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Research paper

An economic evaluation of targeted case-finding strategies for identifying postnatal depression: A model-based analysis comparing common case-finding instruments

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ABSTRACT

Background: Half of women with postnatal depression (PND) are not identified in routine care. We aimed to estimate the cost-effectiveness of PND case-finding in women with risk factors for PND.
Methods: A decision tree was developed to represent the one-year costs and health outcomes associated with case-finding and treatment for PND. The sensitivity and specificity of case-finding instruments, and prevalence and severity of PND, for women with ≥1 PND risk factor were estimated from a cohort of postnatal women. Risk factors were history of anxiety/depression, age < 20 years, and adverse life events. Other model parameters were derived from published literature and expert consultation. Case-finding for high-risk women only was compared with no case-finding and universal case-finding.
Results: More than half of the cohort had one or more PND risk factor (57.8 %; 95 % CI 52.7 %–62.7 %). The most cost-effective case-finding strategy was the Edinburgh Postnatal Depression Scale with a cut-off of ≥10 (EPDS-10). Among high-risk women, there is a high probability that EPDS-10 case-finding for PND is cost-effective compared to no case-finding (78.5 % at a threshold of £20,000/QALY), with an ICER of £8146/QALY gained. Universal case-finding is even more cost-effective at £2945/QALY gained (versus no case-finding). There is a greater health improvement with universal rather than targeted case-finding.
Limitations: The model includes costs and health benefits for mothers in the first year postpartum, the broader (e.g. families, societal) and long-term impacts are also important.
Conclusions: Universal PND case-finding is more cost-effective than targeted case-finding which itself is more cost-effective than not case-finding.

1. Background

Postnatal depression is depression that occurs within the first year following childbirth. The prevalence of PND in mothers is estimated to be around 17–18 % (Hahn-Holbrook et al., 2018; Shorey et al., 2018), ranging between 3 % to 38 % globally (Hahn-Holbrook et al., 2018). PND is associated with long-term mental health problems for mothers, reduced quality of life, difficulties with partner and other social relationships (Slomian et al., 2019). There is also evidence of negative outcomes for babies of mothers with PND including growth (weight and length) and development (Slomian et al., 2019). The need to identify and support women who experience PND is clear, however evidence consistently shows that perinatal mental illness (i.e. during and beyond pregnancy) is not well-identified or treated in current systems. For example, a prospective cohort study of pregnant women in London reported that contact with mental health services during pregnancy or in

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the early postnatal period was recorded for just a third of women with a diagnosable mental disorder antenatally (Lee-Carbon et al., 2022).

Systematic screening or case-finding is one way of potentially improving the identification of PND. A recent review of PND screening recommendations in Organisation for Economic Co-operation and Development (OECD) member countries reported that most publications they identified did endorse screening, although noted that there were some exceptions (El-Den et al., 2022). Guidelines from the National Institute for Health and Care Excellence (NICE) in England for antenatal and postnatal mental health recommend that at all contacts during pregnancy and the early postnatal period healthcare providers should "consider" asking women two probing questions related to depression (known as the Whooley questions (Whooley et al., 1997)) (National Institute of Health and Care Excellence (NICE), 2014). Guidance for postnatal care suggests a list of topics that healthcare providers "may" discuss with postnatal women which includes their mental health (National Institute of Health and Care Excellence (NICE) and Royal College of Obstetricians and Gynaecologists, 2021). There is a growing body of evidence which suggests some women experience direct and indirect discrimination in the context of maternal healthcare (e.g., migrant populations and women from minority ethnic groups) (Higginbottom et al., 2019; MacLellan et al., 2022). Studies have shown that these inequalities extend to the identification of perinatal mental health difficulties (Darwin et al., 2022; Prady et al., 2016b). The non-specific recommendation to "consider" asking about mental health is an additional opportunity for health inequalities to be perpetuated within the system. A universal case-finding strategy (whereby *all* women are asked to complete the same depression case-finding instrument) is potentially less open to bias than the current recommendation.

As part of the NICE guideline development process a cost-effectiveness analysis was conducted to determine the cost-effectiveness of a universal case-finding strategy compared with standard care (cases identified when they consult their General Practitioner (GP)) (National Institute of Health and Care Excellence (NICE), 2014). The cost-effectiveness analysis found that a strategy of using Whooley questions followed by the Patient Health Questionnaire (PHQ-9) was most likely to be cost-effective (compared with other case-finding strategies) and that this was more effective and less costly than standard care. A subsequent cost-effectiveness analysis used observational data from the Born and Bred in Yorkshire PeriNatal Depression Diagnostic Accuracy (BaBY PaNDA) cohort study and replicated the finding from the NICE guideline (Littlewood et al., 2018). Other studies have also suggested that case-finding (or screening) for PND may be cost-effective, for example in Canada (Premji et al., 2021), and the United States (Wilkinson et al., 2017). However, the NICE guidance does not recommend an explicit universal case-finding strategy and as many as half of women with PND remain undetected in standard care in the United Kingdom (UK) (National Childbirth Trust (NCT), 2017). A key barrier to implementing a universal case-finding strategy may be scarcity of healthcare staff and limitations on the time they can spend with patients.

