV experiences, total score of adverse childhood experience, suicidal ideation, C-section delivery, breastfeeding status, and health of infant) were sequentially added to the eight models to assess whether these factors improve prediction of postpartum PHQ-9 score (R^2 value).

2.5. Ethics

The research protocols were approved by the Human Research Ethics Committee at the Queensland University of Technology in Australia (Approval Number: 1,900,000,082) and the University of Cambridge's Ethics Committee in the UK (Approval Number: 18/180). Local ethics clearance was gained from Hue University of Medicine and Pharmacy in Vietnam (Approval Number: H2018/430). All participants provided written informed consent before interview.

3. Results

The sample characteristics are presented in **Table 1**. Nearly all of the women reported Kinh ethnicity (98%), most were in the age group 25–34 years (71.3%) and lived with an extended family in their household (60.2%). Many had completed post-school vocational training for had a college diploma or university (45.9%). About half lived in peri-urban areas of the city (50.7%) and most were employed (71.6%). One in every seven women (13.5%) lived in a household officially classified as poor by local authorities based on standard criteria for the province. Most women had prior births (71.6%), and at least one unplanned pregnancy (68.7%). The majority of women reported moderate to high levels of wellbeing, low daily stress and few symptoms of depression. Conversely, approx. 30% of mothers experienced low wellbeing on the WHO-5 Index, and PSS-10 scores indicated that 28% experienced high stress in the

previous month, while 12.7% reported moderate to severe prenatal depression. After childbirth, 21.6% mothers reported mild depression and 4.05% experienced moderate to severe depression. The demographic characteristics of the sample are similar to Hue city in general including educational attainment. The population of Hue has a high adult literacy rate (93%) and high enrolment rates to college/ university (49%) (Thua Thien Hue Provincial Department of Population and Family Planning, 2018).

3.1. Reliability – internal consistency

Table 2 shows good internal consistency with Cronbach's alphas > 0.7 for all three scales including α (WHO-5) = 0.81; α (PSS-10) = 0.76; and α (PHQ-9) = 0.79. All items were worthy of retention.

3.2. Convergent and discriminant validity

The correlation matrix shown in **Table 2** indicates good convergent and discriminant validity for the WHO-5 as all five items are theoretically correlated (factor loading > 0.4 and these correlations were greater than found for the items from other scales. The correlation matrix also indicates that PSS and PHQ-9 are correlated on some items. Two items of the PHQ-9 (item 17 and 24 shown in Table 2) and six items of the PSS-10 (item 6–8, item 11, 14 and 15 in Table 2) are less correlated to its theoretical scale (<0.4). Two items (8 and 15) of the PSS-10 show stronger correlation with PHQ-9 rather than its own scale (PSS-10). However, all items should be retained, as no correlation coefficient to its scale was lower than 0.2.

3.3. Internal structure

Fig. 1 shows where the parallel analysis dashed line crosses the solid factor analysis. The parallel analysis indicates there is one factor for WHO-5-R, at least two factors for PSS-10 as the dashed line cross before reaching the second factors for WHO-5-R and before reaching the third factor for PSS-10.

Although the parallel analysis for the PSS-10 suggests two factors (stress in the first five items and self-control in the last five items), the CFA model confirms that the scale is unidimensional as the CFA-one-factor-model had a significantly improved fit (RMSEA = 0.001,

Table 2
Internal consistency and correlation matrix between items and scales.

