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BMJ Open Preventing postnatal maternal mental health problems using a psychoeducational intervention: the cost-effectiveness of *What Were We Thinking*

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ABSTRACT

Objectives: Postnatal maternal mental health problems, including depression and anxiety, entail a significant burden globally, and finding cost-effective preventive solutions is a public policy priority. This paper presents a cost-effectiveness analysis of the intervention, *What Were We Thinking (WWWT)*, for the prevention of postnatal maternal mental health problems.

Design: The economic evaluation, including cost-effectiveness and cost-utility analyses, was conducted alongside a cluster-randomised trial.

Setting: 48 Maternal and Child Health Centres in Victoria, Australia.

Participants: Participants were English-speaking first-time mothers attending participating Maternal and Child Health Centres. Full data were collected for 175 participants in the control arm and 184 in the intervention arm.

Intervention: *WWWT* is a psychoeducational intervention targeted at the partner relationship, management of infant behaviour and parental fatigue.

Outcome measures: The evaluation considered public sector plus participant out-of-pocket costs, while outcomes were expressed in the 30-day prevalence of depression, anxiety and adjustment disorders, and quality-adjusted life years (QALYs). Incremental costs and outcomes were estimated using regression analyses to account for relevant sociodemographic, prognostic and clinical characteristics.

Results: The intervention was estimated to cost $A118.16 per participant. The analysis showed no statistically significant difference between the intervention and control groups in costs or outcomes. The incremental cost-effectiveness ratios were $A36 451 per QALY gained and $A152 per percentage-point reduction in 30-day prevalence of depression, anxiety and adjustment disorders. The estimate lies under the unofficial cost-effectiveness threshold of $A55 000 per QALY; however, there was considerable uncertainty surrounding the results, with a 55% probability that *WWWT* would be considered cost-effective at that threshold.

Strengths and limitations of this study

- The prospectively designed economic evaluation was conducted alongside a cluster-randomised controlled trial of the intervention's clinical effectiveness.
- The sample size, based on the clinical effect rather than cost-effectiveness analysis, and the cluster-randomised nature of the trial may have limited the ability to detect statistically significant differences between the control and intervention groups.
- Data collected in the trial included use of health, social and early childhood services and participant out-of-pocket costs, allowing the results to be examined from a range of perspectives.
- Results presented include probabilistic sensitivity analysis and scenario analyses to allow the reader to assess the impact of key uncertainties.

Conclusions: The results suggest that, although *WWWT* shows promise as a preventive intervention for postnatal maternal mental health problems, further research is required to reduce the uncertainty over its cost-effectiveness as there were no statistically significant differences in costs or outcomes.

Trial registration number: ACTRN12613000506796; results.

BACKGROUND

Prevention of postnatal mental health problems is a challenge for healthcare systems internationally. Depression, anxiety and adjustment disorders are common among women who have recently given birth[1] [2] which is a population subgroup of substantial size. These disorders have a significant impact on the well-being of women at a pivotal time in the life of the mother, baby

and wider family.[3] [4] There is an associated burden on the public sector; for example, women with postnatal depression (PND) have higher use of health and other services than their non-depressed counterparts, not limited to greater use of mental health services.[5–7]

Research on the cost-effectiveness of interventions to prevent the development of postnatal distress, depression and anxiety has shown mixed results. A programme of structured midwife-led care was found to improve postnatal mental health without increasing costs;[8] counselling and support for women at high risk of PND[9] and peer support[10] were found to reduce symptoms or duration of depression but at a higher cost; and postnatal support worker home visits[11] were found to increase costs with no associated improvement in mental health. Preventive approaches that address the woman's relationship with her spouse or partner have shown some promise in terms of clinical effectiveness;[12] however, there has been little research into the cost-effectiveness of such interventions.

What Were We Thinking (*WWWT*) is a psychoeducational intervention that targets the parental partner relationship, management of infant behaviour and parental fatigue. A community-based before and after controlled study found that *WWWT* reduced postnatal mental health problems among women with no history of psychiatric disorders.[13] The Sleep, Parenting and Relationships in a Community Setting (SPARCS) trial was subsequently conducted to examine the clinical and cost-effectiveness of *WWWT* for the prevention of depression, anxiety and adjustment disorders in women at 6 months postpartum.[14] The intervention was delivered soon after birth to first-time parents (FTPs) in the setting of Maternal and Child Health Centres (MCHCs) in Victoria, Australia. MCHCs are a publicly funded universal service for families of children up to school age, with the goal to 'promote healthy outcomes for children and their families' (ref. 15, p. 6). High participation rates are a stated policy objective in pursuance of this goal; more than 90% of families with recent births in Victoria attend MCHCs.[16] One element of the Maternal and Child Health (MCH) service is FTP group sessions, which focus on parent–child interactions, parenting confidence, emotional well-being and support for FTPs.[17]

Public sector decision-makers have made a commitment to using evidence to inform modifications to the MCH service model.[18] A complexity of developing appropriate evidence is that in Victoria, early childhood service costs (including MCHCs) fall under the Department of Education and Training (formerly the Department of Education and Early Childhood Development). This means that funding of MCHCs is shared between the Department of Education and Training and Local Governments, rather than sitting within health, despite the clear health focus of the MCH service.

Economic evaluation provides decision-makers with evidence on how best to allocate limited resources by comparing the alternatives in terms of costs and outcomes. In cost-effectiveness analyses (CEA), outcomes are expressed in natural or clinical units, such as symptom improvement or life years saved. In cost-utility analyses (CUA), outcomes are expressed in terms of quality-adjusted life years (QALYs), which take into account differences in life span and health-related quality of life (HRQoL). QALYs are generally preferred in health economic evaluations as they facilitate allocative decisions between interventions with different outcomes,[19] [20] and there are data to guide what might be considered cost-effective in terms of QALYs. However, studies in prevention of postnatal mental health problems often use condition-specific clinical end points, such as cost per month of PND averted.[9] It is not clear what societies would be willing to pay for prevention in terms of these clinical end points. One US study found individuals were willing to pay ~9% of their monthly household income for treatment of depression,[21] and a German study found that people were willing to pay personally for prevention of depression;[22] however, neither informs us of societal-level willingness-to-pay (WTP) for prevention of depression. Although not an official threshold, US$50 000 per QALY (approximately $A55 000 in 2014) is often used as a guide, which could vary with factors such as budget constraints or special consideration of certain populations or diseases.[23] Other thresholds have been proposed, and vary considerably;[24] one study found that Australian WTP for one QALY gain was approximately $A75 000,[25] while in the UK, a threshold of £20 000–30 000 (approximately $A41 000–61 000) per QALY gained is used,[26] although Claxton *et al*[27] suggest it should be lower, approximately $A31 000 (figures adjusted to 2014 terms).

