






# BMJ Open Is proactive telephone-based breastfeeding peer support a cost-effective intervention? A within-trial cost-effectiveness analysis of the 'Ringing Up about Breastfeeding early' (RUBY) randomised controlled trial

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## ABSTRACT

**Objective** The 'Ringing Up about Breastfeeding early' (RUBY) randomised controlled trial showed increased breastfeeding at 6 months in participants who received the proactive telephone-based peer support breastfeeding intervention compared with participants allocated to receive standard care and supports. The present study aimed to evaluate if the intervention was cost-effective.

**Design** A within-trial cost-effectiveness analysis.

**Setting** Three metropolitan maternity services in Melbourne, Victoria, Australia.

**Participants** First time mothers intending to breastfeed their infant (1152) and peer volunteers (246).

**Intervention** The intervention comprised proactive telephone-based support from a peer volunteer from early postpartum up to 6 months. Participants were allocated to usual care (n=578) or the intervention (n=574).

**Main outcome measures** Costs during a 6-month follow-up period including individual healthcare, breastfeeding support and intervention costs in all participants, and an incremental cost-effectiveness ratio.

**Results** Costs per mother supported were valued at \$263.75 (or \$90.33 excluding costs of donated volunteer time). There was no difference between the two arms in costs for infant and mothers in healthcare and breastfeeding support costs. These figures result in an incremental cost-effectiveness ratio of \$4146 (\$1393 if volunteer time excluded) per additional mother breast feeding at 6 months.

**Conclusion** Considering the significant improvement in breastfeeding outcomes, this intervention is potentially cost-effective. These findings, along with the high value placed on the intervention by women and peer volunteers provides robust evidence to upscale the implementation of this intervention.

**Trial registration number** ACTRN12612001024831.

## INTRODUCTION

The health and economic benefits of breastfeeding at an individual and population level are undeniable, and are a vital impetus

## STRENGTHS AND LIMITATIONS OF THIS STUDY

- ⇒ This economic evaluation was conducted alongside the largest (to date) randomised controlled trial of a proactive telephone-based peer support for breastfeeding intervention.
- ⇒ The quality of this analysis is strengthened by the inclusion of an incremental cost-effectiveness ratio.
- ⇒ The inclusion of members of the Australian Breastfeeding Association in the research team will support implementation and up-scale of the intervention.
- ⇒ Estimates of healthcare costs have wide CIs, even with a significant sample size.
- ⇒ Costs of implementing the intervention are fully captured within this study, however, the improved breastfeeding outcomes of the intervention have implications for resource use extending beyond 6 months, therefore the measure of cost-effectiveness detailed here is a conservative estimate.

to increase the rate of breastfeeding worldwide to attain the Sustainable Development Goals (SDG) of improved nutrition (SDG 2), prevention of child mortality (SDG 3) and support of cognitive development (SDG 4), by 2030.<sup>1</sup> Breastfeeding offers protective effects for infants against disease,<sup>2</sup> and extends a health promotion effect through a reduction in the risk of developing obesity<sup>3</sup> and type I diabetes,<sup>4</sup> as well as life enrichment through improved cognitive development<sup>5</sup> and intelligence quotient (IQ).<sup>6</sup> Mothers who breastfeed also benefit with a reduction in the risk of developing breast and ovarian cancers and type II diabetes.<sup>7</sup>

The health advantages of breastfeeding to individuals has a considerable flow-on effect

to healthcare systems, including decreased healthcare provision and hospitalisations, as well as reduced medication use.<sup>8</sup> Society also benefits from the associated economic advantages, with labour markets profiting from increased productivity from lower rates of workplace sick and carer's leave<sup>9</sup> due to mother and infant illness.

Conversely, households and populations bear the detrimental impacts of not breastfeeding. Losses suffered as a result of early deaths impact both human and economic capital, with studies estimating the economic costs of the avoidable deaths of children and women associated with suboptimal breastfeeding to be US\$53.7 billion in future lost earnings.<sup>10</sup> Reduction in cognition and IQ<sup>11</sup> associated with not breastfeeding infants contributes to a lower level of educational achievement, employment and subsequent lifetime earnings,<sup>12</sup> and it is estimated that high-income countries lose 0.53% of gross national income each year due to this cognition loss.<sup>10</sup>

The environmental impact of the production of infant formula is also considerable, with the dairy industry a key contributor to greenhouse gas emissions with an estimated 3.9 kg of CO<sub>2</sub> produced for every 1 kg of powdered infant formula manufactured for infants 0–6 months,<sup>13</sup> and further estimated 11–14 kg of CO<sub>2</sub> for the entire product lifecycle.<sup>14</sup>

Despite the known human and economic benefits of breastfeeding and detrimental impacts of not breastfeeding, global breastfeeding rates remain suboptimal. In Australia, while national breastfeeding initiation rates are high at 96%, the rate of premature weaning is also high, with only 60% of infants still receiving any breast milk at 6 months and 15% exclusively breastfed to 5 months.<sup>15</sup> The initiation rate is indicative of women's breastfeeding intentions, yet for various reasons, many women do not achieve their breastfeeding goals. To improve rates of breastfeeding initiation and maintenance and realise the full potential that breastfeeding offers, an investment in, and scaling up of, effective interventions supporting breastfeeding women is required.

The recent Cochrane review of 'Support for healthy breastfeeding mothers with healthy term babies' found evidence of increased breastfeeding with face-to-face support by health professionals, however, provision of additional professional support for up to 6 months would require significant, and ongoing, investment in infrastructure and personnel.<sup>16</sup> The economic and operational burdens on healthcare systems are increasing worldwide<sup>17</sup> and innovative models of care provision and support are needed to ensure impactful, high quality, cost-effective healthcare is delivered. Peer support has the potential to reach broad, diverse and often hard-to-reach populations.<sup>18</sup> Peer support interventions, particularly those delivered by telephone, may offer a cost-effective, accessible and sustainable model of support. At the time of the 2017 Cochrane review of 'Support for healthy breastfeeding mothers with healthy term babies' there was no evidence that peer support models increased breastfeeding duration. Since then we published outcomes from the 'Ringing Up about Breastfeeding early' (RUBY) randomised controlled trial

(RCT) of 1152 women, in which a positive association was found between women receiving the proactive telephone-based peer support intervention and breastfeeding rates at 6 months postpartum: 75% of infants received breast milk in the previous 24 hours, compared with 69% in the control group.<sup>19</sup>