Items	α if item deleted	WHO-5	PHQ-9	PSS
		Scales		
WHO-5 (Cronbach's alpha)	**0.83**			
1. Feeling cheerful and in good spirits	0.74	**0.70**	0.38	0.41
2. Feeling calm and relaxed	0.76	**0.64**	0.39	0.39
3. Feeling active and vigorous	0.78	**0.59**	0.35	0.29
4. Feeling fresh and rested when waking up	0.75	**0.67**	0.43	0.32
5. Filling with things that interested in daily life	0.83	**0.41**	0.28	0.39
PSS-10 (Cronbach's alpha)	**0.76**			
6. Being upset because of unexpected things	0.75	0.36*	0.29	**0.34**
7. Feeling unable to control the important things in life	0.75	0.31	0.36*	**0.33**
8. Feeling nervous and "stressed"	0.75	0.31	0.51*	**0.37**
9. Feeling confident to handle personal problems (Reversed)	0.76	0.20	0.15	**0.41**
10. Feeling that things were going my way (Reversed)	0.74	0.26	0.22	**0.56**
11. Feeling unable to cope with all the things	0.77	0.33	0.36*	**0.28**
12. Being able to control irritations in life (Reversed)	0.76	0.13	0.09	**0.42**
13. Feeling being on top of things (Reversed)	0.73	0.35	0.28	**0.61**
14. Being angered because of out- of-control things	0.74	0.27	0.46*	**0.40**
15. Feeling that difficulties were piling up so high that could not overcome	0.73	0.39	0.54*	**0.53**
PHQ-9 at Wave 1 (Cronbach's alpha)	**0.79**			
16. Little interest or pleasure in doing things	0.76	0.47	**0.55**	0.41
17. Feeling down, depressed or hopeless	0.77	0.41	**0.42**	0.50*
18. Trouble falling or staying asleep, or sleeping too much	0.78	0.13	**0.42**	0.13
19. Feeling tired or having little energy	0.75	0.49	**0.64**	0.38
20. Poor appetite or overeating	0.76	0.22	**0.56**	0.21
21. Feeling bad about yourself	0.77	0.31	**0.50**	0.30
22. Trouble concentrating on things	0.77	0.28	**0.45**	0.32
23. Moving or speaking so slowly or being so fidgety or restless	0.76	0.30	**0.52**	0.41
24. Would be better off dead, or of hurting yourself	0.8	0.10	**0.24**	0.31*

Note: Items with factor loadings in bold lower than 0.4 have low convergent validity. An item with factor loadings in bold lower than factor loadings of other rows shows low discriminant validity. Items with asterisk have a higher factor loading on a scale other than the one it is designed to measure.
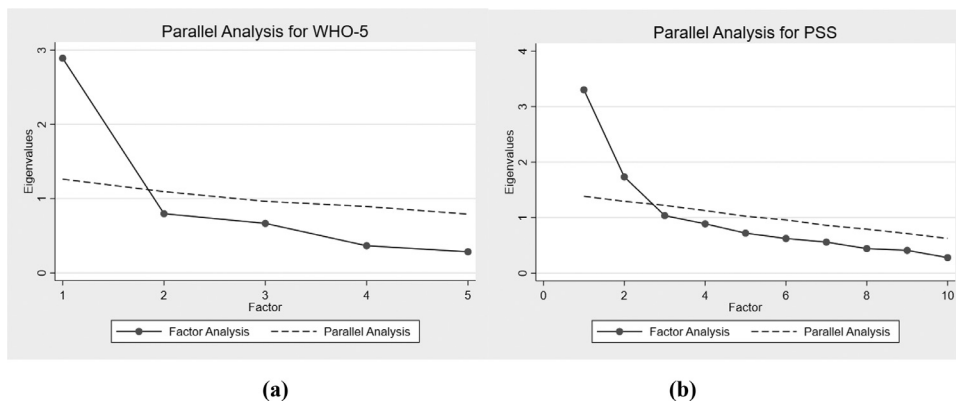

Fig. 1. Factor extraction for WHO-5 (1a) reversed and PSS-10 (1b) based on parallel analysis.

CFI = 0.99) while the two-factor model had unacceptable fit indices (RMSEA = 0.078, CFI = 0.92). The parallel analysis and CFA verified the unidimensionality of WHO-5-R and PSS-10 (Fig. 2). The multiple-factor measurement models using SEM approach was further assessed in the Additional file 2 - Figure A3 and A4.

3.4. Concurrent and predictive validity

The area under ROC curves (AUC) of the WHO-5-R and PSS-10 were estimated using the PHQ-9 as a 'proxy reference standard'. The AUC values shown in Fig. 3a denote a good classifier for both the WHO-5-R [0.80, 95% CI (0.72 – 0.87)] and the PSS-10 [0.84, 95% CI (0.76 – 0.93)]. The sensitivity, specificity, LR+, LR- and the proportion of correctly classified cases for each cut-off point of PHQ-9 and PSS-10 are shown in Table 3. Based on the proportion of correctly classified cases and optimum balanced indicators of sensitivity and specificity, we suggest the cut-off scores of ≤ 60/100 for WHO-5 and ≥ 20 for PSS-10 should be useful for maternal depression screening. These cut-points produce satisfactory sensitivity and specificity to identify approx. 70% of cases where participants reported moderate to severe depressive symptoms.