This paper describes the results of an economic evaluation of *WWWT* conducted alongside the SPARCS trial. The protocols for the clinical study[14] and economic evaluation[28] have been published previously, as have the trial results.[29] This paper presents the results of a CEA and a CUA, and discusses the implications of these results for decision-makers seeking cost-effective interventions for the prevention of postnatal mental health problems.

METHODS

The economic evaluation took a public sector perspective (incorporating healthcare, early childhood and social service costs), plus the participant's out-of-pocket (OOP) costs. The time horizon of 6 months mirrored the trial follow-up period. No discounting was necessary due to the duration of the follow-up period. Ethical approval was provided by the Southern Health (now Monash Health) Human Research Ethics Committee (11388B) and the Education and Policy Research Committee, Victorian Government Department of Education and Early Childhood Development (now Department of Education and Training) (2012 001472), and the study was registered with the Monash University

Human Research Ethics Committee (CF12/1022-20122000474). Data were collected from participants via computer-assisted telephone interview at baseline (6 weeks postpartum) and follow-up (26 weeks postpartum).

Sample and setting
The trial was conducted in Victoria, Australia, with MCHCs as the unit of cluster randomisation. To check for similarity between participants within clusters, which could adversely affect the trial's ability to detect a difference between trial arms, the intracluster correlation coefficient (ICC)[30] is reported for cost and outcome variables. Participants were English-speaking first-time mothers who had recently given birth and attended participating MCHCs. Baseline participant characteristics were compared between trial arms using two-sample t-tests and Pearson's χ^2 tests.

Intervention
The training programme for nurses at intervention MCHCs comprised online and face-to-face components, with nurses who worked at more than one centre excluded to avoid cross-contamination between the intervention and control groups. Participants at intervention centres received *WWWT*-informed care during MCH visits, and both parents were invited to attend an extra 6-hour FTP group session on a Saturday, during which the *WWWT* intervention was delivered, and received printed materials to take home. Participants at control MCHCs were provided usual MCH care, and were offered no extra FTP group sessions.

Resource use and cost
Participants were sent a card at baseline on which to record the use of health and other services during the follow-up period for themselves or their baby (specifying the service type and cost including OOP cost), and these data were collected at follow-up. This card and the service use questions asked at follow-up were developed specifically for the trial. Resource unit costs were identified from the Medicare Benefits Schedule (MBS),[31] National Efficient Price (NEP) determination weights for hospital episodes,[32] the standard hourly rate of MCH service provision,[18] participants' OOP costs and market rates (for further detail, see online supplementary material). All unit costs were in 2013–2014 Australian dollars ($A).

The estimated cost of the intervention per participant was based on the costs of developing the intervention, training MCH nurses in the intervention and delivery of the *WWWT* session as an additional FTP group session. It was assumed that *WWWT*-informed MCHC care would entail the same cost per visit as standard care, with any difference in the number of visits or phone calls captured in participants' service use history. The cost of delivering the intervention to participants was based on the hourly rate of MCH services. In the base case, it was assumed that MCH nurses would need retraining after 3 years, and that six families would attend each FTP group session on average.

Outcomes
For CEA, the outcome was 30-day prevalence of depression, anxiety and adjustment disorders according to the criteria of the Diagnostic and Statistical Manual of Mental Disorders, Fourth Edition (DSM-IV).[33] For CUA, the outcome was QALYs, with HRQoL measured using the three-level version of the EQ-5D (EQ-5D-3L), and calculated using Australian weights derived using the time trade off approach.[34] QALYs were calculated as a linear change in HRQoL over time between baseline and follow-up.

The EQ-5D is a multiattribute utility instrument[35] that assesses HRQoL over five domains of health: mobility, self-care, usual activities, pain/discomfort and anxiety/depression. A score of one reflects full health, and zero, death. It is the most frequently used HRQoL measure when estimating QALYs,[36] and has been used in the postnatal context.[37–40] Petrou *et al*[41] found, among women at 6 months postpartum, an average EQ-5D score of 0.861 (95% CI 0.844 to 0.877), and a statistically significant correlation with PND risk.

Analysis
Costs and outcomes were adjusted using regression modelling to account for relevant sociodemographic, prognostic and clinical characteristics, including those differing between groups, with the effect of the intervention captured by the inclusion of the trial arm as a variable. All regression models included baseline measures of the participant's psychological well-being and psychiatric history and a measure of the baby's crying behaviour, to account for differences in baseline risks for postnatal mental health problems, plus the baby's age at baseline to account for timing of data points. In addition, the cost model included factors that might influence utilisation of health and other services: level of education, health care card status (a health care card provides access to concessions on pharmaceuticals and medical services for low-income earners and those receiving government benefits) and relative socioeconomic disadvantage of the participant's area of residence.[42] The outcome models included baseline EQ-5D-3L score to account for baseline HRQoL, plus other factors which might influence quality of life: perceived quality of the intimate partner relationship and level of support, and a measure of adverse life events (for further details regarding measures used in the study, see ref. 29). Analyses were performed in STATA V.13 using a generalised linear regression model (GLM) for cost, to allow for the non-normal distribution of costs without requiring transformation of the cost variable,[43] a linear regression model for QALYs and a logit model for the binary clinical outcome (presence or absence of depression, anxiety and adjustment disorders). The

specifications of the GLM model for costs were informed by a modified Parks test, resulting in a log link and gamma family,[43] while the distribution of QALYs fitted with the assumption of normality in the linear regression model. Since these regression models included different explanatory variables than those included in the clinical evaluation,[29] the results may differ slightly. Cluster-robust SEs were used to account for randomisation at the level of the MCHC, rather than the individual.