### Current evidence

Economic and financial factors are crucial to consider when justifying investment in interventions, and essential for sustainability of interventions over time, yet few trials include cost-effectiveness evaluations.<sup>20</sup> Existing literature reporting cost-analysis of breastfeeding support strategies are often limited by reporting costs of the intervention only, and fail to report a complete costing, including impact on broader health service use and other related factors. Cost data also fall short of full economic evaluation, which compares the cost impact of an intervention to the associated change in health outcomes, typically through an incremental cost-effectiveness ratio (ICER).<sup>21</sup> It is this comparative analysis of costs and outcomes that is essential in high-quality analysis of health interventions.<sup>22</sup> To date only five breastfeeding intervention studies have included a full economic analysis and ICER. Three found cost-effective uses of healthcare resources—two testing enhanced staff contact for mothers and babies in neonatal units,<sup>23 24</sup> and a group education and breastfeeding counselling intervention to reduce HIV transmission.<sup>25</sup> A UK study testing a financial incentive improved breastfeeding at 6–8 weeks postpartum at a cost of £974 per additional baby breastfed at 6–8 weeks was considered potentially cost-effective.<sup>26</sup> A Ugandan study of a community peer counselling programme found an increase in breastfeeding at 12 weeks (82% intervention to 44% control) but reported the intervention unlikely to be cost-effective in reducing diarrhoeal disease (the primary outcome), as the cost was above the assumed 'willingness-to-pay' (WTP) threshold (a benchmark judgement of value-for-money in a country) of per capita Gross Domestic Product.<sup>27</sup> This paper fills an important gap regarding cost-effectiveness of breastfeeding support strategies by providing a robust economic evaluation of the RUBY RCT testing the effect of a proactive breastfeeding peer support programme in a high-income country setting.

### Aims

The aim of this paper is to evaluate the cost-effectiveness of providing proactive telephone-based peer support to increase breastfeeding (in addition to standard care), compared with standard care, in the early postpartum period.

## METHODS

### Study design

This cost-effectiveness analysis is one component of the RUBY RCT, a multicentre, two-arm un-blinded RCT conducted in three hospitals in Victoria, Australia.<sup>19</sup> More detail is provided elsewhere<sup>19 28</sup> but a brief description is

provided below for context. The economic evaluation is a within-trial cost-effectiveness analysis from a societal perspective, comparing the impact of peer support for breastfeeding on the proportion of infants receiving any breast milk at 6 months postpartum (primary outcome) to the impact on costs in terms of the resources required for the intervention plus any change in use of health and related services to 6 months post partum.

### Patient and public involvement statement

Members of the RUBY research team included representatives from the Australian Breastfeeding Association (ABA) (<https://www.breastfeeding.asn.au/>), Australia's largest breastfeeding advocacy group. The ABA representatives were also involved in survey design and peer volunteer training.

### Participants

Participants for the evaluation presented here are (1) mothers recruited and randomised to the RUBY RCT who had completed a 6-month postpartum telephone interview and (2) volunteer mothers who provided the peer support intervention.

1. RCT participants were 1152 first-time mothers, intending to breastfeed, recruited in hospital after birth but prior to hospital discharge.<sup>28</sup> Women were ineligible if they had a serious illness, their infant remained in hospital after the mother's discharge, had a multiple birth, chose to formula feed or were an antenatal member of the ABA.
2. Peer volunteers were women who had personal experience of breastfeeding for a minimum of 6 months (and not considered breastfeeding experts), who had expressed an interest in participating, successfully screened for eligibility and had undergone peer support training provided by ABA educators.<sup>19</sup>

### Trial recruitment, randomisation, intervention allocation and description

Research midwives approached all eligible women on the postnatal unit, obtained informed written consent, asked the women to complete a brief background questionnaire, then randomised them via an externally administered randomisation programme. A computerised random number programme generated block sizes of four or six distributed randomly, with stratification by site. Women were randomly assigned (1:1) to usual care or usual care plus proactive telephone-based breastfeeding support from a trained peer volunteer for up to 6 months postpartum. Research midwives were masked to block size, but masking of allocation was not possible. Analyses were by intention to treat, and data were collected and analysed masked to group.

Standard care included a hospital stay of 2–3 days, with hospital lactation consultants available if needed, a minimum of one home visit by a hospital midwife, and access to Maternal and Child Health Services in the local community.

Women allocated to the intervention arm of the trial received standard care, and additionally were scheduled to receive calls from a peer supporter commencing a few days after birth, then weekly up to 3 months postpartum, then 3–4 weekly to 6 months, with this schedule flexible according to the participant's needs.<sup>28</sup> Participants receiving the intervention were able to contact their peer between calls if they needed. More details on the intervention are reported elsewhere.<sup>19 29</sup>

Peers attended an in-person 4-hour training session conducted by an experienced breastfeeding counselling trainer from the ABA. Peers were provided with a manual that included information from the session and sources of further support which could be used for referring the mother to if needed. The peer was also provided with a call log template to record details of the contacts with each mother. Once a mother was allocated to receive the intervention, the volunteer coordinator matched the mother and her peer volunteer. Peers were contacted by the volunteer coordinator at various timepoints throughout the period of support to monitor ongoing contact and discuss any issues. Peers could contact the coordinator if they had any concerns.<sup>29</sup>

