# NICE Maternal and Child Nutrition Programme

# Modelling the cost effectiveness of interventions to promote breastfeeding

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# 1 Executive summary

The health risk associated with not breastfeeding is beyond doubt. Both the mother's and the baby's health will be enhanced by breastfeeding in all circumstances where the mother chooses to do so. However the scarcity of NHS resources raises a question about how much the NHS should be willing to pay to increase the incidence and duration of breastfeeding. Schemes that have very little effect on breastfeeding rates will not be a cost effective use of NHS resources.

This paper reports on the resource implications of using paid and voluntary peer support to increase breastfeeding initiation and duration. It addresses the question of how great an increase in breastfeeding initiation needs be to make the expenditure cost effective. This has two aspects. Firstly, what is the increase required to produce a net saving in NHS costs? Secondly, what is the health gain required to offset any increase in direct NHS costs?

In answer to the first question, peer support which achieves a relatively high increase in breastfeeding rates actually saves the NHS money in the long run, because levels of hospitalisation of babies drop, breastfed babies grow up into healthier children and adults, fewer women develop breast cancer, and less has to be spent on infant formula. This is achieved at an estimated 20 percentage point increase in breastfeeding initiation. For example, where only 20% of mothers currently initiate breastfeeding, an increase to 40% or more would be cost saving. So too would be the increase from 60% to 80% or more. However, where the initiation rate currently exceeds 80% further increase is unlikely to be cost saving, as more than 100% of women would need to breastfeed.

In answer to the second question, the point at which expenditure on breastfeeding support is unjustified in competition with other demands on NHS resources could be evaluated in terms of the expenditure per QALY gained. NICE currently adopts a threshold between £20,000 and £30,000 for this purpose. It is estimated that this is achieved when there is an increase in initiation rates of about 15 percentage points. That is, an increase from 20% to

35% in initiation rates is estimated to be cost effective, as would be an increase from 60% to 75%.

In determining the cost and consequences of an intervention to promote breastfeeding, the model addresses the impact of breastfeeding initiation and duration on the subsequent risk of breast cancer and a number of childhood infections. There are potentially many other health benefits for baby and some to mother associated with breastfeeding, but evidence in these areas is more complex and affected by potential confounders. It wasn't possible within the resources available to develop a model which unravelled in sufficient depth the complexity of this evidence. To the extent there are other health benefits and "downstream savings" not accounted for in the model, the results will tend to underestimate the cost-effectiveness of any such intervention.

A bigger problem potentially in interpreting the model results relates to the poor quality evidence concerning the efficacy and cost of public health interventions designed to promote breastfeeding. It is the cost-effectiveness of such interventions that has to be considered, and not breastfeeding per se, in making any recommendations. No matter how beneficial breastfeeding is to women and their children, an intervention that is ineffective in promoting it, is unlikely to be cost-effective. The model utilises a "what-if" approach in order to reflect the uncertainty between an intervention and its impact on breastfeeding.

## 2 Introduction

Breastfeeding support, designed to encourage greater initiation and duration, can take many forms:

Peer support – paid and voluntary

Breastfeeding support centres

Antenatal education workshops

Healthcare assistants

Qualified breastfeeding counsellors/supporters

Education/training for healthcare professionals

School education

Whatever form it takes, support utilises scarce resources and therefore has an ***opportunity cost***, in that other alternative uses of those resources have to be foregone. Therefore, it is desirable that such support schemes demonstrate their cost-effectiveness, that is that not only do they 'work' but also provide at least as good value for money as other funded NHS activity.

The primary focus of this analysis is breastfeeding peer support but the simple model developed here could be applied generically to any other intervention designed to support breastfeeding.

Whilst there is much evidence linking breastfeeding incidence and duration with health outcomes, there is less good quality evidence on the efficacy of public health interventions designed to achieve better breastfeeding rates. As was noted in a NICE 2005 systematic review - http://www.nice.org.uk/page.aspx?o=511622

> *"In spite of the importance of this topic area to public health and to the work of the health service, few of the studies reviewed included outcomes related to costs for families, employers or the health services. From the material reviewed here it is not possible to inform the debate on cost effectiveness of interventions to increase the duration of breastfeeding."*

Intervention → Breastfeeding → Health outcomes

**?** √

This model essentially utilises a "what if" approach. It uses the literature to derive assumptions about the relationship between breastfeeding and health outcomes and, in particular, the "downstream costs" of those outcomes. It then explores the cost-effectiveness of interventions by developing "what if scenarios" for a given cost of intervention, population size and estimated impact of the intervention on breastfeeding initiation. Using sensitivity analysis it is possible to investigate how different scenarios affect results and thresholds for cost neutrality. Clearly, if the net impact of the breastfeeding intervention is cost saving or cost neutral then the cost-effectiveness is established on dominance grounds[1].