The main analysis was conducted on participants for whom complete data were collected, and repeated with imputation of missing data. Characteristics of those with missing data were compared with the complete cases using two-sample t-tests and Pearson's χ^2 tests. Missing values for cost, outcomes and two characteristics (adverse life events and levels of support) used in regression analyses were imputed using the 'mi impute chained' command in STATA with V.30 imputations. Predictive mean matching was used for continuous variables, with logistic regression for binary and ordered logistic regression for ordinal variables, using an imputation model that included characteristics associated with missingness of data as well as the variables in the analytic model.

The incremental cost-effectiveness ratio (ICER) compares the control and intervention groups by dividing the difference in cost by the difference in outcome (each calculated using average marginal effects from the relevant regression model). Uncertainty surrounding the ICER was estimated using non-parametric bootstrapping[44] (resampling with replacement from the original data to produce replicates of the sample), resampling clusters rather than individuals. The distribution of the resulting 2000 estimates of the ICER on the cost-effectiveness plane[45] depicts the joint uncertainty surrounding costs and outcomes. Estimates in the lower right quadrant of a cost-effectiveness plane suggest that the intervention is more effective and less costly, while estimates in the upper right quadrant suggest it is more effective but costlier. Estimates in this quadrant require further analysis to determine if the decision-maker would be willing to allocate the extra expenditure for the extra benefit. The cost-effectiveness acceptability curve[46] is used for that purpose, to display the probability that the intervention is cost-effective at a given societal WTP threshold (ie, the proportion of the bootstrapped estimates that fall below the threshold) over a range of thresholds.

Scenario analyses
Cost per QALY was re-estimated under alternative scenarios to explore the results' sensitivity to particular assumptions or parameters. (1) Using only variables collected at baseline to adjust cost and outcomes; that is, excluding support and adverse life event variables from the regression models, which were collected at follow-up. (2) Assuming that MCH nurses would require retraining in the intervention after 1 year (instead of 3 years as in the base case). (3) Assuming that the average number of

families per session would be 5 or 7 (rather than 6 as in the base case). (4) Limiting the cost analysis to the health sector, the early childhood sector or combined public sector without participant OOP costs. (5) To test the sensitivity of the results to variation in costs and outcomes, for a worst-case scenario, incremental costs were assumed to be at the upper end of the 95% CI and incremental outcomes at the lower end for each individual, while for a best-case scenario, the reverse assumptions were applied. (6) To test the sensitivity of the results to the specifications of the models, linear regression was used for all three models.

EQ-5D-3L scores across clinical states
We also explored the usefulness of the EQ-5D-3L for discriminating between clinical states in postnatal mental health, using the Mann-Whitney U test to investigate whether EQ-5D-3L scores differed significantly between participants with and without major depressive disorder, and those with and without symptoms of anxiety or depression. The Mann-Whitney U test[47] was used because the EQ-5D-3L scores were (as expected) non-normally distributed, with a skew to the upper limit of 1, and so would not meet the assumptions for a two-sample t-test.

RESULTS
Baseline
Cluster randomisation resulted in the allocation of 196 participants across 24 MCHCs to the control arm and 204 participants across 24 MCHCs to the intervention arm (although one MCHC in the control arm did not recruit any participants). Overall, 21 participants (10.7%) from the control arm and 20 (9.8%) from the intervention arm did not complete the full follow-up interview, leaving 175 in the control arm and 184 in the intervention arm for complete case analysis. Baseline interviews took place between May 2013 and April 2014, and follow-up interviews between September 2013 and August 2014.

Participants' baseline characteristics, outlined in table 1, were similar between groups except that the intervention group had higher depression (p=0.045) and anxiety (p=0.004) scores and more participants with a history of eating or dieting disorders (p=0.039), while the control group reported a higher number of hours that the baby cried or fussed per day (p=0.048). These variables were included in the regression models for costs and outcomes, along with other relevant characteristics.

The pattern of missing data was monotone, since close to 100% of data were non-missing at the initial interview, and most data missing at follow-up involved the entire interview. Data were not missing completely at random, as those with missing data were more likely to be born overseas, speak a language other than English, hold a health care card had lower levels of education and gave lower self-reported health ratings, but were no different in psychiatric history. These characteristics were included

Table 1 Baseline participant characteristics

Characteristic at baseline N	Control group 175 Mean (SD)	Intervention group 184 Mean (SD)	p Value test of difference* t-test
Mean age, years	31.3 (5.12)	31.0 (5.10)	0.563
EQ-5D score	0.859 (0.14)	0.858 (0.15)	0.910
Socioeconomic index for areas[1]	1009.57 (30.12)	1014.43 (40.08)	0.197
Depression score[2]	3.46 (3.27)	4.20 (3.61)	**0.045**
Anxiety score[2]	2.77 (2.97)	3.85 (3.90)	**0.004**
Number of hours baby fusses or cries per 24 hours	3.30 (2.52)	2.83 (1.92)	**0.048**
	N (%)	**N (%)**	**Pearson χ^2 test**
Country of birth			0.794
Australia	138 (78.86)	143 (77.72)	
Language spoken at home			0.310
English	145 (82.86)	159 (86.41)	
English+other	21 (12.00)	21 (11.41)	
Other	9 (5.14)	4 (2.17)	
Level of education			0.738
University degree	115 (65.71)	114 (61.96)	
TAFE or college certificate or diploma	33 (18.86)	37 (20.11)	
Up to completion of high school	27 (15.43)	33 (17.93)	
Marital status			0.083
Married or de facto	165 (94.29)	180 (97.83)	
Single or not living with partner	10 (5.71)	4 (2.17)	
Health care card holder	26 (14.86)	18 (9.78)	0.143
Private health insurance	124 (70.86)	113 (61.41)	0.059
Self-rated health			0.706
Excellent	62 (35.43)	64 (34.78)	
Very good	89 (50.86)	89 (48.37)	
Good	24 (13.71)	31 (16.85)	
History of…			
Any psychiatric disorder	37 (21.14)	52 (28.26)	0.118
Depression	24 (13.71)	37 (20.11)	0.107
Anxiety	25 (14.29)	30 (16.30)	0.596
Post-traumatic stress disorder	6 (3.43)	4 (2.17)	0.470
Eating or dieting disorder	2 (1.14)	9 (4.89)	**0.039**
Alcohol or drug dependence	1 (0.57)	4 (2.17)	0.195
Physical or sexual abuse	10 (5.71)	18 (9.78)	0.151

[1] [42] [2] PHQ-9[58] [3] PHQ GAD-7.[59]
*Bold indicates statistically significant at 5% level of significance.

in the model for multiple imputation of missing data in scenario analysis.