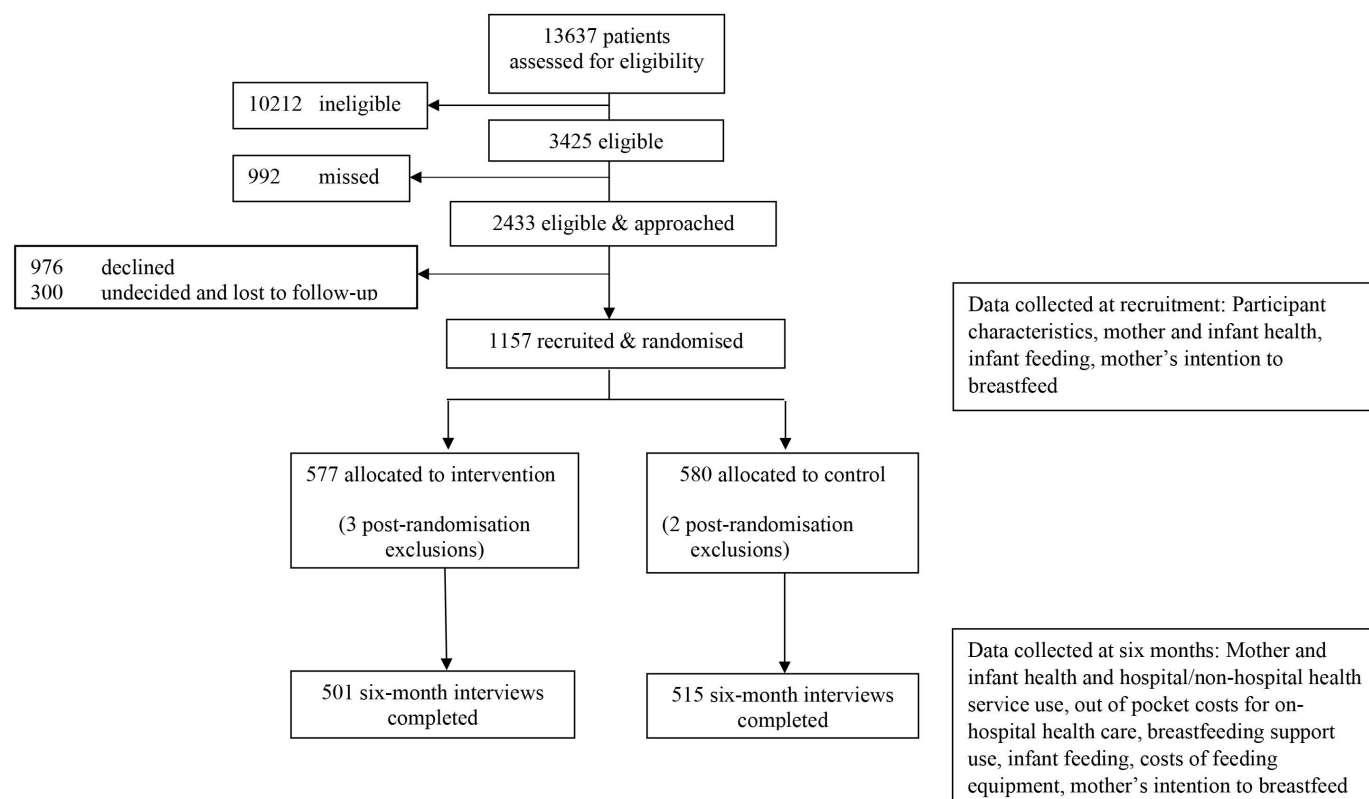
### Data collection

Demographic data (including maternal age, marital status, education, income, infant feeding intention) were collected by questionnaire at recruitment and prior to randomisation. Resource use on infant feeding and associated costs, mother and infant health service use since discharge from hospital after the birth including admission to hospital, emergency department visits, outpatient services, community health services, direct medical costs (eg, healthcare professional fees, medication prescriptions) and supports used for breastfeeding were collected at 6 months postpartum, via structured telephone interview.

Peer support intervention costs and time, including volunteer screening, recruitment, training sessions, programme coordination and support activities were collected by the RUBY peer volunteer coordinator. Details of contacts with the assigned mother (eg, call date/time and length, text messages) were recorded in the call activity log by the peer volunteer and returned to the volunteer coordinator at the completion of the period of support.<sup>29</sup>

### Data analysis

Data were entered onto REDCap (Research and Electronic Data Capture) and downloaded to Stata Statistical Software V.14 (Statacorp, 2015) for data cleaning and analysis. Data cleaning included cross-checking missing data fields with original paper-based questionnaires, range and logic checks. All participant data analysis was undertaken on an intention-to-treat basis. Categorical data are presented as numbers and percentages, and continuous data as means and standard deviations (SDs) (or median and interquartile range (IQR) for non-normally



**Figure 1** Participant flow chart.

distributed data). All costs are presented in Australian dollars.

Health service (hospital and non-hospital) use, infant feeding costs, estimated out-of-pocket expenses and supports used for breastfeeding were compared between the two trial arms using t-tests. We report the means using the whole trial arm group as the denominator to be representative of average use and costs within a population, important given the data relating to some aspects of health service use (and costs), particularly hospital use, are skewed due to a large number of participants not using these services.

As health service and breastfeeding support costs were reported by multiple participants across multiple providers, costs were estimated using national tariffs. Hospital service price weights were derived from the Independent Hospital Pricing Authority (IHPA), an independent government agency which determines the national efficient price (NEP) for public hospital services nationally. The IHPA National Weighted Activity Unit 2020–2021 calculators<sup>30</sup> were used to determine unit prices for admitted acute care services, admitted emergency department services (length of stay 4 hours or more), non-admitted emergency department services (less than 4 hours length of stay) and non-admitted services. Calculations assumed a mean age of participants of 31 years for mothers and less than 1 year for infants. Maternal inpatient admissions were estimated using the Diagnosis Related Group (DRG) 'Postpartum minor complexity' (bundled as length of stay either 'same day', 1–6 days

or 7 days or more) and infant inpatient admissions were calculated as 'Neonate >2500 g and ≥37 weeks gestation' (bundled as length of stay either 'same day', 1–7 days or 8 days or more). Outpatient visits were estimated using the DRG 'Midwifery and maternity' for mothers and 'Paediatric medicine' for infants. Emergency department use was coded at a triage level of 3 (from a range of levels 1–5) for both admitted and non-admitted visits, mothers and infants.

Medicare is a universal health insurance scheme for all Australians providing access to health and hospital services at low or no cost to the individual. Health service use in the community was costed using the Department of Health Medicare Benefits Schedule<sup>31</sup> price weights of health service items, as a standard costing. As gap fees paid by individuals are unknown, the scheduled fee (full rate) for these services was used and has also been used as a guide for services not billed through Medicare. All 'out-of-pocket' costs reported by participants including health service and feeding equipment costs were adjusted for a 6.5% inflation rate over 4 years (2016–2020), at an average annual inflation rate of 1.6%, to present all costs in 2020 Australian dollars.<sup>32</sup>

Resource use costs were estimated for each mother and infant individually, and then as a mother–infant dyad, with breastfeeding supports added to mother's costs. Costs were then compared between trial arms.