Fig. 3b shows Area under ROC curves (AUC) of the WHO-5-R and PSS-10 against postpartum depression (PPD) as indicated by scores above the cut-point of the PHQ-9 scores for women 3 to 5 months after delivery. The AUC values suggest these scales are good classifiers for the prenatal WHO-5-R score [0.73, 95% CI (0.60 – 0.86)] while PSS scores are fair classifiers [0.69, 95% CI (0.45 – 0.92)]. However, there is no statistically significant difference among the AUCs (p = 0.68). These data indicate that cut-off scores of ≤ 60/100 for WHO-5 and ≥ 20 for PSS-10 can predict around 60% of moderate PPD cases three to five months after childbirth [More detail is provided in Additional file 2 – Table A4].

The Fagan's nomogram was used to quantify the post-test probability for positive and negative test results of PSS_10 and WHO-5 using sensitivity, specificity and pre-test probability. The assumed pre-test probability was based on 32% of women who felt unhappy and were crying often during pregnancy in previous study in Vietnam as a reference for
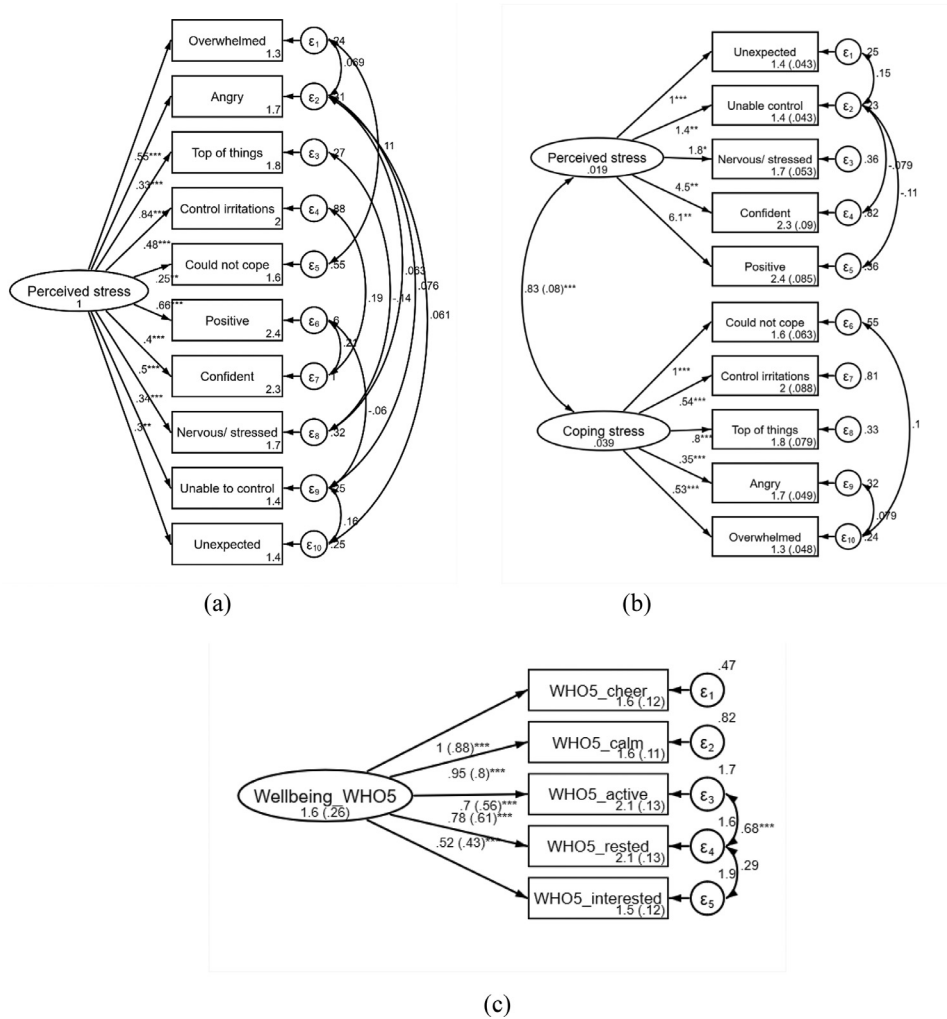
Fig. 2. Diagrammatic representations of the two alternative CFA models for PSS-10 and WHO-5