To manage competing demands on their time, healthcare providers are likely to need to prioritise when, and to whom, they ask case-finding questions. This would involve making an implicit judgement on an individual's risk of developing PND. Heterogeneity is natural variation between people which can be explained by their characteristics (e.g., age and clinical history) (Grutters et al., 2013). Economic evaluations most commonly apply averages from populations. This method does not account for individual heterogeneity and ignores potentially different results across subpopulations (Grutters et al., 2013). This is the approach taken by the economic evaluation reported in the current NICE guidance and the BaBY PaNDA study (Littlewood et al., 2018; National Institute of Health and Care Excellence (NICE), 2014).

There is known heterogeneity in the population of postnatal women which affects an individual's risk of PND (Hutchens and Kearney, 2020). A targeted case-finding strategy (whereby only women who are identified as being at high-risk of PND would complete a case-finding instrument) would require fewer resources to implement than a universal strategy and so may be more appealing to decision-makers and healthcare professionals. However, it may also be less effective, with fewer cases being identified in people who are characterised as low risk.

This study aims to explicitly consider patient heterogeneity in the context of case-finding for PND and to assess the cost-effectiveness of a targeted approach focusing on women with risk factors for PND. We aim to explore the potential costs and health benefits of PND case-finding in women who are at high risk of developing PND, and to assess whether case-finding is cost-effective (versus no case-finding) from the perspective of NHS and social care service in England. To our knowledge, this has not been done before. This work will provide healthcare practitioners and decision-makers with clear evidence on the cost-effectiveness of targeting high-risk women, which may challenge and help to move away from suggestive approaches to more conclusive recommendations (i.e. as a minimum high-risk women should be screened).

2. Methods

2.1. Participants

This analysis is based on a hypothetical one-year birth cohort of postnatal women who complete case-finding instruments at around 12 weeks after having given birth. The timing of case-finding approximates the BaBY PaNDA study which was an observational longitudinal cohort study of 391 pregnant women in Yorkshire, England, who were followed until one year postpartum (Littlewood et al., 2018). The full protocol for the BaBY PaNDA study has been published previously (Littlewood et al., 2016). We used data from the BaBY PaNDA study to identify the prevalence of risk factors for PND so that we could estimate the cost-effectiveness of case-finding for PND in high-risk women. A number of risk factors for PND have been consistently identified in published literature (Hutchens and Kearney, 2020). For this model, we focused on three key aspects of patient heterogeneity (risk factors) which are collected and easy to assess as part of routine antenatal care: age (<20 years), history of anxiety, and history of depression. These were based on self-reported information from BaBY PaNDA participants. We also explored a fourth risk factor, for which there is considerable evidence in the literature, that can be broadly described as "difficult life events". This includes things such as domestic violence, relationship breakdown, and unplanned pregnancy. Although in routine practice there is not a standardised approach for collecting this information, participants in the BaBY PaNDA study completed the List of Threatening Events/Experiences Questionnaire (LTE-Q) (Brugha et al., 1985). In our model, anyone who had at least one life event or at least one of the other three risk factors was classified as being at high risk for developing PND.

2.2. Economic decision model

We used a decision tree to compare the costs and outcomes of PND case-finding versus no case-finding in our hypothetical cohort of postnatal women. The decision tree model used in previously published cost-effectiveness analyses of PND case-finding was adapted for the current analysis (Littlewood et al., 2018; National Institute of Health and Care Excellence (NICE), 2014, p. 192). The decision tree diagram can be found in Supplementary Material (Fig. S1). In brief, there were two stages in the tree: diagnostic and treatment. The terminal nodes in the diagnostic stage were true negative, true positive, false negative, and false positive. The treatment stage included chance nodes for depression severity, treatment response, and spontaneous recovery and subsequent identification of depression in women with a false negative case-finding outcome. While the model structure closely aligns to previous published research, adaptation was made to more accurately reflect and account for the severity of depression. For women with a false negative case-finding outcome who do not spontaneously recover form PND, there is

a chance that they are subsequently identified as depressed by their general practitioner (GP). In previously published models the severity of depression in this group was not specified. In the current model, mild and moderate-to-severe depression identified at this stage had separate branches.

The current model was predominantly parameterised by conducting secondary analysis of data from the BaBY PaNDA study. Additional model parameters were identified from published literature using targeted literature searching (including the previous model developed by NICE (National Institute of Health and Care Excellence (NICE), 2014, p. 192)) and expert opinion. The experts consulted were members of the study team which included a GP, psychiatrist, clinical psychologist, and expert by lived experience of PND. External to the study team, two additional GPs and three experts by lived experience of PND were consulted.

Model parameters are reported in full in supplementary material (Table S1). The time horizon for the model was from the point of case-finding (which was assumed to take place at 12 weeks postnatally as this was when data on case-finding instruments were collected for the BaBY PaNDA study) until one-year post-partum. The perspective for the cost-effectiveness analysis was the English NHS and social care services, in line with NICE guidance (NICE, 2022). The currency was British pounds (£), and the price year was 2021. Costs included in the model were for the administration and scoring of the case-finding instruments, additional assessment of cases (either by GPs or health visitors), treatment (pharmacological, psychological, or both), and monitoring of women identified as having PND. For mild-to-moderate depression, treatment and monitoring costs for facilitated self-help were included (£273). For moderate-to-severe depression, treatment and monitoring costs for intensive psychological therapy (£910), the anti-depressant sertraline (£300), or both (£935). The measure of health benefit was quality-adjusted life years (QALYs), derived from the EQ-5D-3L (The EuroQoL Group, n.d.) (which was collected as part of the BaBY PaNDA study) and index values for the United Kingdom (Dolan, 1997). As the time horizon for the model was less than one year, no discounting of costs or outcomes was required.