[1] Dominance exists when an intervention is both cheaper and more effective than the alternative (no support in this case)

However, breastfeeding support may still be cost-effective even if it increases overall costs. This is dependent on the additional benefits being worth the additional costs. NICE generally considers interventions to be cost-effective at an incremental cost-effectiveness ratio of between £20,000 and £30,000 per QALY.

# 3 Baseline Data and assumptions

These are largely based on a paper by Battersby et al. (2004) evaluating the cost-effectiveness of The Breastfeeding is Best Supporters (BIBS) project, a peer support scheme in North Sheffield[2]. The scheme was run by two midwives and had seven paid peer support workers and ten volunteers.

**Table 1: Population**

| Variable | Value | Source | Notes |
|---|---|---|---|
| Population | 210 | Battersby (2004) | No. of births in the Sure Start Foxhill and Parson Cross area between 1 April 2001 and March 2002 |

[2] The use of this data should be seen within the context of the "what-if" analysis rather than as an affirmation of the data quality within that study

| Table 2: Costs and 'downstream' savings | | | |
|---|---|---|---|
| **Variable** | **Value** | **Source** | **Notes** |
| Cost of scheme | £19,081 | Battersby (2004) | Annual aggregate salaries (£16,972) of peer supporters in the BIBS project[3]<br>Updated by RPI to 2006 prices |
| Not breastfeeding cost of gastroenteritis, respiratory infections and otitis media in 1st year of life | £301 | Ball and Wright (1999) | Range £206 - £296 per infant (mid-point £251)<br>Cited by Battersby (2004)<br>Updated by RPI to 2006 prices |
| Daily cost of formula milk | £1.00 | Morrell at al. (2000) | Average weekly quantity of powdered infant formula for a totally bottle fed baby is 900g. Cost of 900g tin is £6.00<br>Updated by RPI to 2006 prices |
| Pre-menopausal breast cancer | £488 | Woolridge (1995) | Cited by Battersby (2004) in deriving a saving of £1,100 for averting three cases of pre-menopausal breast cancer<br>Updated by RPI to 2006 prices |

[3] Non-salary costs of the project are not given and therefore this figure underestimate the total costs of the project, although salaries are likely to be by far the most important cost element

**Table 3: Effectiveness**

| Variable | Value | Source | Notes |
|---|---|---|---|
| Initial breastfeeding rate | 22% | Battersby (2004) | |
| Increasing in breastfeeding rate[4] | 29% | Battersby (2004) | |
| Initial average breastfeeding duration | 67 days | Battersby (2002) | The estimation method is described in appendix 1 |
| Increase in average breastfeeding duration | 37 days | Battersby (2002) | The estimation method is described in appendix 2 |
| Breast cancer risk (never breastfed) | 0.063 | Collaborative Group on Hormonal Factors in Breast Cancer (2002) | |
| Relative risk reduction in breast cancer for every 12 months additional breastfeeding | 4.3% | Collaborative Group on Hormonal Factors in Breast Cancer (2002) | See appendix 3 |
| Hospitalisation due to infection risk (never breastfed) | 0.126 | Talayero et al. (2007) | |
| Relative risk reduction for hospitalisation due to infection for every additional month breastfeeding | 30.1% | Talayero et al. (2007) | See appendix 4 |

[4] The percentage increase relates to the entire population – i.e. it is not the percentage increase, but rather the absolute increase in the percentage of the population breastfeeding

| Table 4: QALYs | | | |
|---|---|---|---|
| **Variable** | **Value** | **Source** | **Notes** |
| NICE willingness to pay for a QALY threshold | £20,000 | NICE | |
| QALY gain from averted infection requiring hospitalisation | 0.00 | n/a | This value is set to zero for baseline analysis. It **does not** mean that there is a zero QALY gain from averting these infections[5] |
| QALY gain from averted pre-menopausal cancer | 0.00 | n/a | As above – this is set to zero for the purpose of baseline analysis |