The mean baseline EQ-5D-3L utility score was 0.859, with no statistically significant difference between the groups. However, in answering the anxiety/depression EQ-5D-3L domain question, more of the intervention group (20%) reported moderate anxiety or depression than the control group (13%) (p=0.054).

Outcomes
At follow-up, the unadjusted 30-day prevalence of DSM-IV diagnoses of depression, anxiety and adjustment disorders was 8.57% in the control group, and 8.70% in the intervention group (p=0.967, ICC <0.001).

EQ-5D-3L scores at follow-up were also similar between the control (0.890) and intervention groups (0.889) (p=0.980), with 23% of the control group and 20% of the intervention group reporting moderate anxiety/depression, and 2% of the intervention group reporting extreme anxiety/depression (none in the control group) (p=0.107).

Individual QALYs were calculated by dividing the mean of the two EQ-5D-3L scores for each person by their duration of follow-up, which varied from 78 to 288 days depending on the baby's age at recruitment (1.1–15.6 weeks) but was similar between groups (p=0.779). The mean QALY accumulated for the control group was 0.371 and for the intervention group was 0.372 (p=0.883, ICC 0.034).

After regression modelling to account for relevant sociodemographic, prognostic and clinical characteristics, the differences between groups were still not statistically significant; using complete case analysis, the intervention group had a 1.77 percentage-point lower

prevalence of depression, anxiety and adjustment disorders (p=0.497) and 0.007 higher QALYs accrued (p=0.417) than the control group. From the analysis using multiple imputation of missing data, the intervention group had 0.33 percentage-point lower prevalence (p=0.643) and 0.006 higher QALYs (p=0.544).

Costs

The estimated intervention cost per participant was $A118.16 in the base case. This included MCH nurse time to deliver the intervention (based on an average of 6 families attending each *WWWT* 6-hour session) and to complete the 3-hour self-directed training and the day and a half of face-to-face training in the intervention. It also included development costs to account for previous research conducted in developing *WWWT*. Average per-participant intervention costs were calculated as if the intervention were to be delivered state-wide, rather than using the numbers in attendance during the trial, as the intervention was delivered as routine at intervention MCH centres. The intervention MCH centres delivered *WWWT*-informed care to all women at the centres, as it was randomised at the centre level, and more women

attended WWWT sessions than the number who enrolled in the trial, so the approach had to vary from the usual per-participant trial cost estimation. For the trial, 33 MCH nurses were trained in the *WWWT* approach, and a total of 44 seminars were delivered by these nurses to an average of 4 families per session. Almost half (46%) of women in the intervention arm of the trial attended a seminar (further details of the implementation of the intervention in the trial are available in Fisher *et al*.[29])

Table 2 outlines the service use accrued during the period of follow-up. There were no statistically significant differences in service use between the intervention and control groups.

As shown in table 3, costs of health and other services were $A158.37 higher per participant (p=0.580, ICC 0.002) in the intervention than control group, mostly arising from statistically insignificant higher health service costs in the intervention group. Inclusive of intervention costs, the difference was $A276.53, and although this difference was not statistically significant, the intervention cost component was an addition to usual care costs.

Table 2 Service use during the follow-up period

Service type	Control (N=175)		Intervention (N=184)		Two-sided t-test
	No.	Mean	No.	Mean	p Value
MCH services					
MCH visit	793	4.5	800	4.4	0.581
MCH home visit	74	0.4	89	0.5	0.612
MCH telephone line	192	1.1	232	1.3	0.581
First-time parents' group	845	4.8	924	5.0	0.525
Mental health					
Psychologist, psychiatrist or counsellor	105	0.6	108	0.6	0.966
Psychiatric mother–baby unit admission	0	0.0	2	0.0	0.167
Web therapy session	16	0.1	106	0.6	0.289
Antidepressant, anxiolytic or sedative	11	0.1	20	0.1	0.161
Primary care					
GP	516	2.9	623	3.4	0.213
Clinic nurse	27	0.2	42	0.2	0.324
Nurse-on-call (telephone helpline)	59	0.3	70	0.4	0.599
Medical					
Obstetrician	67	0.4	88	0.5	0.232
Paediatrician	117	0.7	115	0.6	0.764
Other specialist	12	0.1	12	0.1	0.924
Allied health (physiotherapist, dietician or social worker)	197	1.1	268	1.5	0.316
Complementary healthcare	266	1.5	254	1.4	0.693
Hospital-related					
Outpatients	85	0.5	105	0.6	0.597
Emergency department visit	47	0.3	54	0.3	0.725
Total days hospital admission	71	0.4	35	0.3	0.320
Early parenting services					
Residential early parenting centre	6	0.0	6	0.0	0.940
Early parenting centre day stay	16	0.1	17	0.1	0.976
Breastfeeding telephone helpline	85	0.5	90	0.5	0.979
Lactation consultant, mothercraft nurse, support group or other parenting service	145	0.8	157	0.9	0.922

Table 3 Unadjusted costs by sector ($A, 2014)

Cost sector	Control Mean (SE)	Intervention Mean (SE)	Difference Mean (SE)	Two-sided t-test
Public sector	1353.66 (188.18)	1428.60 (190.19)	74.93 (267.79)	p=0.780
Health	776.84 (176.06)	847.95 (156.50)	71.11 (235.02)	p=0.762
Early childhood	429.40 (22.02)	438.80 (15.76)	9.41 (26.87)	p=0.727
Human services	147.43 (50.43)	141.85 (61.41)	-5.58 (79.90)	p=0.944
Participant out-of-pocket	343.77 (31.28)	377.29 (42.07)	33.52 (52.88)	p=0.527
Total (non-intervention)	1647.52 (192.67)	1805.89 (209.49)	158.37 (285.50)	p=0.580
Intervention cost	–	118.16	118.16	
Total cost	1647.52 (192.67)	1924.05 (209.49)	276.53 (285.50)	p=0.333

After adjustment using regression modelling and inclusive of costs relating to the intervention, with complete case analysis, the intervention group had $A268.69 additional costs (p=0.335) per participant; with imputation of missing data, the estimated additional cost was $A249.75 (p=0.311).

