NICE RAPID REVIEW

Rapid Economic Review of Public Health Interventions Designed to Improve the Nutrition of Children aged 0-5 years

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Executive Summary

This rapid systematic review, commissioned by the National Institute of Clinical Excellence (NICE), investigates the cost-effectiveness of public health interventions designed to improve the nutrition of children aged 0-5 years.

More details to the background of this review can be found in the NICE scope (http://www.nice.org.uk/page.aspx?o=529431)

It is recognized that that nutritional status is a foundation of health for the infant's later life. However, there are concerns that nutritional status is sub-optimal, especially in lower socioeconomic groups.

The literature review indicated a dearth of good quality economic studies in this area. Furthermore, much of what is published relates to a non-UK context and the conclusions and costs from such studies may not be readily generalised to a different setting.

There is published literature which indicates that increased breastfeeding rates could produce cost savings by reducing various childhood diseases. However, there is little good quality evidence on the cost-effectiveness on interventions which aim to increase breastfeeding.

1. Methodology

1.1 Literature Search

The searches were carried out across the Medline, Embase, Cinahl, CCTR, CDSR, DARE and NHSEED bibliographic databases. The search strategy combined relevant terms relating to children up to five years with nutrition terms as outlined in the scope. The search incorporated a sensitive health economics filter and focused on interventions rather than being restricted to outcomes. The search was restricted to English language and the years 1990-present.

1.2 Exclusion criteria

In selecting studies for the review the main exclusion criteria were as follows:

- Primary studies set in developing or low income countries
- Studies published before 1990
- Papers in a language other than English
- Papers not held at the British Library
- Abstracts

1.3 Selection of studies

The initial search identified articles, reflecting the broad search strategy adopted. A first screen was used to exclude papers which were clearly not relevant to the research question being addressed and papers were retrieved for further examination.

These articles were appraised using a checklist devised by Drummond et al. (1997) during a second screen. However, due to the limited quality and quantity of published economic studies addressing the research question, articles were included in the review providing they contained, as a minimum,

some potentially relevant cost or resource use data. A total of 9 articles were included in the review.

Data from included studies was then extracted in a standardized format through a Microsoft Access® data extraction form approved by NICE.

2. Results

2.1 Oral Health

Two studies were identified for inclusion in the review under this heading.

Ramos-Gomez FJ, Shepard DS. Cost-effectiveness model for prevention of early childhood caries. Canadian Dental Association Journal 1999; 27(7):539-544

Lee JY, Rozier G, Norton EC et al. The effects of the Women, Infants, and Children's Supplemental Food Program on dentally related Medicaid expenditures. Journal of Public Health Dentistry 2004; 64(2):76-81

Ramos-Gomez *et al* (1999) built a cost effectiveness model in order to evaluate three successively more complete levels of preventive intervention ("minimal", "intermediate", and "comprehensive") in treating dental caries in disadvantaged children up to 6 years old. The proposed minimal preventive intervention has two components: risk assessment and preventive treatment. The intermediate intervention adds another component, counselling, which would include advice on nutrition and diet as well as other aspects of oral health education. Finally, the comprehensive intervention adds a final component, outreach and incentives. Using existing data on the costs of early childhood caries (ECC), the authors estimated the probable cost-effectiveness of each of the three preventive interventions levels by comparing treatment costs with prevention costs as applied to a low income California child for five years. The 40% effectiveness assumption for the minimal intervention is based on the lower bound of effectiveness reported by Twetman et al. (1996). The 70% and 80% effectiveness assumptions for the intermediate and comprehensive interventions respectively are based on clinical observations at the UCSF Pediatric Dental Clinic. Given these assumptions, the number of carious surface averted in each child in the California cohort would range from 4.32 to 8.60 over 5 years. The cost per carious surface averted is $72.69 for the minimal intervention, $65.74 per carious surface averted is for

intermediate intervention and $66.28 per carious surface averted is for the comprehensive one. The authors state that the intermediate intervention is the most cost-effective, as it has the lowest cost per carious surface averted, although they did not use an incremental approach in their analysis. Dividing the cost per carious surface averted ($65.74) by the cost of treatment per surface ($112) yields a cost saving of 59 percent. The authors thus calculate that there would be cost savings if 59% or more carious surfaces were treated.

Lee J.Y *et al* (2004) estimated the effects of the Special Supplemental Nutrition Program for Women, infants, and Children (WIC) on dentally related Medicaid expenditures for young children. It was used a five-year cohort study design to compare dentally related Medicaid expenditures for children enrolled in WIC versus those not enrolled for each year of life up to 5 years . Oral health screenings are provided at WIC clinics and children must be screened every six months to retain their WIC eligibility. The screen assesses a number of oral health risk factors – nursing or bottle caries, inappropriate use of the bottle, cavities and abscessed teeth[1]. WIC nurses and nutritionists may make dental referrals if indicated. The analysis strategy included a logit and OLS two-part model with Consumer Price Index (CPI) dollar adjustments. Children who participated in WIC at ages 1 and 2 years had significantly less dentally related expenditures than those who did not participate. WIC participation at age 3 years did not have a significant effect. The analysis also showed that fewer WIC children had dental care under general anesthesia than non-WIC children.

2.2 Breastfeeding

Three studies were identified for inclusion in the review under this heading. In addition NICE suggested a further two publications.