## 4 Results

With baseline data and assumptions the model suggests that an investment of £20,000 in a peer support scheme of this type produces net societal savings of £5,500, after "downstream savings" from increased breastfeeding initiation and duration are taken into account. In addition the model suggests that the scheme would avert 0.057 cases of pre-menopausal breast cancer in mothers

[5] The baseline analysis seeks to establish the scenarios (or threshold) at which a scheme would be cost neutral. Any such scheme which is cost neutral or cost saving would unambiguously be considered cost-effective, providing additional benefit without any concomitant need to sacrifice benefits elsewhere - i.e. having no opportunity costs. However, the model allows QALY gains to be assigned as part of further threshold sensitivity analysis. The model can then provide information about the scenarios in which a scheme would be cost-effective even if there were associated opportunity costs. A scheme can still be cost-effective if the additional benefits are worth the additional costs, i.e. if the benefits of the scheme are greater than could be achieved than if the resources devoted to it were utilised elsewhere

(2.7 cases per 10,000) and almost 6 cases (285 cases per 10,000) of infections requiring hospitalisation in the first year of life.

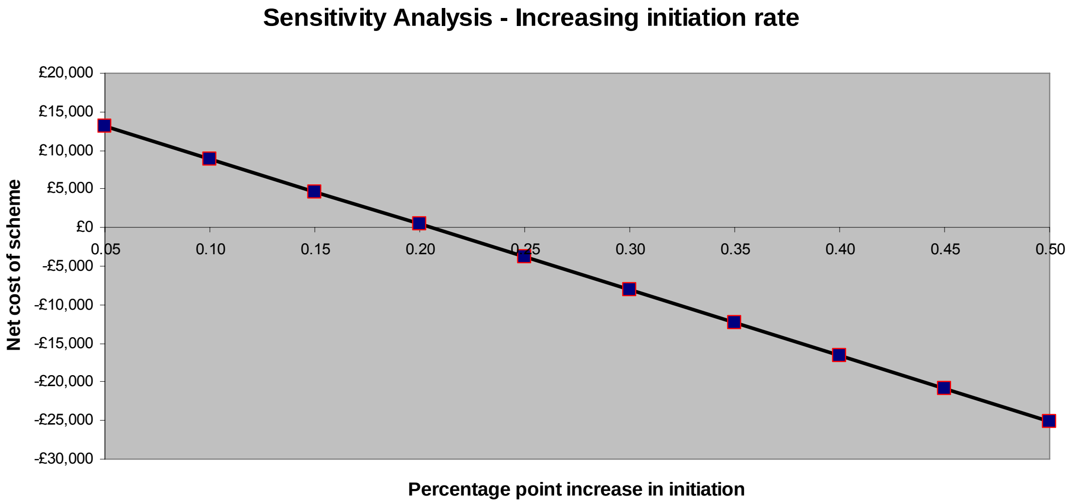
### 4.1 Sensitivity Analysis

Sensitivity analysis is used in economic evaluation to assess how sensitive the results of the model are to the assumptions made about the model parameters, particularly those parameters where considerable uncertainty exists as to their actual value.

One way sensitivity analysis involves altering the value of a single parameter, holding all the others constant, to determine how sensitive the cost effectiveness conclusion is to the assumptions made about that particular parameter. Multi-way sensitivity analysis means that several default parameters are changed simultaneously.

The one-way sensitivity analysis below graphs the effect of changing the assumption about the efficacy of the intervention in terms of breastfeeding initiation while holding all other parameters constant.

*Figure 1*




This graph indicates how the net costs of the scheme fall as a result of increased initiation. A threshold analysis suggests that an increase in initiation of 20.5 percentage points is necessary for cost neutrality, holding all other factors constant. For any initiation greater than this the scheme would be unambiguously cost-effective. Each additional percentage point increase in initiation, leads to a £850 reduction in net costs.

Figure 2 shows how the net costs of the scheme are affected by varying the efficacy of the intervention in terms of increased duration, holding all other factors constant. It suggests that the scheme would still dominate even if there was no impact on average duration of breastfeeding.