Cost-effectiveness

While neither costs nor outcomes demonstrated statistically significant differences between groups, a point estimate of the ICER can still be calculated based on the trial results, and can be informative as the best available estimate of cost-effectiveness,[48] albeit with a high degree of uncertainty surrounding the result. Using complete case analysis, the estimated cost per percentage-point reduction in 30-day prevalence of depression, anxiety and adjustment disorders was $A152 (95% CI −16 453 to 16 756). The estimated cost per QALY was $A36 451 (95% CI −1554 006 to 1 626 908). As shown in figure 1, the bootstrapped estimates of incremental costs and QALYs were in all four quadrants, reflecting the

uncertainty both costs and effectiveness. The majority (69%) fell in the northeast quadrant, suggesting that the intervention might be costlier and more effective. The bootstrapped estimates for the clinical effectiveness outcome showed a similar pattern (available as online supplementary figure S1).

At a threshold of $A55 000 per QALY, there is a 55% probability that the intervention is cost-effective. (Cost-effectiveness acceptability curve is available as online supplementary figure S2.) At a threshold of $A100 000 per QALY, the probability only rises by a small increment (to 67%) due to the uncertainty surrounding the effectiveness of the intervention.

Using the analysis that imputed missing values (intention-to-treat analysis), the estimated cost per percentage-point reduction in 30-day prevalence of depression, anxiety and adjustment disorders was $A747 and the estimated cost per QALY was $A44 830. These higher ICERs were driven by smaller differences in outcomes in the imputed data set. Using this approach, at the $55 000 per QALY threshold, there
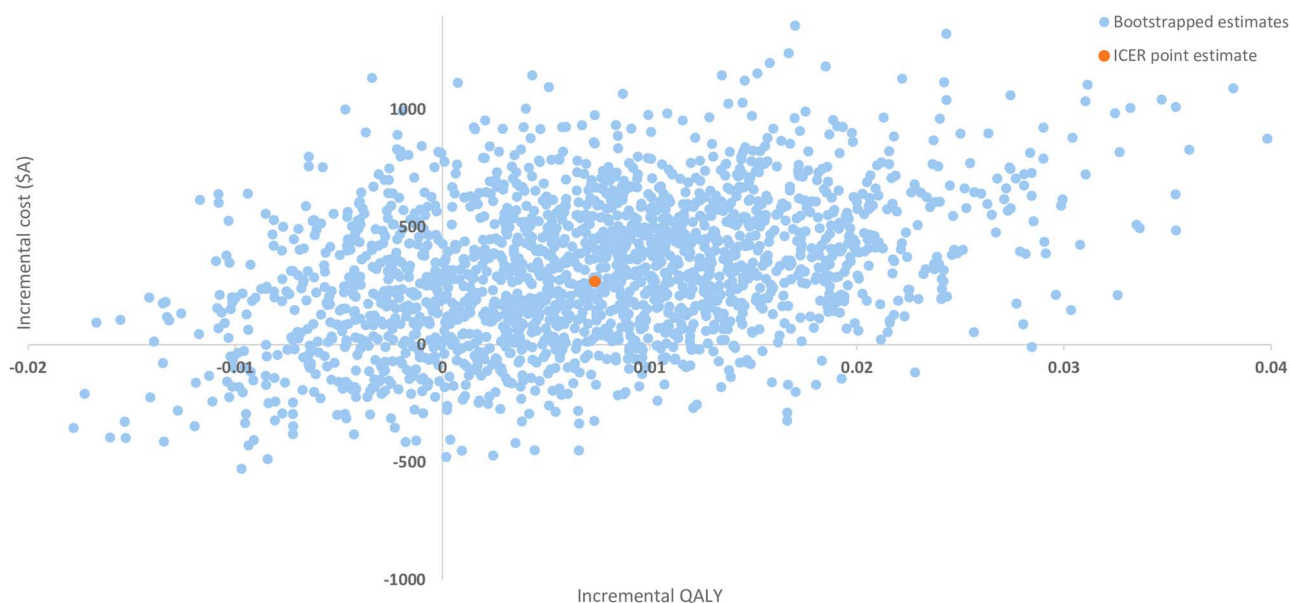

Figure 1 Cost-effectiveness plane—cost per quality-adjusted life year.

Table 4 Scenario analyses: cost-effectiveness ($A, 2014)

Scenario	Incremental cost-effectiveness ratio (ICER)		Probability of cost-effectiveness at threshold of $A55 000 per QALY (%)
	Cost per quality-adjusted life year (CUA)	Cost per %-point reduction in 30-day prevalence of depression, anxiety and adjustment disorders (CEA)	
Base case	$36 451.04	$151.67	55
With multiple imputation of missing data	$44 830.07	$746.68	53
Only baseline variables in regression models	$34 332.92	$159.10	57
Assuming MCH nurse training lasts 1 year	$39 041.07	$162.44	54
Number of participants per *WWWT* session=5	$39 214.87	$163.17	54
Number of participants per *WWWT* session=7	$34 473.05	$143.44	56
Health sector costs only	$50 359.59	$209.54	47
Early childhood sector costs only	$18 466.31	$76.84	68
Public sector costs only	$29 919.03	$124.49	58
Incremental costs at upper end of 95% CI, incremental outcomes at lower end of 95% CI	$65 362.84	$1881.41	36
Incremental costs at lower end of 95% CI, incremental outcomes at upper end of 95% CI	$19 245.54	$25.91	67
Linear models for costs and outcomes	$19 706.80	$97.28	62

was a 53% probability that the intervention is cost-effective.