Costs for implementation, training and delivery of the peer support intervention included all activities of the peer volunteer coordinator, all training and time

**Table 1** Participant characteristics

Characteristic	Intervention, n=501		Control, n=515	
	n	%	n	%
<b>At recruitment</b>				
Maternal age (mean (SD))	31.2	(4.9)	31.3	(4.7)
Marital status				
Married or living with partner	479	95.6	497	96.5
Have partner but do not live together	8	1.6	5	0.97
Single	14	2.8	13	2.5
Highest level of education (n=500, n=515)				
Degree or higher	327	65.4	355	68.9
Household weekly income pretax (\$)				
Less than \$1000	87	17.4	82	15.9
\$1000–\$1999	174	34.7	165	32.0
\$2000 or more	182	36.3	217	42.1
Declined to answer	58	11.6	51	9.9
Pension or benefit main income for family (n=500/515)	30	6.0	23	4.5
Healthcare card (n=481/503)	58	12.1	40	8.0
Born in Australia	247	49.3	228	44.3
English first language	315	62.9	332	64.5
Residency status (n=494, n=508)				
Australian citizen	326	66.0	312	61.4
Permanent resident	107	21.7	123	24.2
Student visa	7	1.4	12	2.4
Other, temporary visa	54	10.9	60	11.8
Smoking				
Smoked prepregnancy	68	13.6	66	12.8
Smoking at recruitment	17	3.4	8	1.6
Maternal BMI prepregnancy (n=468/498)				
Underweight (<18.5)	23	4.9	25	5.0
Normal range (18.5–24.99)	319	68.1	328	65.8
Overweight (25–29.99)	81	17.3	98	19.7
Obese (≥30)	45	9.6	47	9.4
Onset of labour—spontaneous	254	50.7	252	48.9
Epidural analgesia for labour	223	44.5	218	42.3
Caesarean birth	142	28.3	147	28.5
Baby gestation at birth (weeks) mean (SD)	39.6	(1.2)	39.5	(1.2)
Birth weight (g) mean (SD) 3395	3392	(450)	3398	(493)
Received infant formula since birth, before recruitment	102	20.4	143	27.8
Infant admitted to neonatal/special care nursery	30	6.0	38	7.4
Intention for breastfeeding duration				
12 months or longer	160	31.9	175	34.0
6 months or longer	222	44.3	248	48.2
Less than 6 months	31	6.2	20	3.9
I plan to breastfeed but have no plans for how long	88	17.6	72	14.0
<b>At 6-month interview</b>				
Intention for breastfeeding duration 12 months or longer	238	47.5	210	40.8
Edinburgh Postnatal Depression Scale 13 or more (n=504, n=485)	34	6.7	23	4.7
BMI, body mass index.				

and call costs of phone calls. Costs of time worked by the coordinator, ABA educator and peer volunteers was calculated at the average hourly rate of pay.<sup>33</sup> Intervention costs were totalled for all women allocated to the intervention arm of the trial. Intervention costs were additionally calculated with the peer time valued as \$0, due to the donated nature of this resource. Mean intervention costs were then added to mother-infant dyad health service and supports costs to give an overall cost per mother-infant dyad. Incremental (where incremental means the difference between the two—intervention group over the control group) costs of the peer support intervention were divided by incremental effects for ‘any’ breast feeding at 6 months to calculate an ICER. As the costs related to the intervention include those paid for by health services, families and peer volunteers, our analysis also assesses the sensitivity of results to inclusion of volunteer and household resources.

## RESULTS

A total of 1016 of the 1152 participants (88%) recruited and randomised to the RUBY RCT (from February 2013 to December 2015) completed a follow-up interview at 6 months postpartum (n=501 intervention, n=515 control) (figure 1). The participant characteristics are shown in table 1 and are similar between groups. The proportion of infants who had received infant formula prior to recruitment was higher in the control group (27.6% compared with 20.4%) and women in the control group were more likely to plan a breastfeeding duration of 6 months or more (82.2%) compared with women in the intervention group (76.2%). Respondents are representative of the randomised trial arm groups in the RCT.<sup>19</sup>

### RUBY trial outcomes

The RUBY RCT outcomes have previously been published.<sup>19</sup> At 6 months postpartum, the proportion of infants receiving any breast milk in the previous 24 hours (primary outcome) was 75.0% in the intervention group and 68.7% in the control group (relative risk 1.09, 95% CI 1.01 to 1.18).<sup>19</sup> At 6 months postpartum, mothers’ intention to breastfeed for 12 months or more had increased 6.8% in the control group (34.0%–40.8%) compared with 15.6% in the intervention group (31.9%–47.5%) (table 1).

### Use of healthcare and related resources

Hospital, non-hospital health service and support service use for mother and infant health, as well as infant feeding costs were reported by mothers at 6 months (table 2).

### Healthcare use for mothers

Approximately 29% of mothers in each group used hospital services for their own health, following discharge from hospital after birth (table 2). Reasons most frequently cited for emergency department presentations were mastitis (intervention n=13/89, 15%, control n=14/81,

17%) and perineal tear/episiotomy infection (intervention n=16/89, 18%, control n=13/81, 16%). The main reasons reported for inpatient admissions were treatment of mastitis/breast abscess (intervention n=6/29, 21%, control n=3/18, 17%), caesarean section wound infections (intervention n=3/29, 10%, control n=3/18, 17%) and cholecystitis/cholecystectomy (intervention n=6/29, control n=0). The most frequently reported reasons for a maternal outpatient visit were breastfeeding support (intervention n=34/144, 24%, control n=42/135, 31%) and physiotherapy (intervention n=27/144 19%, control n=19/135, 14%).

Approximately 64% of mothers in each group reported using non-hospital services for their health, including general practitioners, specialist physicians, physiotherapists and other allied health services including psychology and osteopathy. Average estimated out-of-pocket expenditure for these services was similar in both groups (intervention \$130, control \$118).

### Non-hospital breastfeeding support

Women reported seeking professional help in the community for breastfeeding, with around 23% of women in each group consulting a lactation consultant (private, community or local council lactation consultant), and about one in five calling the ABA helpline (intervention 19%, control 17%). Non-professional social support was sought from family members, friends and other mothers as well as from the internet. While women in the control group reported a slightly higher use of all sources of social support, the intervention group also reported seeking help from their RUBY volunteer.