*Figure 2*

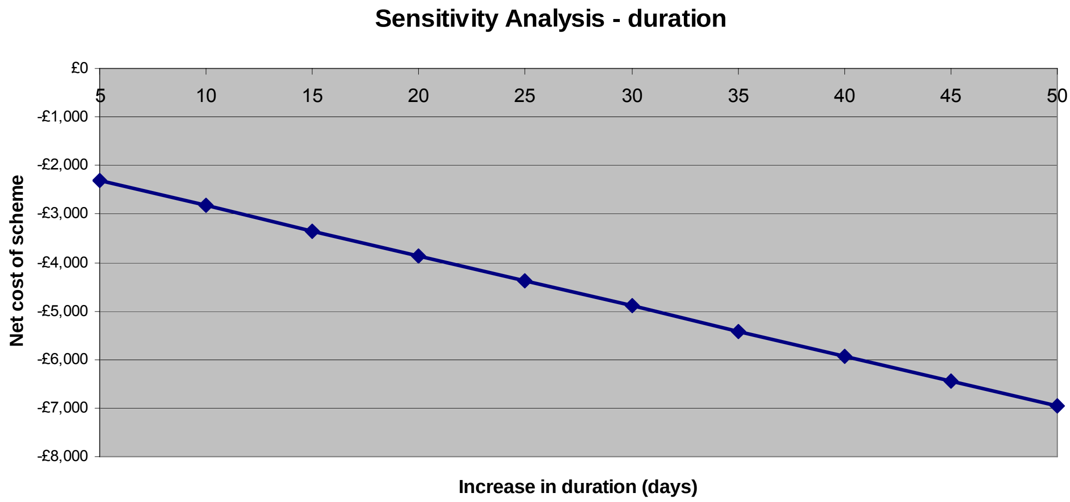



Figure 3 below shows how the incremental costs vary with the costs of the scheme holding efficacy constant. It shows that a scheme costing £24,598 is the threshold value for cost neutrality. For scheme costs below this threshold value the scheme is unambiguously cost-effective.

*Figure 3*

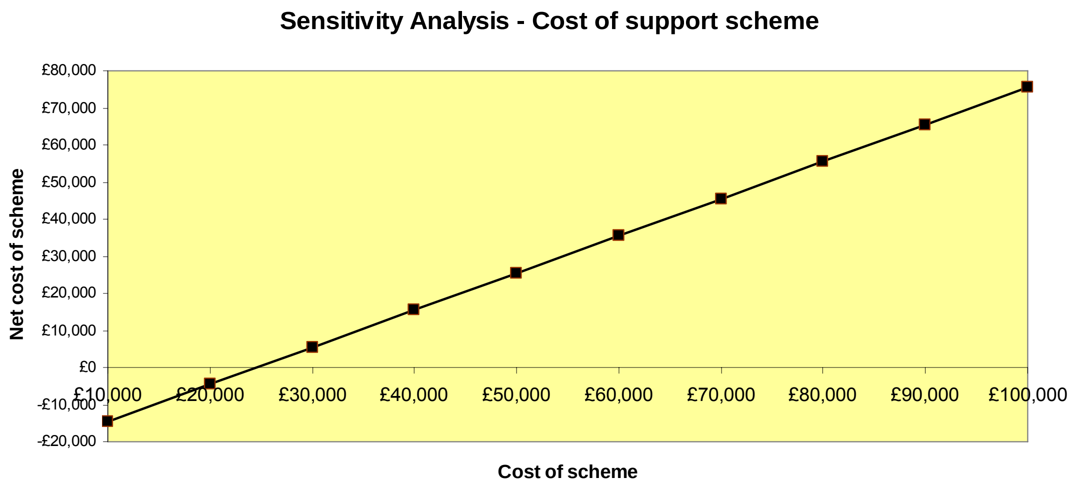
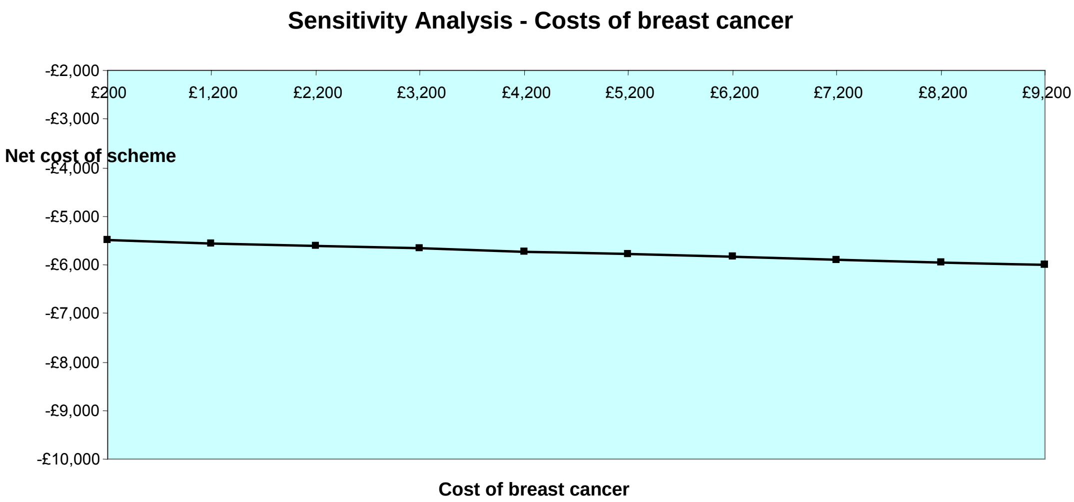