Scenario analyses

The estimated ICERs under each scenario shown in table 4 demonstrate the potential impact of different methodological approaches or perspectives. Since most of the difference in non-intervention costs arose from the use of health rather than other services, limiting the perspective to the health sector gave a higher ICER than the base case. Limiting it to costs attributable to the early childhood sector (which is responsible for funding MCH services in Victoria) shows a much more favourable ICER. Participant OOP costs contributed to the cost difference, so that a public sector perspective (which excludes these) gave a lower ICER. The use of a GLM model for costs and logit model for the clinical outcome, chosen because of their superior theoretical basis, produced a higher ICER than when linear regression models were used.

EQ-5D-3L scores across clinical states

There was a gradient of EQ-5D-3L scores over increasing severity of depression and anxiety symptoms, as shown in figure 2. The mean EQ-5D-3L scores were found to differ significantly between those with (0.682) and without (0.878) major depressive disorder (p<0.001), and those with (0.806) and without (0.917) symptoms of depression or anxiety (p<0.001).

DISCUSSION

This study found that *WWWT* may be associated with higher costs and a small improvement in HRQoL and reduced prevalence of PND, anxiety and adjustment disorders when compared with usual MCH care, although

Figure 2 The mean EQ-5D-3L scores by severity of PHQ depression and anxiety scores. *PHQ, Patient Health Questionnaire.
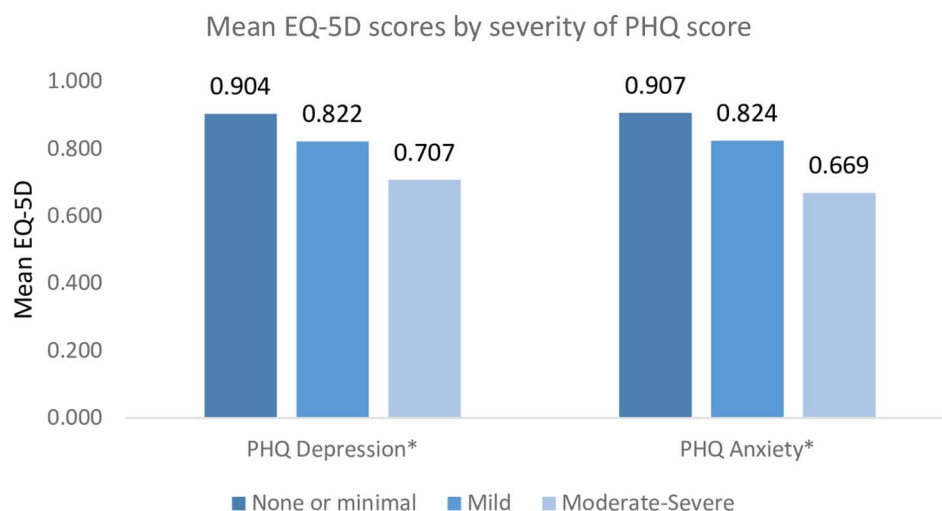
these differences were not statistically significant. We focus on the findings regarding cost per QALY gained, since there is no generally accepted level of WTP for one unit of improvement in the clinical outcome, and there is more acceptance of cost per QALY evidence by decision-makers.

The point estimate of the ICER, $A36 451 per QALY gained, was lower than the unofficial threshold of $A55 000,[23] as were all but one of the higher ICERs estimated under differing assumptions in the scenario analyses outlined in table 4. There was considerable uncertainty surrounding this result, with only a 55% probability that the intervention was cost-effective at a threshold of $A55 000 per QALY. The large differences in ICER dependent on which public sector costs were included are of particular importance since MCH services in Victoria are funded with early childhood services, while the intervention might be considered to fit better within a health sector perspective.

Other CEA of preventive interventions in postnatal mental health have evaluated targeted rather than universal preventive interventions and/or have used differing clinical end points as the measure of effectiveness, leading to difficulties in comparing results. For example, the PoNDER trial,[49] which used QALYs as an outcome measure but targeted women at risk of PND, found no statistically significant difference in costs or QALYs and a probability of cost-effectiveness of around 80% at a threshold of £20 000–30 000 per QALY gained. A Canadian study,[10] which investigated a programme of peer support for high-risk women in terms of cost per case of PND averted (rather than cost per QALY), found the point estimate of the ICER to be $CAD10 009 per case averted. In a UK study[9] focusing on counselling and support for women at risk of PND, no statistically significant differences were found in costs and outcomes, with a probability of cost-effectiveness of 71% at a threshold of £1000 per month of PND averted.

While this study did not demonstrate savings in unadjusted health service utilisation associated with the intervention, the intervention group had statistically significantly worse baseline depression and anxiety scores but not (as might have been expected) statistically significantly higher health service costs. This finding in relation to the use of residential early parenting centres may be of particular interest to the early childhood sector, since these are high-cost services and have similar risk factors to those addressed by the intervention.[50]

The data were not missing completely at random, suggesting that intention-to-treat analysis with imputation of missing values may be appropriate. However, it is not possible to tell from the observed data whether the pattern of missingness also depends on the outcome variable, and under some patterns of missingness (involving correlation with covariates), complete case analysis may be unbiased. Therefore, complete case and intention-to-treat analyses are presented.[51]

The correlation we found between EQ-5D-3L score and postnatal mental health supports previous findings that the EQ-5D-3L is able to discriminate between clinically significant mental health states.[52 53] We found statistically significant differences in EQ-5D-3L scores based not only on diagnosis of major depressive disorder, but also based on symptoms of depression or anxiety (a lower clinical threshold).

Limitations and possibilities for further research

Sample size calculations were based on the clinical effect rather than cost-effectiveness analysis,[54 55] which may have contributed to uncertainty surrounding the results. The cluster-randomised nature of the trial and small but non-negligible ICC for QALYs may also have reduced the ability to detect an effect of the intervention on QALYs in this trial.[30]

No extrapolation beyond the 6-month time horizon of the trial was conducted, since there were no statistically significant differences in this period. However, significant differences between the intervention and control groups may have emerged with a longer follow-up period.

This evaluation focused on costs of public sector services and OOP costs for mothers and infants. Since postnatal mental health problems in couples tend to co-occur,[56] and since the intervention explicitly included participants' partners and addressed the partner relationship, future research into WWWT could include partners' costs and outcomes, including partners' productivity. In the postnatal context, mothers' workforce participation may be low even in the absence of mental health problems,[57] which may limit the relevance of productivity in terms of mothers' employment.