2.3. Measures (case-finding strategies)

Seven case-finding strategies were considered, four one-stage strategies and three two-stage strategies. The one-stage strategies were the Edinburgh Postnatal Depression scale (EPDS) (Cox et al., 1987) (with thresholds of ≥10 and ≥13), the Whooley questions (a 'yes' response to either question indicates possible depression) (Whooley et al., 1997), and the PHQ-9 (with a threshold of 10) (Kroenke et al., 2001). The two-stage strategies all included the Whooley questions as the first stage, followed by either the EPDS (both thresholds) or the PHQ-9.

The sensitivity and specificity of each strategy (in the high-risk subgroup of the BaBY PaNDA cohort), was assessed against a diagnostic gold standard clinical assessment of depression, the Clinical Interview Schedule – Revised (CIS-R) (Lewis et al., 1992). The main aim of the case-finding programme is to identify more cases of PND. As such, strategies with a sensitivity of <70 % were not considered to perform to an acceptable level (given that a sensitivity of 50 % is no better than chance) and so were not included in the analysis. There are resources consumed when false positive cases are diagnosed and treated and so it is important to minimise this outcome. For this reason, strategies with a specificity of <60 % were considered not to perform to an acceptable level and so were excluded. The sensitivity and specificity of the strategies are reported in supplementary material (Table S2). The strategies included in our model were: EPDS with a threshold of ≥10 (subsequently referred to as EPDS-10), the Whooley questions, and EPDS (with a threshold of ≥13; subsequently referred to as EPDS-13) following a positive response to the Whooley questions.

2.4. Data analysis

The costs, outcomes, and probabilities were entered into the model to estimate incremental cost-effectiveness ratios (ICERs) for a series of comparisons. In the first instance, the relative cost-effectiveness of the different case-finding strategies among high-risk women was estimated. The relative cost-effectiveness of the different case-finding strategies was also estimated for the whole sample. Subsequent analyses comparing case-finding to no case-finding were all based on the most cost-effective case-finding strategy. The next step was to compare the cost-effectiveness of case-finding to no case-finding among high-risk women only. Finally, three strategies were compared: no case-finding, universal case-finding, and targeted case-finding (i.e. case-finding with high-risk women only). In the 'no case-finding' comparator, women can only be identified as having PND if they visit their GP. To quantify decision uncertainty in the analyses which included 'no case-finding' as the comparator, probabilistic analyses were conducted. The value for each of the probabilities and utilities in the primary (deterministic) model were randomly selected 10,000 times from a distribution around the values. This generated a 95 % confidence interval around the mean cost and mean QALYs. Beta distributions were assumed for probabilities and utility values. Unit costs were assumed to be fixed (as in the BaBY PaNDA model (Littlewood et al., 2018)). The results from these simulations were used to calculate the probability that the different strategies would be cost-effective at willingness to pay thresholds of £0, £20,000, and £30,000/QALY.

To provide an estimate of the resources required to implement a nationwide PND case-finding programme, total costs and QALYs were calculated based on the approximate number of women who give birth per year in England and Wales (n = 600,000, 2020 data) (Office for National Statistics, 2020).

The model was built by one health economist and was validated separately by two other health economists (one who was part of the study team and one external person). Validation included checks around face validity, logical consistency (including using extreme and null values, and tracing patients throughout the model) and cross validation testing using the results of other studies.

2.5. Secondary analyses

One-way sensitivity analyses were conducted to explore the impact of key assumptions on the cost-effectiveness of case-finding. These were: including a utility decrement for women with a false positive case-finding outcome (2 % and 10 %), alternative durations of health visitor time required to administer and score case-finding instruments (0 min if done online prior visit; three-times the duration observed in the BaBY PaNDA study to allow a more conversational approach: 5.13 min for the Whooley questions and 10.62 min for the EPDS), alternative resource use associated with false positive cases initiating treatment (10 % and 30 % of the full treatment/monitoring cost for mild depression).

An additional sensitivity analysis was conducted for the comparison of the different case-finding instruments within the high-risk subgroup. In the BaBY PaNDA cohort, the mean utility value for non-depressed women in the high-risk group was lower than for the whole sample (0.884 [high-risk] versus 0.907 [whole sample]). A sensitivity analysis was conducted which assumed that when high-risk women with PND responded to treatment, their health utility recovered to the mean value for the whole sample. The impact of varying the likelihood of women who were initially incorrectly classified as not having PND being subsequently identified by their GP was also explored. In the previous NICE and BaBY PaNDA models, a value of 8.3 % was used, however this was derived from observational data from a single GP surgery, collected in 1997 (Kessler et al., 2002) and not likely to reflect current care. Based on expert opinion, a value of 10 % was used in our base case model. Alternative values of 5 % and 25 % were explored in sensitivity analyses. Finally, for the no case-finding strategy, the amount of time that GPs

spent assessing women at their initial presentation with PND (true and false positives) was assumed to be the average appointment length in the base case model (9.22 min (Jones and Burns, 2021)). Consultation with experts (clinical and by lived experience) suggested that this is likely to be an underestimation. Typically, this appointment would be 10–15 min long if by telephone or 15–20 min face-to-face. This was explored in a sensitivity analysis.