(a) **M1: One-factor PSS-10** [χ^2 (25, n = 148) = 21.9, RMSEA (90% CI) = 0.001 (0.001; 0.0056), CFI = 0.99, TLI = 1.01, SRMR = 0.055]; (b) **M2: Two-correlated factor PSS-10** [χ^2 (29, n = 148) = 55.7, RMSEA (90% CI) = 0.078 (0.046; 0.109), CFI = 0.92, TLI = 0.88, SRMR = 0.088]; (c) **M3: One-factor WHO-5** [χ^2 (3, n = 148) = 3.01, RMSEA (90% CI) = 0.005 (0.001; 0.138), CFI = 1, TLI = 1, SRMR = 0.017.
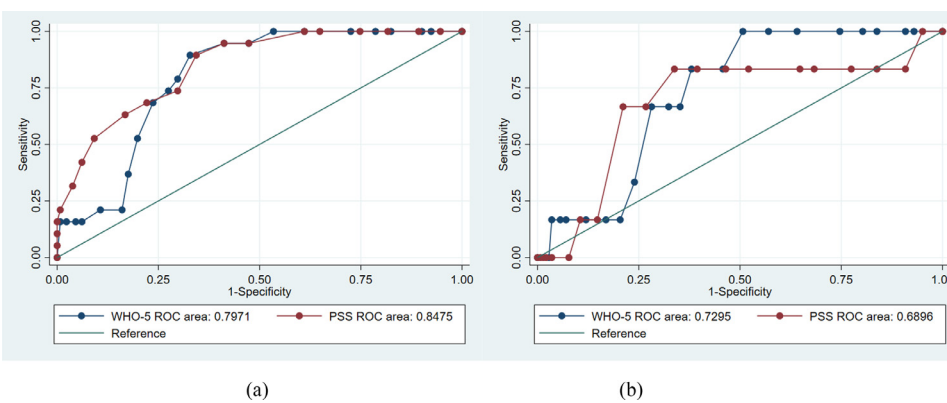
Fig. 3. ROC curve and properties of WHO-5-R and PSS-10 in screening for prenatal depression (a) and postpartum depression (b).

target disorder. The post-test probabilities for the presence of prenatal depression after testing WHO-5 or PSS-10 were 56% and 55%, respectively. In practical terms, if a score indicates low general wellbeing on the WHO-5, there is a corresponding 56% certainty that the person has prenatal depression and should be ruled in for prenatal depression treatment. The post-test probability for negative results of 7% for both scales shows how a negative result can rule out the presence of prenatal depression [See Additional file 2 – Figure A5].

Table 4 shows the outcomes that may be related to maternal wellbeing pre- and postnatally by using depression scale and MH profiles based on the above cut-off scores of PSS-10 and WHO-5. The combined measurement of WHO-5 and PSS-10 scales detected additional women with traumatic childhood experiences and adverse postpartum outcomes. Based on the PHQ-9 scale, 19 women were classified prenatally as having moderate-severe depression while 34 women had low wellbeing and high stress. Those with moderate-severe depression have significantly higher proportions of suicidal ideation, C-Section delivery and non-exclusive breastfeeding. In contrast, combining measures of WHO-5 and PSS-10 captured some women who had experienced child abuse, those who had sick babies, or postnatal depression, compared to prenatal PHQ-9 score alone.

Table 3

Concurrent and predictive validity of the WHO-5 and PSS-10, based on standard PHQ-9.

	Prenatal depression		Postpartum depression	
	WHO-5	PSS-10	WHO-5	PSS-10
AUC (95% CI)	0.80 (0.72 – 0.87)	0.84 (0.76 – 0.93)	0.73 (0.60 – 0.86)	0.69 (0.45 – 0.92)
Optimal cut-off point (original score)	≤ 60/100 or 15/25 (raw score)	20/40	≤ 60/100 or 15/25 (raw score)	>20/40
Sensitivity	89.47%	89.47%	83.33%	83.33%
Specificity	67.18%	65.65%	61.97%	66.20%
Correctly Classified	70%	68.67%	62.84%	66.89%
Positive likelihood ratio	2.73	2.60	2.19	2.47
Negative likelihood ratio	0.16	0.16	0.27	0.25
Post-test probability (+)	56% (49%,63%)*	55% (48%,62%)*		
Post-test probability (-)	7% (3%,14%)*	7% (3%,15%)*		

Note:.

* Post-test probability was calculated based on an assumed pre-test probability of 32%.

Table 4

Patterns of maternal well-being and birth outcomes between single PHQ-9 and combined measures of WHO-5 and PSS-10.