The cost analysis depended on participants' recall of service use. To minimise recall error, participants were asked to record services used during the follow-up period and were prompted by interviewers to refer to this record and to report use of a wide range of services.

In this study, WWWT was evaluated as additional to standard FTP group sessions. However, there is a range of standard sessions available, from which MCHCs choose. If WWWT were incorporated into this range, the cost would be absorbed into usual FTP group costs but other content would be displaced. Future research could estimate the cost-effectiveness of WWWT in head-to-head comparison with other FTP group sessions rather than as an additional session.

Research into the cost-effectiveness of WWWT using alternative delivery mechanisms (such as online), and WTP (societal and/or decision-makers') for prevention of postnatal mental health problems could also be valuable to decision-makers.

CONCLUSIONS

This economic evaluation conducted alongside a cluster-randomised trial found no statistically significant

difference in either costs or effectiveness, with a point estimate of cost-effectiveness that suggests *WWWT* might be a cost-effective intervention for the prevention of postnatal mental health problems in first-time mothers. Given the dearth of cost-effective preventive interventions in this field and the clinical, social and economic incentives to prevent postnatal mental health problems, further research is warranted to reduce the uncertainty surrounding the results.

REFERENCES

1. Gavin NI, Gaynes BN, Lohr KN, *et al*. Perinatal depression: a systematic review of prevalence and incidence. *Obstet Gynecol* 2005;106(Pt 1):1071–83.
2. Fisher J, Cabral de Mello M, Patel V, *et al*. Prevalence and determinants of common perinatal mental disorders in women in low- and lower-middle-income countries: a systematic review. *Bull World Health Organ* 2012;90:139G–49G.
3. Da Costa D, Dritsa M, Rippen N, *et al*. Health-related quality of life in postpartum depressed women. *Arch Women Ment Health* 2006;9:95–102.
4. Reay R, Matthey S, Ellwood D, *et al*. Long-term outcomes of participants in a perinatal depression early detection program. *J Affect Disord* 2011;129:94–103.
5. Dagher RK, McGovern PM, Dowd BE, *et al*. Postpartum depression and health services expenditures among employed women. *J Occup Environ Med* 2012;54:210–15.
6. Webster J, Pritchard MA, Linnane JW, *et al*. Postnatal depression: use of health services and satisfaction with health-care providers. *J Qual Clin Pract* 2001;21:144–8.
7. Petrou S, Cooper P, Murray L, *et al*. Economic costs of post-natal depression in a high-risk British cohort. *Br J Psychiatry* 2002;181:505–12.
8. MacArthur C, Winter HR, Bick DE, *et al*. Redesigning postnatal care: a randomised controlled trial of protocol-based midwifery-led care focused on individual women's physical and psychological health needs. *Health Technol Assess* 2003;7:1–98.
9. Petrou S, Cooper P, Murray L, *et al*. Cost-effectiveness of a preventive counseling and support package for postnatal depression. *Int J Technol Assess* 2006;22:443–53.
10. Dukhovny D, Dennis CL, Hodnett E, *et al*. Prospective economic evaluation of a peer support intervention for prevention of postpartum depression among high-risk women in Ontario, Canada. *Am J Perinatol* 2013;30:631–42.
11. Morrell CJ, Spiby H, Stewart P, *et al*. Costs and effectiveness of community postnatal support workers: randomised controlled trial. *BMJ* 2000;321:593–8.
12. Pilkington PD, Whelan TA, Milne LC. A review of partner-inclusive interventions for preventing postnatal depression and anxiety. *Clin Psychol—UK* 2015;19:63–75.
13. Fisher JR, Wynter KH, Rowe HJ. Innovative psycho-educational program to prevent common postpartum mental disorders in primiparous women: a before and after controlled study. *BMC Public Health* 2010;10:432.
14. Rowe H, Wynter K, Lorgelly P, *et al*. A cluster randomised controlled trial of a brief couple-focused psychoeducational intervention to prevent common postnatal mental disorders among women: study protocol. *BMJ Open* 2014;4:e006436.
15. Department of Education and Early Childhood Development Victoria. Maternal and Child Health Service Program Standards, 2009.
16. Department of Education & Training. Maternal and Child Health Annual Report Archive: State Government Victoria. 2014. http://www.education.vic.gov.au/childhood/providers/support/Pages/mchannualreportarchive.aspx
17. Edgecombe G, White S, Marsh G, *et al*. First-time parent group resource and facilitation guide for maternal and child health nurses. Melbourne: Victorian Department of Human Services, 2001:1–120.
18. Department of Education and Early Childhood Development Victoria, Municipal Association of Victoria. Memorandum of Understanding between Department of Education and Early Childhood Development AND Municipal Association of Victoria in relation to Maternal and Child Health Services July 2012—June 2015. VIC, Australia, 2012.
19. Drummond MF, Sculpher MJ, Torrance GW, *et al*. *Methods for the economic evaluation of health care programmes*. 3rd edn. Oxford, UK: Oxford University Press, 2005.
20. Weinstein MC, Siegel JE, Gold MR, *et al*. Recommendations of the panel on cost-effectiveness in health and medicine. *JAMA* 1996;276:1253–8.
21. Unützer J, Katon WJ, Russo J, *et al*. Willingness to pay for depression treatment in primary care. *Psychiatr Serv* 2003;54:340–5.
22. Schomerus G, Angermeyer MC, Matschinger H, *et al*. Public attitudes towards prevention of depression. *J Affect Disord* 2008;106:257–63.
23. Simoens S. Health economic assessment: cost-effectiveness thresholds and other decision criteria. *Int J Environ Res Public Health* 2010;7:1835–40.
24. Ryen L, Svensson M. The willingness to pay for a quality adjusted life year: a review of the empirical literature. *Health Econ* 2015;24:1289–301.
25. Shiroiwa T, Sung YK, Fukuda T, *et al*. International survey on willingness-to-pay (WTP) for one additional QALY gained: what is the threshold of cost effectiveness? *Health Econ* 2010;19:422–37.
26. NICE. *Guide to the methods of technology appraisal 2013*. UK: NICE, 2013.
27. Claxton K, Martin S, Soares M, *et al*. Methods for the estimation of The National Institute for Health and Care Excellence cost-effectiveness threshold. *Health Technol Assess* 2015;19:1–503.
28. Ride J, Rowe H, Wynter K, *et al*. Protocol for economic evaluation alongside a cluster-randomised controlled trial of a psychoeducational intervention for the primary prevention of postnatal mental health problems in first-time mothers. *BMJ Open* 2014;4:e006226.
29. Fisher J, Rowe H, Wynter K, *et al*. Gender-informed, psychoeducational programme for couples to prevent postnatal common mental disorders among primiparous women: cluster randomised controlled trial. *BMJ Open* 2016;6:e009396.
30. Killip S, Mahfoud Z, Pearce K. What is an intracluster correlation coefficient? Crucial concepts for primary care researchers. *Ann Fam Med* 2004;2:204–8.
31. Australian Government Department of Health. MBS Online: Commonwealth of Australia. http://www.mbsonline.gov.au/internet/mbsonline/publishing.nsf/Content/downloads
32. Independent Hospital Pricing Authority. National Efficient Price Determination 2013-14: Commonwealth of Australia. http://www.ihpa.gov.au/internet/ihpa/publishing.nsf/content/nep-determination-2013-14
33. American Psychiatric Association. *Diagnostic and statistical manual-text revision (DSM-IV-TRim, 2000)*. American Psychiatric Association, 2000.
34. Viney R, Norman R, King MT, *et al*. Time trade-off derived EQ-5D weights for Australia. *Value Health* 2011;14:928–36.
35. Brooks R. EuroQol: the current state of play. *Health Policy* 1996;37:53–72.