2.6. Stakeholder involvement and engagement

The model and analysis plan were discussed with a group of mothers ($n = 3$) who had experienced postnatal mental illness. The group were introduced to economic evaluation in healthcare and the purpose of economic modelling in the context of decision making. The group were provided with an overview of planned methods and asked to comment. As a result of this consultation, the PHQ-9 was considered as a potential case-finding strategy. However, as the sensitivity was below 70 % it was not included in the final model. A key outcome from our consultation with experts described above was that the model parameters reflect current practice in the NHS. For example, the GPs consulted advised on the number of follow-up appointments they would typically arrange with someone who had been diagnosed with PND.

3. Results

The prevalence of PND risk factors in the BaBY PaNDA cohort are reported in Table 1. Data on risk factors for PND were available for 391 participants, 226 (57.8 %; 95 % CI 52.7 % to 62.7 %) of whom were classified as high-risk for PND (i.e. had one or more risk factor). Postnatal data on case-finding instruments and CIS-R depression diagnosis were available for 334 participants, this subset was included in the original BaBY PaNDA analysis. The prevalence of CIS-R diagnosed PND was 14.6 % in the high-risk subgroup, and 4.9 % in the rest of the BaBY PaNDA cohort. Across the whole cohort, the prevalence of PND was 10.5 %.

3.1. Comparing case-finding strategies in the high risk sub-group

The top section of Table 2 presents the total costs and QALYs associated with the included PND case-finding strategy in high-risk women, in order of ascending average cost per woman. The average cost ranged from £71.24 to £78.25, with EPDS-10 being the least costly strategy and the Whooley questions being the most expensive. The Whooley questions were associated with a marginally larger health gain than the EPDS-10, resulting in an ICER of £41,659 to gain an additional QALY by using the Whooley questions compared to EPDS-10. Therefore, using typical thresholds for cost-effectiveness, the Whooley questions strategy is unlikely to offer better value for money than the EPDS-10 strategy.

The lower section of Table 2 presents the same results based on the prevalence of depression, utility values, and sensitivity and specificity of the different strategies in the whole sample (i.e. not restricted to high-risk women). The results are largely the same as for the high-risk subgroup, suggesting that the differences in sensitivity and specificity in the group with the higher prevalence of depression are not a key driver of cost-effectiveness.

Table 1
Summary of PND risk factors in the BaBY PaNDA study cohort.

Sample characteristics	Women with data on PND risk factors $n = 391$
Age at consent (years), *mean* (*SD*)	31.2 (5.1)
Aged <20 years at consent, *n* (%)	11 (2.8)
History of anxiety, *n* (%)	138 (35.3)
History of depression, *n* (%)	133 (34.0)
One or more threatening life event[a], *n* (%)	122 (50.4)
One or more PND risk factor, *n* (%)	226 (57.8)

[a] According to response on List of Threatening Events Questionnaire (LTE-Q); LTE-Q data available for 242 participants.

Table 2
Costs and QALYs of case-finding strategies in women at high risk of PND and whole sample.

Strategy	Mean cost per person (£)	Mean QALYs per person	ICER (£)[a]
High risk sub-group			
EPDS-10	71.24	0.6880	–
Whooley questions followed by EPDS-13	74.13	0.6875	Dominated
Whooley questions	78.25	0.6882	41,659
Whole sample			
EPDS-10	51.36	0.7083	–
Whooley questions followed by EPDS-13	55.32	0.7079	Dominated
Whooley questions	57.58	0.7084	63,907

QALYs = quality adjusted life years; ICER = incremental cost-effectiveness ratio.
[a] Mean costs and QALYs reported are rounded values whereas ICERs are calculated based on unrounded values.

The results of one-way sensitivity analyses of the different strategies among women at high risk of PND are reported in full in Supplementary Material (Table S3). In brief, EPDS-10 remained the most cost-effective strategy in all sensitivity analyses. The only notable difference was that when it is assumed that women who receive a false positive result experience a loss of health utility, EPDS-10 becomes the most effective strategy, and therefore dominates both of the alternatives.

Table 3 reports the mean costs and QALYs per person for the most cost-effective strategy (EPDS-10) compared with not case-finding, just for women who are at high-risk of PND. Standard care is associated with lower costs (because fewer people are identified with and received treatment for PND) and fewer QALYs than the EPDS-10 strategy. The cost per QALY gained by employing the EPDS-10 strategy for women at high-risk is £8146 which is lower than typical cost-effectiveness thresholds used by decision-makers in England. At a willingness to pay threshold of £20,000/QALY, there is a 78.5 % chance that using the EPDS-10 strategy is more cost-effective than no case-finding strategy for high-risk women. This increases to above 80 % at a threshold of £30,000/QALY. If decision makers are not willing to pay any money to improve health (i.e. a threshold of £0/QALY), then not case-finding is more likely to be cost-effective.