Outcome	Total (n = 150)	MH profiles(Combined measures of WHO5 and PSS-10)				Prenatal depression(PHQ-9 cut-off scoring)		
		Poor(n = 34)	Moderate(n = 44)	Good (n = 72)	p value	M/S depression(n = 19)	No depression(n = 131)	p value
P-IPV experienced	22 (14.67)	5 (14.71)	7 (15.91)	10 (13.89)	0.955	5 (26.32)	17 (12.98)	0.125
Childhood abuse	53 (35.33)	17 (50)	17 (38.64)	19 (26.39)	0.045	10 (52.63)	43 (32.82)	0.091
Suicidal ideation	8 (5.33)	3 (8.82)	4 (9.09)	1 (1.39)	0.075	3 (15.79)	5 (3.82)	0.03
C-Section	72 (48.65)	19 (55.88)	25 (56.82)	28 (40)	0.136	15 (78.95)	57 (44.19)	0.005
Not breastfeeding	59 (39.86)	17 (50)	20 (45.45)	22 (31.43)	0.128	13 (68.42)	46 (35.66)	0.006
Baby sick	24 (16)	9 (26.47)	3 (6.82)	12 (16.67)	0.047	3 (15.79)	21 (16.03)	0.979
PPD	6 (4.05)	5 (14.71)	–	1 (1.43)	0.001	1 (5.26)	5 (3.88)	0.775

This study examined the utility and psychometric properties of the WHO-5 and the PSS-10, two brief screening tools for general wellbeing and stress among pregnant women in central Vietnam. Although most women indicated they had good mental health, many had low well-being (29.7%) or perceived high stress (22%) during pregnancy, and one in eight women (12%) reported moderate to severe a symptoms of antenatal depression. This pattern is similar to the experience of pregnant European women regarding low-wellbeing (27.1%) (de Wit et al., 2015) and depression (12.4%) (Le Strat et al., 2011). With the longitudinal design and high response rate, this study enabled comprehensive evaluation of psychometric properties, including internal consistency, concurrent and predictive validity, discriminant, convergent validity and the optimal cut-off score, specificity, sensitivity to predict adverse birth and postnatal outcomes.

The study strongly suggests that brief screening of emotional wellbeing during pregnancy in Vietnam should go beyond asking questions about depressive symptoms. When women's mental health was classified in relation to moderate to severe prenatal depression using the PHQ-9 alone, the tool was not a sensitive indicator of well-established correlates, including women's a history of childhood trauma, or postnatal maternal and child health problems. In contrast, when questions about subjective wellbeing and perceived stress were combined with depression scores, more mothers with common health problems (Xu et al., 2017; Smithson et al., 2020), or behaviour problem (e.g. failure of exclusive breastfeeding) (Young et al., 2020; Channell Doig et al., 2020) were indicated. This brief combination of questions about positive wellbeing, stress and depression may help to enhance focus on women's well-being during primary care (Accortt and Wong, 2017; O'Connor et al., 2016; Thombs et al., 2018) (Melville and Hincks, 2016) in countries like Vietnam where this aspect of care is not yet routine.

An important outcome from the analysis of concurrent validity was the derivation of clinically meaningful a cut-off score of ≤ 60/100 for the WHO-5 and 20/40 for the PSS-10 to detect moderate to severe depression during pregnancy. Prior research in eight studies found the optimal threshold to be ≤ 50/100 (or 13/25 raw score) for the WHO-5 to predict depressive symptoms (Topp et al., 2015). The PSS-10 normally has no fixed cut-off but scores of 20 points or more are considered to indicate a "high level of stress" (Thua Thien Hue Provincial Department of Pop-

ulation and Family Planning, 2014). To predict postpartum depression, this study found the cut-off point of 60/100 on the WHO-5 and 20/40 for PSS-10 achieved optimal sensitivity (83%) and specificity (66%) to detect depressive symptoms after childbirth. Both scales provide potentially good predictive validity for mental health status in women during late pregnancy and after childbirth.