Figure 4 shows that the incremental costs of the scheme are not particularly sensitive to changes in assumptions about the cost saving from averting a pre-menopausal breast cancer.

*Figure 4*




The thresholds for cost neutrality will be higher than the thresholds for cost-effectiveness. The preceding analyses do not take into account society's willingness to pay for improved health. In other words a public health intervention to promote breastfeeding could still be cost-effective even if has a net cost attached to it. This depends on the additional benefit from the intervention being greater than would be the case if the resources used to support it were deployed elsewhere. NICE uses the QALY (Quality Adjusted Life Year)[6] as the measure of health gain and considers interventions which can be delivered at less than £20,000 to £30,000 per QALY as cost-effective.

[6] A QALY combines both length of life and its quality (averaged over the whole of remaining life) as a single index of health gain.

The QALY gain from averting infectious disease in any particular individual will be quite small given its normally acute short term nature. If we were to estimate the duration of infectious illness as one week, with as associated 0.5 quality of life loss, then the QALY gain from an averted case of infectious disease (gastroenteritis, otitis media and lower respiratory tract infection) would be approximately 0.01 [7].

However, the QALY gain from an averted breast cancer, because of its impact on morbidity and mortality, is of a much greater order of magnitude. In the following sensitivity analyses we have assumed a discounted[8] 4.0 QALY gain from an averted breast cancer.[9]

Using these QALY values, would suggest that an increase in initiation rate of just over 14 percentage points is necessary for the intervention to be considered cost-effectiveness using a willingness to pay threshold of £30,000 per QALY and holding all other parameter values in the model constant.

To the extent that there are other benefits of breastfeeding not incorporated within this analysis, this may overstate the increase in breastfeeding initiation which is necessary for an intervention to be considered cost-effective.

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[7] 1/50th a year x 0.5 QALY

[8] QALYs that are gained in the future are not valued as highly as those gained in the present. A discount rate of 3.5% per year is applied to the QALYs gained. This discount rate is the rate recommended by the UK Treasury for public sector discounting.

[9] This is based on the average discounted life expectancy loss of a 30 year old woman from breast cancer, and assuming a 0.8 quality of life weight

Necrotising enterocolitis (NEC) has not being included within the model because it almost exclusively affects preterm babies who are outside the scope of this guideline. Nevertheless, interventions to promote breastfeeding in women who have preterm birth are likely to be cost-effective at much lower rates of increased initiation. Lucas (1992) reported that the incidence of NEC is 1% in exclusively breastfed low birth weight babies compared to 7% in formula fed low birth weight babies. Chapple (2000) notes that 7% of all babies fall into the low birth weight category. Therefore, we can estimate a weighted 0.1 QALY gain for each additional woman breastfeeding as a result of averted NEC, assuming that those who initiate breastfeeding do so exclusively[10]. Increasing the QALY gain associated with a percentage point increase in breastfeeding, reduces the increase in breastfeeding necessary for the intervention to be considered cost-effective.