### Feeding equipment costs

Participants were asked to estimate how much they had spent on breastfeeding and infant formula feeding equipment (table 2). These costs included purchasing breast pads and pumps, infant formula, bottles, teats and sterilising equipment. If the mother was both formula feeding and giving expressed breast milk, the cost of bottles and sterilising equipment was split between their breastfeeding and formula feeding expenses. Expenditure on feeding equipment was somewhat lower in the intervention group, spending a mean of \$217.69 on breastfeeding equipment (control \$233.91), and \$209.52 on formula feeding equipment (control \$216.40).

### Peer intervention costs

Costs associated with the screening, recruitment and training of peer volunteers, as well as delivery of the peer support intervention are summarised in table 3. There were 693 enquiries from potential peer volunteers. For each of these, the volunteer coordinator conducted a screening interview. Of these, 246 women completed training and became peer volunteers (figure 2). This recruitment and screening process (time and call costs) was costed at \$12 681.90. Figure 3 outlines the volunteer coordination including training sessions resources, time

**Table 2** Resources used since birth up to 6 months

	Intervention, n=501		Control, n=515	
	n	%	n	%
<b>Hospital service use for mother's health (at least once) (n=499, n=512)</b>	<b>143</b>	<b>28.7</b>	<b>153</b>	<b>29.9</b>
Mother presentations to hospital (could be more than one visit per mother)*				
Inpatient stay	29	5.8	18	3.5
Emergency department presentation	89	17.8	81	15.7
Outpatients visit	144	28.8	135	26.2
Total number hospital presentations for mother's health per trial arm (mean)	262	(0.5)	234	(0.5)
<b>Used non-hospital health service for mother's health (at least once)</b>	<b>318</b>	<b>63.5</b>	<b>327</b>	<b>63.5</b>
Estimate of out-of-pocket expenses in \$A mean/SD (n=493, n=502)	130.33	320.49	117.78	291.28
Median/IQR	0	(0–2000)	0	(0–1500)
<b>Hospital service use for infant's health (at least once)</b>	<b>170</b>	<b>34.0</b>	<b>183</b>	<b>35.7</b>
Baby presentations to hospital (could be more than one visit per baby)*				
Inpatient admission	20	4.0	24	4.7
Emergency department presentation	133	26.5	141	27.4
Outpatient visit	83	16.6	131	26.6
Total number hospital presentations for baby's health (mean)	236	(0.5)	296	(0.6)
<b>Used non-hospital health service for infant's health (at least once)</b>	<b>327</b>	<b>65.3</b>	<b>332</b>	<b>64.5</b>
Estimate of out-of-pocket expenses in \$A mean/SD	23.53	SD 110.1	28.59	SD 134.37
Median/IQR	0	(0–639)	0	(0–692)
<b>Estimate of costs of feeding equipment (n=488, n=501)</b>				
Breastfeeding equipment in \$A† mean/SD (IQR)	231.84	SD 227.55	249.11	SD 232.54
Median/IQR	182.85	(0–1097)	212.0	(0–1118)
Formula feeding equipment in \$A† mean/SD (IQR)	223.14	SD 345.00	230.47	SD 278.25
Median/IQR	74.20	(0–2130)	106.0	(0–1097)
<b>Sought help or advice for breastfeeding after discharge from hospital</b>				
ABA telephone hotline	96	19.2	88	17.1
Number calls (mean/SD) n=54, n=74	1.98	SD 2.43	1.86	SD 1.54
Local doctor (GP)	61	12.2	70	13.6
Number visits (mean/SD) n=61, n=70	1.75	SD 1.52	1.54	SD 0.95
Lactation consultant from local council	54	10.8	74	14.4
Number visits (mean/SD) n=54, n=74	1.81	SD 1.18	1.5	SD 0.81
Lactation consultant (private)	38	7.6	30	5.8
Number visits (mean/SD) n=38, n=30	1.3	SD 0.78	1.4	SD 0.67
Lactation support unit (community)	23	4.6	19	3.7
Number visits (mean/SD) n=23, n=19	2.04	SD 1.52	1.57	SD 1.26
Paediatrician	22	4.4	7	1.4
Number visits (mean/SD) n=22, n=7	1.13	SD 0.21	2.14	SD 1.86
ABA local counsellor	8	1.6	13	2.5
Number calls (mean/SD) n=8, n=13	1.5	SD 1.06	1.46	SD 0.77
MCHN helpline	29	5.0	40	7.8
<b>Social sources of help for breastfeeding</b>	<b>n</b>	<b>%</b>	<b>n</b>	<b>%</b>
Mother/other family member	111	22.2	136	26.4
Internet websites	110	22.0	131	25.4
Friend/s	107	20.8	124	24.1
Other mothers	75	15.0	73	14.2

Continued

**Table 2** Continued

Social sources of help for breastfeeding	n	%	n	%
Partner	43	8.6	52	10.1
Read books for advice	35	7.0	43	8.3
Pharmacist/pharmacy staff	4	0.8	6	1.2
RUBY volunteer mother	298	59.5	0	0

\*Trial arm denominator used for percentages of presentations.

†2016 costs adjusted for inflation. Total change in cost in 2020 is 6.5%, over 4 years, at an average annual inflation rate of 1.6%.

ABA, Australian Breastfeeding Association; RUBY, Ringing Up about Breastfeeding early.

and calls (mean calls and call time from volunteer call logs).<sup>19</sup> Volunteer coordinator, ABA educator and peer time has been calculated using the national average hourly rate,<sup>33</sup> of \$36.00 per hour. As part of the trial, volunteers were offered reimbursement of \$50 for each mother supported to cover call costs, however, less than 43% of volunteers claimed this, therefore only actual call and text costs have been included in these calculations.

Peer volunteer screening, recruitment and training was estimated to cost \$286.80 per volunteer (which includes the costs of volunteers screened but who did not go on to complete training). The time of peer volunteers is a large part of this cost, and a sensitivity analysis with the peer time valued as \$0 to reflect the donated nature of this resource estimates training costs at \$99.45 per volunteer trained (table 3).

Total costs for the peer support intervention were estimated at \$151 392.30 or \$263.75 per mother supported. When the peer volunteer time was valued as \$0 the total cost was \$51 850 or \$90.33 per mother supported (table 3).