3.2. Comparing EPDS-10 with no case-finding

Table 4 reports the costs, QALYs, ICERs, and probability of cost-effectiveness at different willingness to pay thresholds for EPDS-10 as a targeted strategy, as a universal strategy, and no case-finding for the approximate number of women who give birth in England and Wales per year (600,000). The results are reported for a hypothetical cohort of 1000 women in supplementary material (Table S4). The differences in costs and QALYs across all three strategies were small in real terms. Both case-finding strategies (targeted and universal) were associated with greater health gains and higher costs than not case-finding. Costs were higher in the targeted approach compared with the universal approach because in the targeted approach women in the low-risk group (i.e. those not considered for case-finding) visited their GP in order to be identified as depressed. The universal approach dominates the targeted approach as costs were lower and QALYs higher, making the universal approach the preferred option of the two case-finding strategies. Compared to not case-finding, the additional cost to gain one QALY was less than £3000 for the universal approach, which is well below cost-effectiveness thresholds used by decision-makers. The cost-effectiveness acceptability curve in Fig. 1 shows the probability that each strategy was the most cost-effective option at alternative willingness to pay thresholds.

Table 3
Costs and QALYs of most cost-effective strategy versus no case-finding in women at high risk of PND.

Strategy	Mean cost per person (£) (95 % CI)	Mean QALYs per person (95 % CI)	ICER[a] (£)	Probability of cost-effectiveness for maximum WTP		
				£0	£20,000	£30,000
EPDS-10	71.28 (54.88–90.31)	0.6880 (0.6761–0.7000)	8146	0.003	0.785	0.830
No case-finding	57.84 (47.66–69.89)	0.6864 (0.6734–0.6994)		0.997	0.215	0.170

QALYs = quality adjusted life years; ICER = incremental cost-effectiveness ratio; WTP = willingness to pay.
Note: when there is no case-finding, women can only be identified as having PND if they visit their GP.
[a] Mean costs/QALYs reported are rounded values whereas ICERs are calculated based on unrounded values.

Table 4
Sensitivity, specificity, resources, and outcomes in a hypothetical cohort of 600,000 women.

Strategy	No case-finding	EPDS-10 universal	EPDS-10 targeted	
			High risk	Low risk
Prevalence of depression	10.5 %	10.5 %	14.6 %	4.9 %
Sensitivity	50.1 %	82.9 %	85.7 %	50.1 %
Specificity	81.3 %	87.6 %	82.3 %	81.3 %
Proportion who visit GP	52.2 %	52.2 %	54.8 %	48.6 %
Number of people screened	600,000	600,000	346,800	253,200
Health visitor time to conduct case-finding (hours)	n/a	35,400	20,461	n/a
Total cost of health visitor time to conduct initial case-finding (£)	n/a	£1,947,000	£1,125,355	n/a
Number with depression	63,000	63,000	50,633	12,367
True positives	31,563	52,227	43,392	6196
True negatives	484,581	470,412	243,745	218,946
False negatives	31,437	10,773	7241	6171
False positives	52,419	66,588	52,422	21,887
Total costs	£28,818,596	£30,799,167	£33,441,611	
Total QALYs	424,272	424,956	424,864	
ICER (£/QALY)[b]	–	2897 (vs. no case-finding)	Dominated by universal	
Probability cost-effective at maximum WTP[a]:				
£0/QALY	0.580	0.269	0.151	
£20,000/QALY	0.064	0.513	0.423	
£30,000/QALY	0.058	0.509	0.433	

QALYs = quality adjusted life years; ICER = incremental cost-effectiveness ratio; WTP = willingness to pay.
[a] Based on 10,000 iterations.
[b] Costs and QALYs reported are rounded values whereas ICERs are calculated based on non-rounded values.

At a willingness to pay threshold of £0, the universal approach is still more likely to be cost-effective than the targeted approach. The total number of women with a false negative outcome (i.e. those who are not identified as depressed and so do not have the opportunity to access treatment) is smallest for the universal approach (1.8 %) compared with 5.2 % when there is no case-finding and 2.2 % for the targeted approach.

In terms of the probability of cost-effectiveness, the universal approach is most likely to be cost effective at each of the WTP thresholds. However, there is little difference in probability between the targeted and universal approaches whereas not case-finding is very unlikely to be cost-effective in comparison.

The cost of health visitor time to administer and score the EPDS is estimated to be £1.57 (based on the 3.54 min it was found to take during the BaBY PaNDA study (Littlewood et al., 2018)). For a cohort of 600,000 women, administering the EPDS in the targeted approach (i.e. only with women at high risk) would take just over 20,000 h and cost £1.1 m. Administering the EPDS to all 600,000 in a universal approach would take over 35,000 h and cost £1.9 m.