In this study, we amended the PSS-10 response options by truncating the 5-point Likert rating to a 4-point rating. This change followed cognitive interviewing which recommended simplification of response options by using the same format for the PHQ-9 and the PSS-10. The amended response PSS-10 format might not appreciably affect the findings of this study. Evidence from literature on response formats of instruments shows that criterion-related validity usually is not affected by the number of response points (Lei, 1994). Further, Leung (2011) suggested that there are minimal differences between 4- and 5- point Likert scales regarding psychometric properties (e.g. item–item correlation coefficients, internal consistency, item–total score correlation, or factor structure and item loadings) (Leung, 2011). In this study, the amended PSS-10 showed good internal consistency (the alpha is within the normal range) and adequate convergent and divergent validity based on associations with the WHO-5 and PHQ-9. Notably, PSS-10 data showed strong concurrent and factorial validity in measuring perceived stress. The single factor solution is consistent with unidimensionality of the original PSS designed by Cohen (1988) and has been observed in recent studies (Lee, 2012), although some psychometric analyses of the PSS-10 have indicated two-factors (Dao-Tran et al., 2017; Liu et al., 2020). Combining "never" and "almost never" item responses may have little effect on the ability of the PSS-10 to correctly classify stressed pregnant women. Arguably, the four-point verbal rating options are more equidistant after merging the lower two options (Bocklisch et al., 2012).

Although both WHO-5 at cut-off 60 and PSS-10 at cut-off 20 provide good sensitivity (>80%) to detect depression pre- and post-natally, the specificity is lower (approx. 60%). However, for a screening tool, achieving adequately high sensitivity is more important than specificity as they are primarily intended to alert clinicians and clients to the possible need for deeper assessment of mental health, but by themselves will not be used to decide whether or not to commence therapy (Topp et al., 2015).

Table 5

Presents the Hierarchical Multiple Regression Models for postpartum depression symptoms. Initially, the first model shows that ACE events significantly contributed to the increased PHQ-9 score after childbirth (R^2 =0.061). Then, the introduction of the WHO-5 score (model 2), PSS-10 (model 3) and PHQ-9 (model 4) improve the prediction of the model. The correlations were stronger for the PHQ-9 (R^2 =0.016) and WHO-5 (R^2 =0.011) than the PSS-10 (R^2 =0.002). However, these R^2 changes did not achieve statistical significance. In subsequent models where postpartum factors were included (e.g. delivery mode, breastfeeding or infant health condition), no statistically significant correlation was found. Table 5: Hierarchical Multiple Regression Models for postpartum depression (PHQ-9 score).

Predictors	R^2	R^2 change	β (95% CI) Model 1	Model 2	Model 3	Model 4	Model 5	Model 6	Model 7	Model 8
ACE severity			0.55 (0.19, 0.9)**	0.51 (0.15, 0.87)**	0.49 (0.13, 0.85) **	0.42 (0.05, 0.79)*	0.41 (0.03, 0.78)*	0.41 (0.02, 0.78)*	0.4 (0.02, 0.78)*	0.42 (0.02, 0.8)*
Prenatal IPV severity	0.061*		−0.06 (−0.31, 0.2)	−0.05 (−0.31, 0.2)	−0.07 (−0.33, 0.19)	−0.07 (−0.33, 0.19)	−0.09 (−0.35, 0.18)	−0.09 (−0.36, 0.17)	−0.08 (−0.35, 0.19)	−0.1 (−0.37, 0.17)
WHO-5 score	0.071*	0.011		−0.01 (−0.03, 0.01)	−0.01 (−0.03, 0.01)	0.001 (−0.03, 0.02)	0.001 (−0.03, 0.02)	0.001 (−0.03, 0.02)	0.001 (−0.03, 0.02)	0.001 (−0.03, 0.02)
PSS-10 score	0.074*	0.002			0.04 (−0.08, 0.15)	0.01 (−0.12–0.13)	0.01 (−0.12–0.13)	0.01 (−0.13–0.12)	0.01 (−0.14–0.12)	0.02 (−0.14–0.11)
Prenatal PHQ-9 score	0.089*	0.016				0.12 (−0.03, 0.28)	0.12 (−0.04, 0.28)	0.12 (−0.03, 0.28)	0.13 (−0.03, 0.28)	0.12 (−0.04, 0.28)
prenatal suicidal though (yes vs. no)	0.093*	0.004					0.83 (−1.34, 2.99)	0.85 (−1.32, 3.03)	0.83 (−1.35, 3.01)	0.82 (−1.36, 2.99)
caesarean delivery (yes vs. no)	0.094	0.001						0.20 (−0.72, 1.12)	0.24 (−0.69, 1.17)	0.25 (−0.68, 1.17)
Breastfeeding (Yes vs. No)	0.097	0.003							−0.31 (−1.26, 0.64)	−0.26 (−1.21, 0.68)
Baby sick (Yes vs. No)	0.108	0.011								0.87 (−0.27, 4.56)

Note.