### Healthcare use for infants

In total 353 women, approximately 35% in each group, reported taking their infant to hospital for care on one or more occasion. Inpatient, emergency department and outpatient use for infant's health is outlined in table 2. The three most commonly reported reasons for emergency department presentations were jaundice (intervention n=21/133, 15.8%, control n=14/141, 9.9%), vomiting (intervention n=10/133, 8.5%, control n=12/141, 7.5%) and viral illness (intervention n=8/133, 6.0%, control n=10/141, 7.1%). An inpatient stay was the most commonly reported for treatment of jaundice (intervention n=8/20, 40.0%, control n=5/24, 20.8%), infection/viral illness (intervention n=2/20, 10.0%, control n=8/24, 33.3%) and weight loss (intervention n=1/20, 5.0%, control n=5/24, 20.8%). Outpatient visits for infants were higher in the control group (n=131) compared with the intervention arm (n=83). The most common reasons for taking an infant to an outpatient department was follow-up assessment and treatment for congenital hip dysplasia (intervention n=22/83, 26.5%, control n=49/131, 37.4%).

Approximately 65% of both groups reported accessing non-hospital health services for their infant's health, with the average estimated out-of-pocket expenditure similar across groups (intervention \$24, control \$29) (table 2).

### Healthcare costs

The unit and resource costs of hospital healthcare and community supports for breastfeeding are presented by trial arm in table 4. Details of resource unit costs are included in online supplemental tables. There was a pattern of higher hospital costs for mothers in the Intervention group (total costs mean difference of \$113) and lower hospital, non-hospital and total healthcare costs for infants in the intervention group (total costs mean difference of \$71); however, the variation in all health service use meant that these differences were not statistically significant.

Total costs calculated for each mother–infant dyad were a mean of \$2242.30 for the intervention group and \$1981.09 for the control group, with the mean difference of \$261.21 (95% CI \$14.86 to \$507.70), which equates to the cost of the intervention.

Taking the point estimate of the cost difference of \$261.21 (table 4) the cost-effectiveness expressed as the ICER (ICER=difference in costs/difference in outcomes), calculated using the cost difference of \$261.21 and the increased breastfeeding at 6 months of 6.3% (in this case=261.21/0.063) is \$4146 per additional mother breastfeeding at 6 months. If volunteer time is valued at \$0, the resultant estimate of intervention cost is \$90.33, overall cost difference is \$87.79 and cost-effectiveness is \$1393 per additional mother breastfeeding at 6 months.

### DISCUSSION

We have explored the costs of the effective RUBY RCT proactive breastfeeding peer support intervention to inform future investment and policy decisions. This included costs of training of peer volunteers, coordination and provision of peer support, and any health or cost benefits between the intervention and control groups. We have shown that the proactive telephone-based model of peer support for breastfeeding in the RUBY RCT was a low-cost intervention with costs per mother supported valued at \$263.75 (or \$90.33 excluding the cost of

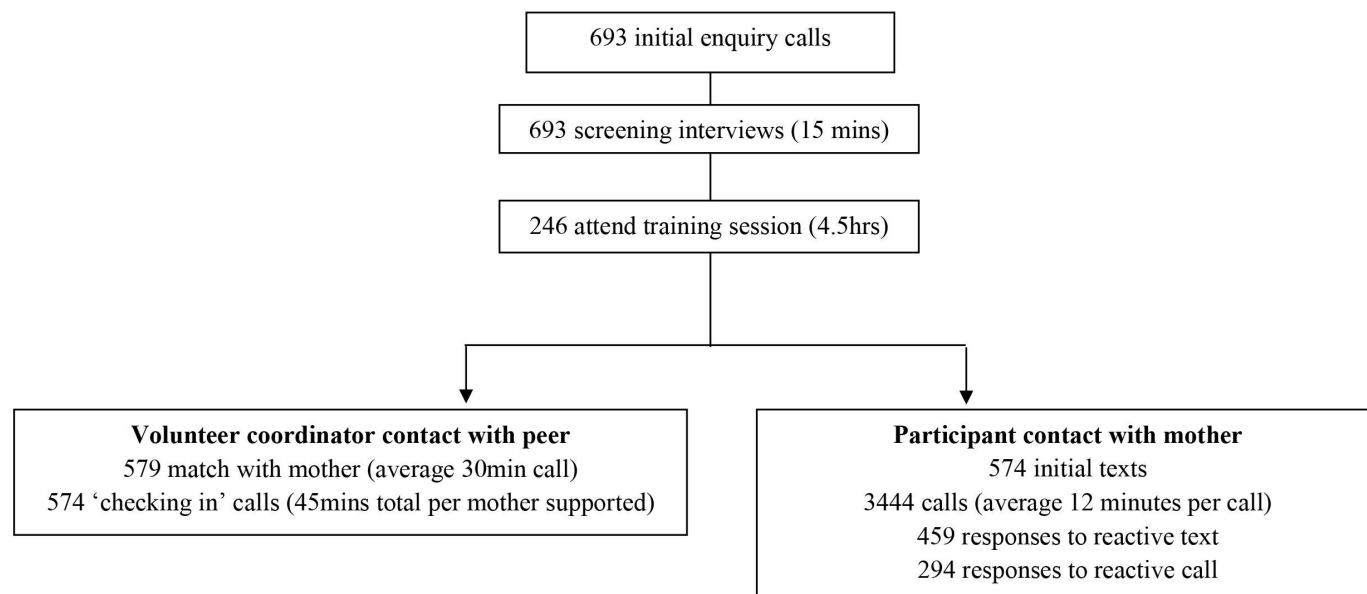
**Table 3** Peer recruitment, training and intervention delivery costs (\$ 2020)