Table 5 reports the results of key sensitivity analyses for the comparison of the two strategies involving the EPDS-10 (targeted and universal) and standard care (the results of all sensitivity analyses are reported in Supplementary Material, Table S5). In almost all analyses a universal case-finding approach was the most likely to be cost-effective at a willingness to pay threshold of £20,000/QALY. The ICERs for universal case-finding compared with no case-finding ranged from case-finding being dominant to a cost of £8671/QALY. Case-finding becomes dominant over no case-finding when the cost of a longer GP appointment is included for initial assessment of PND. The largest ICER was observed when the amount of time to conduct case-finding, as observed in the BaBY PaNDA study, was trebled to allow a more conversational approach. When there is a utility decrement of 10 % for the remainder of the year following a false positive outcome, not case-finding becomes dominant over both case-finding approaches and has the highest likelihood of being cost-effective.

4. Discussion

Case-finding for PND is cost-effective compared to not case-finding. When only considering the needs of women at high-risk of PND, the ICER for case-finding versus not case-finding is £8146/QALY (when the EPDS with a threshold of ≥10 is used), which is considerably below the £20,000/QALY cost-effectiveness threshold cited by decision makers in England. However, this approach does not to consider the health and healthcare resource use of women who are not in this sub-group. If sufficient resources are available for implementation, a universal case-finding programme provides better value for money than a targeted programme (targeted towards women at high-risk of developing PND). At the population level, targeted case-finding is dominated by universal case-finding. Compared to not case-finding, universal case-finding has an ICER of £2945. With universal screening, the proportion of true positive outcomes is highest (which leads to more health benefits) and the proportion of false negatives (i.e. missed cases) is lowest.

The key factors which influence the health benefits associated with case-finding are the likelihood of accessing treatment (which relies upon the likelihood of being correctly diagnosed as having PND) and the presence and extent of a potential negative health impact of incorrectly being diagnosed with PND. Improving the identification of PND in primary care increases the health benefits of all case-finding (and not case-finding) strategies, as even those with a false negative case-finding outcome have a better chance of accessing support. Even if a case-finding strategy were implemented, it would still be beneficial to increase the likelihood of being diagnosed with PND in primary care. The main driver of cost in the model was treatment costs for true positive cases. Based on the assumptions in the model, which were in line with previous models (Littlewood et al., 2018; National Institute of Health and Care Excellence (NICE), 2014, p. 192), the cost of treating false positive cases had minimal impact on the ICER. Case-finding would be potentially cost-saving for the NHS compared to not case-finding if GPs spend longer than the average (9 min (Jones and Burns, 2021))

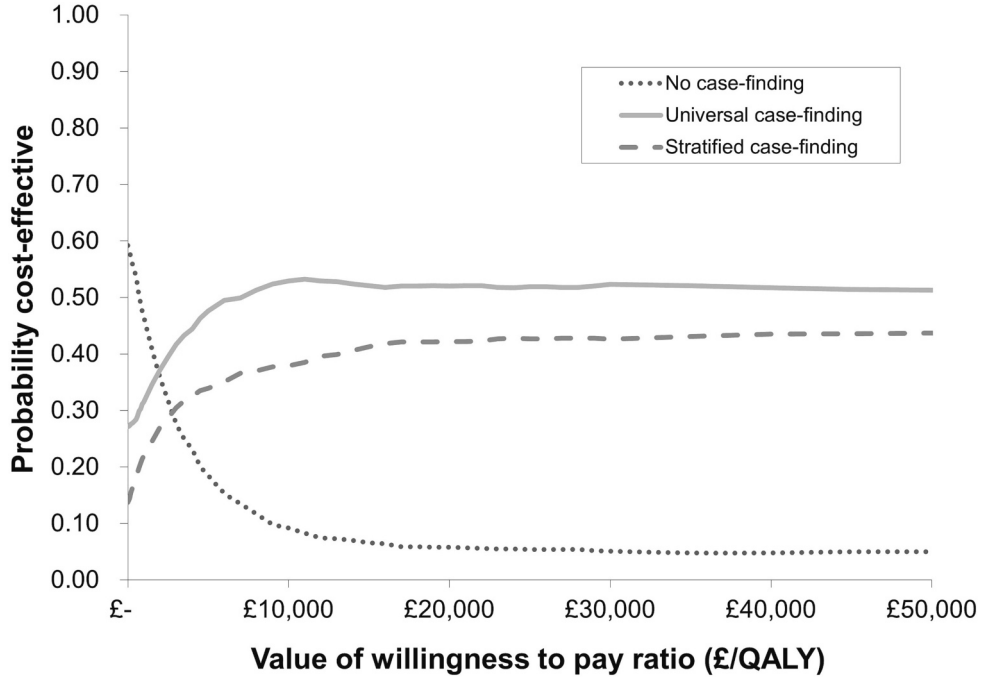

Fig. 1. Cost-effectiveness acceptability curve for no case-finding compared with universal and targeted case-finding with the EPDS-10.

appointment when women initially present with symptoms of PND. The experts consulted in the modelling process agreed that a GP was unlikely to spend as little as the average 9-minute appointment when initially consulting with a woman postnatally in whom they suspected depression. Observational data on appointment duration in this scenario would help to address the uncertainty around this assumption.

The only scenario where no case-finding was dominant over case-finding was when there was a 10 % utility decrement assumed for false positive cases. This is likely to overestimate the impact of a false-positive case-finding outcome as it is applied for the entire time horizon of the model. The number of false positives is lowest with no case-finding, hence this becomes more favourable when the health impact of a false negative outcome is greater. However, because there is still the option of having a false positive outcome without case-finding (i.e. when a GP incorrectly diagnoses PND), PND case-finding is fundamentally different from other screening programmes e.g. for cancer where without the programme a false positive outcome would not be possible.