36. Wisløff T, Hagen G, Hamidi V, *et al*. Estimating QALY gains in applied studies: a review of cost-utility analyses published in 2010. *Pharmacoeconomics* 2014;32:367–75.

37. Gutke A, Lundberg M, Östgaard HC, *et al*. Impact of postpartum lumbopelvic pain on disability, pain intensity, health-related quality of life, activity level, kinesiophobia, and depressive symptoms. *Eur Spine J* 2011;20:440–8.

38. Shorten A, Shorten B. The importance of mode of birth after previous cesarean: success, satisfaction, and postnatal health. *J Midwifery Womens Health* 2012;57:126–32.

39. Jansen AJ, Essink-Bot ML, Duvekot JJ, *et al*. Psychometric evaluation of health-related quality of life measures in women after different types of delivery. *J Psychosom Res* 2007;63:275–81.

40. Turkstra E, Gamble J, Creedy DK, *et al*. PRIME: impact of previous mental health problems on health-related quality of life in women with childbirth trauma. *Arch Womens Ment Health* 2013;16:561–4.

41. Petrou S, Morrell J, Spiby H. Assessing the empirical validity of alternative multi-attribute utility measures in the maternity context. *Health Qual Life Outcomes* 2009;7:40.

42. Australian Bureau of Statistics. Socio-Economic Index for Areas. 2013. http://www.abs.gov.au/websitedbs/censushome.nsf/home/seifa

43. Glick HA, Doshi JA, Sonnad SS, *et al*. *Economic evaluation in clinical trials*. 2nd edn. Oxford, UK: Oxford University Press, 2015.

44. Briggs AH. Statistical approaches to handling uncertainty in health economic evaluation. *Eur J Gastroenterol Hepatol* 2004;16:551–61.

45. Black WC. The CE plane a graphic representation of cost-effectiveness. *Med Decis Making* 1990;10:212–14.

46. Fenwick E, Byford S. A guide to cost-effectiveness acceptability curves. *Br J Psychiatry* 2005;187:106–8.

47. Kirkwood B, Sterne J. *Essential medical statistics*: John Wiley & Sons, Ltd, 2003.

48. Claxton K. The irrelevance of inference: a decision-making approach to the stochastic evaluation of health care technologies. *J Health Econ* 1999;18:341–64.

49. Morrell CJ, Warner R, Slade P, *et al*. Psychological interventions for postnatal depression: cluster randomised trial and economic evaluation. The PoNDER trial. *Health Technol Assess* 2009;13:iii–iv, xi–xiii, 1-153.

50. Fisher JRW, Feekery CJ, Rowe-Murray HJ. Nature, severity and correlates of psychological distress in women admitted to a private mother–baby unit. *J Paediatr Child Health* 2002;38:140–5.

51. White IR, Carlin JB. Bias and efficiency of multiple imputation compared with complete-case analysis for missing covariate values. *Stat Med* 2010;29:2920–31.

52. Brazier J. Is the EQ-5D fit for purpose in mental health? *Br J Psychiatry* 2010;197:348–9.

53. Mihalopoulos C, Chen G, Iezzi A, *et al*. Assessing outcomes for cost-utility analysis in depression: comparison of five multi-attribute utility instruments with two depression-specific outcome measures. *Br J Psychiatry* 2014;205:390–7.

54. Willan AR, O'Brien BJ. Sample size and power issues in estimating incremental cost-effectiveness ratios from clinical trials data. *Health Econ* 1999;8:203–11.

55. Manju MA, Candel MJ, Berger MP. Sample size calculation in cost-effectiveness cluster randomized trials: optimal and maximin approaches. *Stat Med* 2014;33:2538–53.

56. Roberts SL, Bushnell JA, Collings SC, *et al*. Psychological health of men with partners who have post-partum depression. *Aust N Z J Psychiatry* 2006;40:704–11.

57. Australian Bureau of Statistics. Pregnancy and work transitions. 2013 (20 November 2015). http://www.abs.gov.au/ausstats/abs@.nsf/Lookup/4102.0Main+Features10Nov+2013

58. Spitzer RL, Kroenke K, Williams JB. Validation and utility of a self-report version of PRIME-MD: the PHQ primary care study. Primary Care Evaluation of Mental Disorders. Patient Health Questionnaire. *JAMA* 1999;282:1737–44.

59. Spitzer RL, Kroenke K, Williams JB, *et al*. A brief measure for assessing generalized anxiety disorder: the GAD-7. *Arch Intern Med* 2006;166:1092–7.