	Resources	Unit cost (value)	Cost
<b>Peer volunteer recruitment and screening</b>			
	<b>Number</b>		
ABA website post for recruitment of peer volunteers	6	\$0	\$0
Call costs for initial enquiries	693	\$0.30 per call	\$207.90
Volunteer coordinator screening interviews (15 min)	693	\$36.00 per hour*	\$6237.00
Peer time screening interview (15 min)	246	\$36.00 per hour	\$2214.00
Potential peer (expression of interest) screening interview time* (15 min)	447	\$36.00 per hour	\$4023.00
		<b>Subtotal</b>	<b>\$12 681.90</b>
<b>Peer volunteer training sessions (24 sessions)</b>			
ABA educator's time (4.5-hour session)	24	\$36.00 per hour	\$3888.00
Peer trainees' time (4.5-hour session)	246	\$36.00 per hour	\$39 852.00
Peer handbook for general information and referral	246	\$6.08	\$1495.68
Parking	246	\$10	\$2460
Training room	24	\$260 per day	\$6240
Catering	246	\$16 per head	\$3936
		<b>Subtotal</b>	<b>\$57 871.68</b>
<b>Delivery of intervention (n=574†)</b>			
<b>Volunteer coordinator</b>			
Volunteer coordinator time to match peer with mother (30 min)	579	\$36.00 per hour	\$10 422.00
Volunteer coordinator call costs for matching peer with mother	579	\$0.30 per call	\$173.70
Volunteer coordinator time to check in/support peers (total 45 min per period of support)	574	\$36.00 per hour	\$15 498.00
		<b>Subtotal</b>	<b>\$26 093.70</b>
<b>Peer volunteer</b>			
Peer time to be matched with mother (30 min)	579	\$36.00 per hour	\$10 422.00
Peer time with volunteer coordinator checking in (total 45 min per period of support)	574	\$36.00 per hour	\$15 498.00
Peer time on calls with mothers (mean six calls at mean 12 min per call)	3444 calls	\$36.00 per hour	\$24 796.80
Peer telephone call costs (mean six calls per mother supported)	3444 calls	\$0.30 per call	\$1033.20
Peer time on initial texts to mothers (1 min per text)	574 texts	\$36.00 per hour	\$344.40
Peer time on responding to reactive texts (1 min per text, mean 0.8 texts per mother)	459.2 texts	\$36.00 per hour	\$275.52
Peer initial text to mother's costs	574 texts	\$0.25 per text	\$143.50
Peer text costs (mean 0.8 reactive texts per mother)	459.2 texts	\$0.25 per text	\$114.80
Peer time for responding to reactive calls (calculated at 12 min per call)	294 calls	\$36.00 per hour	\$2116.80
		<b>Subtotal</b>	<b>\$54 745.02</b>
<b>Total cost component</b>	<b>Total value</b>	<b>Cost of volunteer time</b>	<b>Cost if volunteer time valued as \$0</b>
Total	\$151 392.30	\$99 542.20	\$51 850.10
Screening (n=693), final recruitment and training costs per trained volunteer (n=246)	\$286.80	\$187.35	\$99.45
Delivery of intervention only, per mother (n=574)	\$140.83	\$93.32	\$47.51
Total cost per mother supported (volunteer trained and delivers intervention) (n=574)	\$263.75	\$173.42	\$90.33

\*These 447 women did not go on to complete peer training after initial screening but still need to be accounted for in the costs.

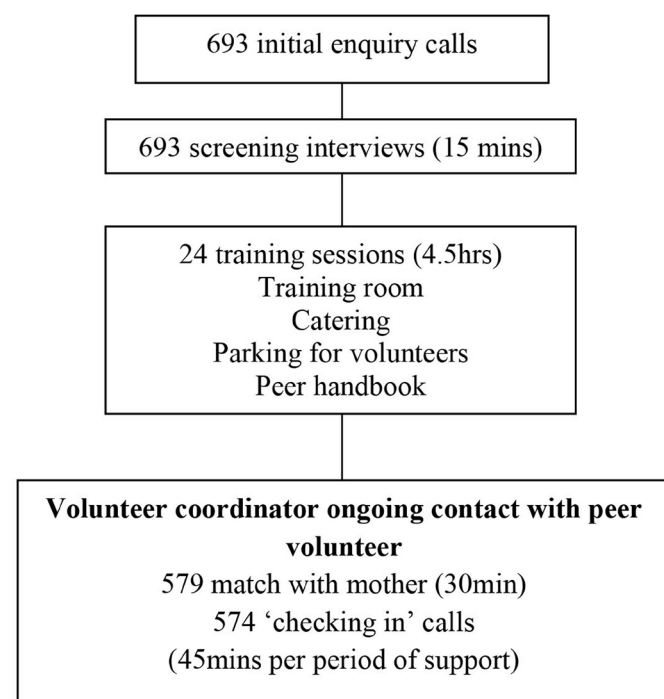
†574 mothers supported with the trial five reallocated to new peer during support period following peer drop-out.

‡Australian Bureau of Statistics average hourly earnings rate August 2020.



**Figure 2** Peer volunteer flow chart.

donated volunteer time). There was no statistically significant difference in costs for infant and mothers between trial arms in healthcare and breastfeeding support costs (excluding the cost of the intervention) in the first 6 months postpartum, which when combined with a significant improvement in outcomes, means that the intervention is potentially cost-effective. Notably the costs of implementing the intervention are fully captured within this study, however, the improved breastfeeding outcomes of the intervention may have implications for resource use extending beyond 6 months, therefore the measure of cost-effectiveness detailed here is a conservative estimate.



**Figure 3** Volunteer coordinator flow chart.

Costs per mother have been calculated as part of a 'within-trial' evaluation and should be considered as artificial, with further cost savings possible in a real-world model. Training costs have been calculated in a trial where the peers supported on average one to two mothers, however, in a real-world model, peers could support on average five women. Training costs could be reduced by delivering the training online and distributing the volunteer manual as an electronic file, eliminating costs for parking, catering and room hire, as well as travel time and costs for volunteers and trainers. We estimate that these adjustments could reduce intervention costs by up to 33% from the costs estimated above. Providing synchronous volunteer training via an online platform would not only be cost-effective but would also improve equity in access, particularly for peers in rural or remote areas, expanding the potential pool of volunteers.