4.1. Comparison with existing evidence

Our finding that EPDS-10 is likely to be a cost-effective case-finding strategy is supported by previous studies based on populations in England. In the BaBY PaNDA model, the ICER for the EPDS-10 strategy compared with no case-finding would have been approximately £16,000/QALY (i.e. still below £20,000) (Littlewood et al., 2018). In the NICE model, EPDS-10 dominates not case-finding as it is associated with higher QALYs and lower costs (National Institute of Health and Care Excellence (NICE), 2014, p. 192). These models both reported that a two-stage approach of the Whooley questions followed by the PHQ-9 was the most cost-effective strategy. In the BaBY PaNDA sample the sensitivity of this approach was just 63 % (i.e. only just better than chance at correctly identifying women with PND). The cost-effectiveness of strategies which are not good at identifying true positive cases is driven by keeping treatment costs low at the population level. This is in conflict with the aim of the case-finding programme (i.e. to improve the identification of PND and enable more women to access treatment). An economic modelling study from England reported that case-finding for PND was unlikely to be cost-effective (Paulden et al., 2009). The case-finding strategy they identified as most likely to be cost-effective (EPDS with a cut-off score of 16) had an ICER of over £40,000/QALY (price year 2006/07) compared with routine care and so was not considered cost-effective. However, they also report that the sensitivity of this approach was just 31 % and so many cases of PND would be missed.

International evidence supports our findings. A study from the United States compared case-finding for PND and psychosis (using the EPDS) with no case-finding (Wilkinson et al., 2017). They reported an ICER of approximately $14,000/QALY (price year 2014) which was below their cited cost-effectiveness threshold of $50,000/QALY. In Canada, PND case-finding with the EPDS was also associated with an ICER below $50,000/QALY when compared with no case-finding ($13,908/QALY; 2019 US dollars) (Premji et al., 2021). An Australian study compared case-finding with the EPDS in two different models of integrated psychosocial assessment (Chambers et al., 2022). It is difficult to draw direct comparison with our analysis as our comparator was no case-finding and they used the EPDS as part of a risk-stratification process, however their findings suggest that more comprehensive risk-stratification may enhance the cost-effectiveness of identifying true positive and false positive cases of PND.

4.2. Implications

Improving the identification of PND is important because for some women untreated depression can lead to a worsening of symptoms. A strength of this model is that we included different utility values for women with mild versus moderate-to-severe PND. This meant that we were able to incorporate the assumption that for women whose PND remained undetected (and who did not spontaneously recover) their utility values were initially equivalent to mild depression, but then worsened over time to moderate-to-severe depression.

The treatment pathways included in the model were based on current guidance in England, and data reported in a publication from the English-based Born in Bradford (BiB) cohort study on the proportion of people receiving different treatment options for common mental disorder in the first year postnatally (Prady et al., 2016a). The BiB data were recent and based on a large number of real-world observations, and so

Table 5
Results of key sensitivity analyses for a universal case-finding strategy using EPDS-10 (based on 10,000 iterations).

	Mean cost per person (£)	Mean QALYs per person	ICER (£/QALY)	Probability of cost-effectiveness at £20,000/QALY
Base case analysis: 10 % likelihood of being identified in primary care following false negative outcome; no utility decrement for false positive cases				
No case-finding	48.05	0.7072	–	0.064
EPDS-10 (universal)	51.41	0.7083	2945	0.511
EPDS-10 (targeted)	55.75	0.7082	Dominated	0.425
Utility decrement associated with a false positive outcome				
Utility decrement - 2 %				
No case-finding	48.05	0.7059	–	0.155
EPDS-10 (universal)	51.41	0.7067	4169	0.466
EPDS-10 (targeted)	55.75	0.7064	Dominated	0.379
Utility decrement - 10 %				
No case-finding	48.05	0.7009	–	0.512
EPDS-10 (universal)	51.41	0.7004	Dominated	0.327
EPDS-10 (targeted)	55.75	0.6993	Dominated	0.161
Time to conduct case-finding				
EPDS completed online – no health visitor time required				
No case-finding	48.05	0.7072	–	0.045
EPDS-10 (universal)	48.15	0.7083	82	0.490
EPDS-10 (targeted)	53.86	0.7082	Dominated	0.540
Allow more time to administer and score case-finding instruments (3× health visitor time)				
No case-finding	48.05	0.7072	–	0.120
EPDS-10 (universal)	57.93	0.7083	8671	0.442
EPDS-10 (targeted)	59.52	0.7082	Dominated	0.438
Longer GP consultation to assess depression with no screening				
1.5 times the 9.22 min average appointment time (13.83 min)				
No case-finding	50.05	0.7072	–	0.052
EPDS-10 (universal)	51.41	0.7083	1192	0.523
EPDS-10 (targeted)	55.96	0.7082	Dominated	0.424
2 times the 9.22 min average appointment time (18.44 min)				
EPDS-10 (universal)	51.41	0.7083	–	0.534
No case-finding	52.04	0.7072	Dominated	0.042
EPDS-10 (targeted)	56.17	0.7082	Dominated	0.424

QALYs = quality adjusted life years; ICER = incremental cost-effectiveness ratio.

likely to reflect current real-world practice. A limitation of the data from the BiB study is that it included a broader group of mental health conditions than PND alone so may not be fully representative. While our model included three treatment options (pharmacological, non-pharmacological, or a combination of both), it did not allow for people to try more than one treatment option in sequence and did not account for engagement with treatment and the impact this may have on likelihood of treatment response. Better primary data on treatment pathways in this population may allow the use of cost-effectiveness models which incorporate more individual variation in treatment pathways (e.g. discrete event simulation).