* $p<0.05$.

** $p<0.01$ ***$p<0.001$. β (95% CI) is a standardized coefficient value with 95% confidence intervals for coefficient. ACE adverse childhood experiences Discussion.

This study has implications for primary care practice in Vietnam and similar countries. It demonstrates that screening for maternal wellbeing and distress using the WHO-5 and PSS-10 is well accepted by women recruited at primary health care clinics. The tools are easy to score and, with the recommended cut-points shown in this study, clinicians may find them useful to consider clinical diagnosis and possible, psychotherapy.

Another important implication of this study is its clinical suggestions on how to ask perinatal women about MH to reduce distress during the interview with clinicians. Our findings emphasize the sensitivity of MH and its potential as a stigmatising topic. Previous studies strongly indicate the sensitivity of raising MH is much greater in countries like Vietnam than in most western countries or high resource settings, where many women have quite good MH literacy (Bambridge et al., 2017). Thus, care needs to be taken to commence with general questions before leading into specific questions about symptoms of depression (e.g. stressful life or suicidal thoughts) (Bambridge et al., 2017). Evidence shows that respondents are more likely to engage the interview if the questions focus on their positive experiences rather than a direct focus on the weaknesses, illnesses, and failures (Melville and Hincks, 2016). A key point from this study's recommendations is that by using the WHO-5 and PSS-10, the brief screening interview covers more than just symptoms of depression. Our findings emphasised that using WHO-5 and PSS-10 to initiate the interview with clinicians, the scores do indicate underlying common mental disorders such as maternal distress, low well-being, and depression. Earlier work found that women are willing to answer screening questions for depression but they prefer to self-help resources (Kingston et al., 2015). Thus, using self-reported non-invasive questionnaire could be helpful to initiate discussion and facilitate rapport and openness, then a broader assessment tool to capture general health such as the PHQ-9. The PSS-10 can then be used to determine a specific MH problem (Hunsley and Mash, 2005).

Some limitations should be noted. First, it is necessary to investigate test-retest reliability to assess the stability at different time points. Second, our evaluation of concurrent validity would have been more valuable if the "gold standard" was derived from clinical diagnosis, rather than a self-reported scale for depressive symptoms. A third limitation is the small sample size which might produce unstable prevalence estimates and this may explain the lower-than-expected prevalence of postpartum depression (4.1%). This low estimate might be related to the relatively high proportion of multiparous women (71%) who in general are less likely to experience postpartum depression than first-time mothers (Do et al., 2018). However, the low rate of postpartum depression estimated using the PHQ-9 might not be adequate to test the predictive utility of the WHO-5 and PSS-10. Further research should examine the extent to which WHO-5 and PSS-10 scores predict other measures of depressive symptoms such as the EPDS, and a broader range of infant health and maternal outcomes. Although several authors recommend a larger sample than we employed in this study to minimize measurements error, gain more stable factor loadings and produce generalizable results (Comrey and Lee, 2013; Boateng et al., 2018), the sample used here does reach the minimum of approximately 150 participants needed for adequate psychometric testing purposes (Anthoine et al., 2014), as a ratio of ten participants per variable is sufficient for CFA approach (Tabachnick and Fidell, 2007).

4. Conclusions

This study supports the validity and utility of brief screening tools (WHO-5 and PSS-10) in detecting low wellbeing, stress and maternal depression among pregnant women in a Vietnamese setting. The cut-off points, specificity and sensitivity of WHO-5 and PSS-10 have practical implications for the detection and care of maternal depression in Vietnam.

Authors' contributions

All authors were engaged in the overall conceptualization, study design, investigation, and findings interpretation. H.P.D., P.B., and M.D. were involved in the analysis and writing draft of this manuscript. H.P.D., T.V.V., BY.L.T., L.H.N., T.D.H., S.V., M.E., P.B., and B.X.T. were involved in the data validation and curation. T.V.V., BY.L.T., L.H.N., T.D.H., S.V. and M.E. were engaged in project administration, resources management for data collection. M.D contributed to provide critical review and revision of multiple drafts of the manuscript. All authors provided inputs for this paper and approved the final version.

Supplementary materials

Supplementary material associated with this article can be found, in the online version, at doi:10.1016/j.jadr.2020.100047.

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