## 5 Discussion

Due to the rather limited nature of data linking interventions to outcomes the analysis presented has made a number of simplifying assumptions and focused on a “what-if” approach. The sensitivity analysis can demonstrate

[10] The risk of an NEC death in a formula fed baby is 0.0049 (0.07 x 0.07). The risk of an NEC death is an exclusively bottle fed baby is 0.0007 (0.07 x 0.01). Therefore for each woman who exclusively breastfeeds, there is a risk reduction of 0.0042. If we assume an NEC averted death would yield 25 discounted QALYs (based on a typical life expectancy lived in good health), then the expected QALY gain from such a risk reduction is estimated as: 0.0042 x 25 = 0.105

what a breastfeeding support scheme would have to cost for a given population and efficacy in order to be cost neutral or saving.

Similarly, the “what-if” approach can suggest how changes in breastfeeding initiation and duration impact on the net cost  is necessary for a scheme of certain cost and population in order to achieve either cost neutrality or cost savings. We might expect, due to diminishing returns, that it is easier to achieve the increases in initiation and duration indicated in areas of the country where existing rates of breastfeeding are relatively low.

The baseline result shows that a breastfeeding peer support scheme of this type would be unambiguously cost-effective producing health benefits and net savings compared to its alternative, which is usual NHS post natal routine breastfeeding support in this case.

The cost of the scheme, for reasons outlined earlier, is a lower bound estimate of the actual cost. However, even with an intervention cost which doesn’t generate net savings it does not automatically follow that the intervention isn’t cost-effective. Ultimately this rests on a valued judgment as to whether the incremental benefits from the intervention, in this case a reduction in gastroenteritis, respiratory infection and otitis media in infants and a small reduction in breast cancer, are worth the incremental costs.

NICE uses a threshold of £20,000 to £30,000 per QALY, known as the incremental cost-effectiveness ratio, to assess cost-effectiveness. So even if the scheme has a net cost it would still be cost effective if the QALY gain from reduced infections and breast cancer (and other benefits not explicitly considered in the model) is achieved at less than £30,000 per QALY.

We should also note that some of the limitations of this model may also cause cost-effectiveness to be under-estimated. The model focused on outcomes where the evidence of a health benefit from breastfeeding is greatest. However, breastfeeding may have health benefits over and above this. Furthermore, breastfeeding has also been linked with improved educational and social outcomes, e.g. Victoria (2005) and Horwood (1998). If the model underestimates both the benefits and “downstream” cost savings arising from breastfeeding, then the cost-effectiveness of public health interventions to encourage increased initiation and duration will be greater than implied by the model.

However, the real area of uncertainty in this area, and where greater research is needed, is the change in breastfeeding behaviour which can be accurately attributed to specific public health interventions. A recent Department of Health report evaluated a large number of Breastfeeding Practice Projects 1999-2002 and whilst projects that reported on breastfeeding rates tended to show an increase they were not based on experimental study designs and there are many methodological issues in using historical controls. In particular it was suggested there would be a confounding effect of the Baby Friendly Initiative for many of these projects.

## Appendix 1 – Estimation of initial breastfeeding duration

Battersby (2002) reports the following as the baseline for breastfeeding prior to the commencement of the Breastfeeding is Best Supporters (BIBS project):

**Table 1: Data from the Health Visitor Audit 1998**

| | |
|---|---|
| Breastfeeding at birth | 22% |
| Breastfeeding at 6 weeks | 10% |
| Breastfeeding at 4 months | 2.5% |

(Source Fox L. 1998. Foxhill & Parson Cross Sure Start Application Document)

This data was used to estimate the average breastfeeding duration (Table 5). It was assumed that those stopping in a particular time period did so at the mid-point between the beginning and start of period.

**Table 5: Mean duration of breastfeeding pre-BIBS**

| Battersby period | Value (1) | Continue Next period (2) | Estimated period | Mid-point duration | Value (1) – (2) | Weight (% BF) | Weighted days BF |
|---|---|---|---|---|---|---|---|
| Breastfeeding at birth | 22% | 10% | 0-6 weeks | 21 days | 12% | 54.55% | 11.45 |
| Breastfeeding at 6 weeks | 10% | 2.5% | 6 wks - 4 mths | 82 days | 7.5% | 34.09% | 27.95 |
| Breastfeeding at 4 months | 2.5% | n/a | 4 mths – 12 mths | 244 days | 2.5% | 11.36% | 27.73 |