Health service use for infants was somewhat lower in the intervention group, which may be attributable to the higher rates of breastfeeding, as benefits are proffered to infants in the short-term as well as long-term. Health benefits of breastfeeding for mothers are seen in the long-term, and therefore maternal health benefits and lower healthcare costs would not be expected in the first 6 months postpartum. Maternal health service use was somewhat higher in the peer support intervention group, which may be explained through the role of the peer in encouraging and directing the mother to seek further advice and support from health services. Any increase in mothers' health service resource use in the intervention arm in the first 6 months may therefore have been a contributing factor to increased breastfeeding duration, leading to mid to long-term benefits.<sup>10</sup>

The intervention is potentially cost-effective at \$4146 per additional mother breastfeeding but given we did not include a measure with associated existing WTP

**Table 4** Mother and infant health service use and out-of-pocket costs (\$A 2020)

Health service use since discharge after birth			Intervention, n=501		Control, n=515		Mean diff (95% CI)	P value
	Mean	SD	Mean	SD				
Infant								
Infant hospital healthcare	\$409.13	(\$1001.01)	\$475.62	(\$1183.24)	–66.49 (–201.59 to 68.61)	0.33		
Infant non-hospital healthcare	\$35.98	(\$63.52)	\$40.64	(\$105.01)	–4.66 (–15.39 to 6.05)	0.39		
Total infant healthcare costs	\$445.11	(\$1006.43)	\$516.27	(\$1191.89)	–71.16 (–207.15 to 64.83)	0.30		
Mother								
Mother hospital healthcare	\$415.57	(\$1349.21)	\$302.73	(\$869.82)	112.83 (–26.54 to 252.22)	0.11		
Mother non-hospital healthcare	\$84.79	(\$168.64)	\$86.65	(\$195.89)	–1.86 (–24.39 to 20.66)	0.87		
Breastfeeding support costs	\$31.71	(\$70.80)	\$29.86	(\$61.29)	1.85 (–6.30 to 9.99)	0.66		
Total mother healthcare costs	\$532.08	(\$1371.73)	\$419.25	(\$902.56)	112.82 (–29.76 to 255.40)	0.12		
Peer support intervention	\$263.75	–	–	–	–	–		
Out-of-pocket expenses								
Infant non-hospital healthcare	\$22.11	(\$126.17)	\$26.85	(\$103.41)	–4.74 (–18.97 to 9.48)	0.51		
Mother non-hospital healthcare (n=493, n=502)	\$130.33	(\$320.49)	\$117.78	(\$291.28)	12.56 (–25.53 to 50.64)	0.52		
Feeding equipment (breastfeeding and artificial formula) (n=488, n=501)	\$427.21	(\$411.82)	\$450.32	(\$340.14)	–23.11 (–70.19 to 23.97)	0.34		
Total out-of-pocket expenses (n=481, n=491)	\$577.19	(\$553.07)	\$595.58	(\$491.20)	–18.39 (–84.20 to 47.42)	0.58		
Mother–infant dyad costs (sum of categories above)								
Hospital costs	\$824.71	(\$1688.88)	\$778.36	(\$1484.96)	46.35 (–149.29 to 241.98)	0.64		
Non-hospital healthcare and peer support intervention	\$416.23	(\$202.11)	\$157.17	(\$247.06)	259.07 (231.24 to 286.90	<0.001		
Total mother, infant and out-of-pocket costs (n=481, n=491)	\$2242.30	(\$2048.98)	\$1981.09	(\$1862.11)	261.21 (14.86 to 507.57)	0.04		

evidence (eg, quality-adjusted life years) further research is needed to establish the value of one additional mother-breastfeeding at 6 months, to establish if this is worth the additional investment required. We have only presented a point estimate for cost-effectiveness, as the background variation in health and other service use, although not significantly different between groups, generates a wide CI around the point estimate. We have chosen to highlight the 'signal' of the cost-effectiveness estimate of this highly variable data set.

For the mothers continuing to breastfeed at 6 months, the percentage planning to continue breastfeeding to 12 months or longer increased from intention at recruitment (shortly after birth), with this effect greater in the peer support group (15.6% compared with 6.9% in control group). Although the intervention was limited to 6 months post partum, its effect on breastfeeding duration appears to extend beyond that period. Providing this model of support to first time mothers could be a cost-effective strategy when considering resource distribution and flow-on effects, as the likelihood of breastfeeding a later-born child is positively related to the duration of breastfeeding of the first child.<sup>34 35</sup> Thus the intervention not only impacts the first child but is also likely to impact breastfeeding outcomes for subsequent children.

While policymakers must consider the financial value of interventions, there are other values to society that should be considered. In the RCT, peers were motivated to give their time through an understanding of the difficulties experienced by new mothers and their 'strong sense of breastfeeding advocacy'.<sup>36</sup> Their time was given freely, but this donated resource has a value estimated here at \$99 542. Volunteering has been reported as providing personal benefits to the volunteer including reduced feelings of isolation,<sup>37</sup> increased self-esteem and social connectedness<sup>38</sup> with peers in the RUBY RCT describing their role as 'personally therapeutic' even resolving negative views of their own breastfeeding experience.<sup>29</sup> In this trial peers were offered \$50 per mother supported to cover expenses, however, only 43% accepted this offer,<sup>29</sup> showing the willingness of peers to volunteer their time. In models such as this, that are proven to improve breastfeeding outcomes, further research could include assessing in greater detail the extent to which peers should be financially rewarded. The mothers receiving the intervention also valued the support as a positive experience, providing practical advice, social connectedness, and empathy and understanding through sometimes challenging experiences.<sup>39</sup>

The RUBY trial was conducted in collaboration with the ABA, the peak national breastfeeding advocacy group in Australia. There is great potential for consumer-led breastfeeding associations such as the ABA, who currently provide reactive models of support and education, to implement and up-scale proactive telephone-based peer support within their existing infrastructure. In contrast to reactive models, this intervention may have more

equitable reach into the community due to the proactive nature and ease of accessibility.

## Conclusion

Evaluation of the cost-effectiveness of providing proactive telephone-based peer support in the RUBY RCT demonstrates the high value, yet low cost of training peers and provision of support. Breastfeeding requires women to invest their time, knowledge and skills—an investment that 'funds' public health savings and boosts economic activity. Society benefits from the positive effects of breastfeeding and thus promotion and support of breastfeeding is a societal responsibility and the costs to support breastfeeding should be supported by communities and government. This intervention shows great potential and could be upscaled to benefit all mothers and children with our findings demonstrating that a small public health investment would be required to up-scale this proven support-enhancing intervention.

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**Data availability statement** Data are available upon reasonable request. Data collected for the study that contributed to this paper, including de-identified individual data and a data dictionary defining each field in the set, will be made available to others after publication of the paper for use by other researchers for further analysis unspecified in the RUBY trial publication plan, with investigator support, after ethical approval including scientific review of a proposal, and with a signed data access agreement.

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