4.3. Limitations

Key limitations of the model include the time horizon and the perspective. The time horizon covers the period from the time of screening to 1-year postnatally and so does not account for the costs or health impacts of persistent depression beyond the postnatal period. The perspective of the model includes only the health impacts for mothers and does not include impacts of maternal PND on other family members (including infants). The longer-term and broader impacts of PND are estimated to be considerable (Bauer et al., 2016). Another limitation of the model is that it assumes that case-finding takes place at around 12-weeks postnatally. This is when data on the case-finding instruments and clinical diagnosis were collected in the BaBY PaNDA study. The model does not explore cost-effectiveness of case-finding at two time points, or whether earlier or later in the postnatal period would be more cost-effective than at 12 weeks. An analysis of primary care electronic health records showed that there was a peak in cases of PND recorded at around 6–8 weeks postnatally (which coincides with the "6-week check" consultation), but that recording of PND levelled off after the first 3–4 months after giving birth (Petersen et al., 2018). This suggests that around 8–12 weeks into the postnatal period (i.e. after the "6-week check" but before the plateau) may be the optimal timing for case-finding.

There is clear evidence that the factors used in our model to identify high-risk women are associated with the likelihood of developing PND (Hutchens and Kearney, 2020). Three of the factors (age, history of depression, history of anxiety) are routinely collected as part of standard antenatal care. This means that they are readily available in medical notes/records and can be identified easily and without no additional resources required. Capturing the fourth risk factor, whether someone

has experienced a recent adverse life event, may be more complex to operationalise in practice. Further research, for example through analysis of electronic health records, would help us to better understand which specific events are relevant and potentially how best this could be captured if a targeted case-finding strategy were to be implemented. In our model, the prevalence of PND in the high-risk group was three times that in the low-risk group (15 % vs 5 %) which suggests that the risk factors selected did identify distinct sub-groups of women.

Data from the BaBY PaNDA cohort were used to estimate the sensitivity and specificity of the case-finding instruments, utility values, and the prevalence of PND and PND risk factors. The sample were recruited predominantly from Yorkshire in the North of England and included areas of varying sociodemographic characteristics (e.g. economic deprivation), although were predominantly (98 %) of white ethnicity. The prevalence of PND in the whole sample (10.5 %) was towards the lower end of the range observed in other population samples. Two meta-analyses of international studies reported pooled prevalence of 17 % and 17.7 % globally (Hahn-Holbrook et al., 2018; Shorey et al., 2018). One of the meta-analyses identified 16 published prevalence rates from studies in the UK which ranged between 9.1 % and 32.0 %, with a pooled prevalence of 16 % (Hahn-Holbrook et al., 2018). The implication of this is that the population-level costs associated with treating PND and the health decrements associated with PND may be underestimated in our model. The parameters derived from BaBY PaNDA data may not be fully generalisable to the rest of England, particularly inner-city areas in the South. Having said this, the ICER for universal case-finding is so far below the £20,000/QALY threshold that even if the margin of difference was three- or four-fold and the ICERs trebled or quadrupled, they would still be below the £20,000 threshold.

4.4. Ethical/equity considerations

In light of the current guidance in England that healthcare providers subjectively consider asking pregnant and postnatal women about their mental health, a key advantage of case-finding is that it is potentially less open to bias from healthcare professionals, but one size does not necessarily fit all. Standardised case-finding tools may be less sensitive or specific in some sociocultural groups and so it is important to consider whether there is a need to culturally adapt case-finding tools. If so, this must be done in partnership with members of the respective groups. Similarly, it is important to consider socio-cultural factors which may impact acceptability of and/or adherence to different treatments, which in turn will influence the likelihood of recovery. For example, limited English and mental health literacy may be a barrier to people in following non-adapted facilitated self-help programmes. A universal case-finding programme may also be more acceptable where there is stigma around mental illness, if people find it more acceptable knowing that everyone was asked to complete the same questions as part of standard care.

CRediT authorship contribution statement

EMC devised and conducted the analysis. GS quality-checked and validated the model and parameters. SG, DM, and EL devised and were involved in participant recruitment and data collection for the original BaBY PaNDA study and for securing access to those data for this work. SA conducted the analysis for the BaBY PaNDA study. EE, CCG, and KW reviewed model parameters to ensure real-world validity and contributed to expert consensus. EE and GS led conversations with experts by experience. All authors contributed to the drafting and editing of the manuscript.

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Declaration of competing interest

All authors report no conflicts of interest.

Appendix A. Supplementary material

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