The weight gives the percentage of all woman breastfeeding who breastfed for a particular duration, estimated as the mid-point of a period. By multiplying the mid-point duration by the weight it is possible to derive a weight number of days for each of the 3 durations estimated. Then, by summing these weights, an estimate of the average duration of breastfeeding is derived:

11.45 + 27.95 + 27.73 = <u>**67 days**</u>

## Appendix 2 – Estimation of breastfeeding duration after intervention

Battersby (2002) reports the following data for the BIBS project:

**Table 2: Sure Start Data 1.4.01 – 31.3.02**

| **Total Births** | **210** | |
|---|---|---|
| No data | 15 | 7.15% |
| Initiated breastfeeding | 103 | 49.05% |
| Initiated formula feeding | 92 | 43.80% |
| **Total** | **210** | **100%** |
| Still breastfeeding 4 weeks | 66 | 31.50% |
| Still breastfeeding 3 mths | 39 | 18.60% |
| Still breastfeeding 6 mths | 23 | 11.00% |

(Source: BIBS database & Sure Start database)

This data was used to estimate the increase in initiation due to the project[11];

49.05% - 22% = 27%

The data was also used to estimate the change in the mean duration of breastfeeding arising from the intervention (Table 6).

[11] It was conservatively assumed that the women did not breastfeed where there was no data

**Table 6: Mean duration of breastfeeding BIBS**

| Battersby period | Value (1) | Continue Next period (2) | Estimated period | Mid-point duration | Value (1) – (2) | Weight (% BF) | Weighted days BF |
|---|---|---|---|---|---|---|---|
| Breastfeeding at birth | 49% | 31.5% | 0-4 weeks | 14 days | 17.5% | 35.78% | 5.01 |
| Breastfeeding at 4 weeks | 31.5% | 18.6% | 4 wks - 3 mths | 60 days | 12.9% | 26.30% | 15.78 |
| Breastfeeding at 3 months | 18.6% | 11.0% | 3 mths – 6mths | 137 | 7.6% | 15.49% | 21.23 |
| Breastfeeding at 6 months | 11.0% | n/a | 6 mths – 12 mths | 274 days | 11.0% | 22.43% | 61.45 |

By summing up the weighted days, the mean duration of breastfeeding as a result of BIBS can be estimated.

$$5.01 + 15.78 + 21.23 + 61.45 = 103 \text{ days}$$

This is an increase in duration of **36 days** compared to the estimation for the pre-intervention mean duration.

## Appendix 3 – The "dose response" relationship between breastfeeding and the risk of hospitalisation due to infection in the first year of life

A study by Talayero et al. (2007) reported that "every additional month of full breastfeeding would prevent 30.1% of hospitalisations as a result of infection in children who had not received full breastfeeding that month". Therefore, the estimated relative risk reduction of a month of full breastfeeding is 0.699. The relative risk reduction of each additional day of breastfeeding was estimated as follows:

Relative Risk 1 months breastfeeding = 0.669

Relative risk of 1 day breastfeeding = $0.669^{(1/(365/12))}$ = 0.9883

(This is likely to be an overestimate if the risk of hospitalisation is a declining function of age – i.e. the 30.1% probably refers to a declining absolute number. That would also seem to tie in with the later observation that breast feeding for 4 months or more would have prevented 56.4% of admissions)

## Appendix 4 – The dose response relationship between breastfeeding and the risk of breast cancer

A study by the Collaborative Group on Hormonal Factors in breast cancer estimated that the “relative risk of breast cancer is reduced by 4.3% (95% CI 2.9 – 5.8) for each year that a woman breastfeeds”. In other words the relative risk of 12 months breastfeeding for breast cancer compared to never breastfeeding is 0.957.

The study finds a dose-response relationship with each increase in lifetime breastfeeding duration giving increased protection. It also finds a protective effect for lifetime breastfeeding duration of <6 months compared to never breastfed. In our model it is necessary to model the reduction in relative risk for each additional day of breastfeeding. This was done as follows:

Relative Risk 12 months breastfeeding = 0.957

Relative risk of 1 day breastfeeding = $0.957^{(1/365)}$ = 0.99988

This study also reports a cumulative incidence of breast cancer of 6.3 cases per 100 women by age 70 years in the developed countries and the model uses this as a woman’s baseline risk in the absence of breastfeeding[12].

[12] This is most likely an underestimate at the cumulative incidence is based on a population of women, in which a proportion would breastfeed