[1] Despite this study reporting on a ‘nutrition program’ it is largely evaluating the use of oral health screening to achieve better access to dental care

Riordan JM. The cost of not breastfeeding: a commentary. Journal of Human Lactation 1997;13(2): 93-97

Battersby S, Aziz M, Bennett K, Sabin K. The cost-effectiveness of breastfeeding support. British Journal of Midwifery 2004; 12(4):201-205

Smith JP, Thompson JF, Ellwood DA. Hospital system costs of artificial infant feeding: estimates for the Australian Capital Territory. Australian and New Zealand Jounal of Public Health 2002; 26:543-51

Breastfeeding: Good Practice Guidance to the NHS. Department of Health 1995.

Weimer J. The Economic Benefits of Breastfeeding: A Review and Analysis. ERS Food Assistance and Nutrition Research Report No. 13. March 2001

Riordan M.J.(1997) estimated the cost of not breastfeeding by looking at the additional annual health care costs incurred for treatment of four medical conditions in infant who were not breastfed. Infant diarrhoea in non breastfed infants cost $291.3 million; respiratory syncytial virus, $225 million; insulin-dependent diabetes mellitus, from $9.6 to$124.8 million;
and otitis media, $660 million. These, four medical diagnoses alone create just over $1 billion of extra health care costs per year. Also, it was calculated that an additional $2,665,715 in federal funds is needed yearly in order for WIC to provide infant formula to non-breastfeeding mothers. For the average the cost of purchasing formula is twice the cost of supplemental food for the breastfeeding mother. Given the important resources implications of not breastfeeding, breastfeeding education and support should be an integral part of health care, especially under managed care which rewards the prevention of health problems and reduced use of health services.

Batterby S. *et al* (2004) provided information as regards the cost-effectiveness of breastfeeding peer support. The *Breastfeeding is Best Supporters* (BIBS) project is a breastfeeding peer support initiative that was funded by a fund

administered by the Department of the Environment, Transport and the Regions, to take forward the work of two (amalgamated) breastfeeding support projects in North Sheffield. The evaluation of BIBS project identified that there had been an increase in the breastfeeding initiation rate in the *Sure Start* Foxhill and Parson Cross Area. It has been calculated that in the first year of baby's life, as result of breastfeeding, the reduced incidence of gastroenteritis and admission to hospital alone produces health gains to the NHS of £4000 per average health district for every 1% increase in breastfeeding. Adjusting these figures in the Sheffield area, the expected savings to the NHS would be £3,255. Also, the potential reductions in pre-menopausal cancers of the breast, ovaries and endometrium in mothers who have breastfed would cause further cost-savings in the future.

Smith P.J., (2002) estimated the hospital system costs of artificial infant feeding. It was identified in the analysis the relative risks of infant and childhood morbidity associated with exposure to artificial feeding in the early months of life vs breastfeeding from cohort studies cited by the American Academy of Pediatrics in 1997. Data for ACT breastfeeding prevalence is assessed from a 1997 perspective population –based cohort study of 1,295 women. Although the initiation rates were high (92%), less than one in 10 ACT are exclusively breastfed for the recommended six months, mainly due to supplementations or weaning on formula within the first three months and the early introduction of solids by breastfeeding mothers. This study estimated that the attributable hospitalisation costs of early weaning in the ACT are about $1-2 million a year taking into account hospital cost of treatment of gastrointestinal illness, respiratory illness and otitis media, eczema, and necrotising enterocolitis. It is clear in the study that early weaning from breast milk is associated with significant costs for treatment for the five illnesses .These costs are minimum estimates of the cost of early weaning as they exclude numerous other chronic or common illnesses and out-of-hospital health care costs. Higher rates of exclusive breastfeeding would reduce these costs. Interventions to protect and support breastfeeding are likely to be cost-effective for the public health system.

The Department of Health (1995) reported that the NHS spent £35 million per year on the treatment of gastroenteritis in bottle fed infants. They estimated that for every 1% increase in breastfeeding at 13 weeks a £500,000 saving in treatment costs for gastroenteritis would be realised.

Weimer (2001) estimated that $3.6 billion would be saved if breastfeeding was increased from current levels (64% in hospital, 29% at six months) to the level recommended by the Surgeon General (75% and 50% respectively). The savings are based on the treatment of just three childhood diseases – otitis media, gastroenteritis and necrotising enterocolitis – and may therefore it may represent a lower bound estimate.

2.3 Food Safety

Two studies were identified for inclusion in the review under this heading.

Varley RCG, Tarvid J, Chao DNW. A reassessment of the cost-effectiveness of water and sanitation interventions in programmes for controlling childhood diarrhoea. Bulletin of the World Health Organisation 1998; 76(6):617-631

Varley R.C.G *et al* (1998) assessed the cost-effectiveness of water and sanitation interventions in programmes for controlling childhood diarrhoea. Cost-effectiveness analysis indicates that some water supply and sanitation (WSS) interventions are highly cost-effective for the control of diarrhoea among under-5-year-olds compared with oral rehydration therapy. These are relatively inexpensive “software –related” interventions such as hygiene education, social marketing of good hygiene practices, regulation of drinking-water, and monitoring of water quality. To be more precise, this study presents cost-effectiveness of the four scenarios. In the first Scenario software added to hardware (water supply and sanitation infrastructure). Under the conservative assumptions adopted for this analysis, the effect of adding hygiene software to existing hardware is to reduce cases by 20%. Using these figures, the cost per case averted is US$2.93, the cost per death

averted is US$689, and the cost per DALY saved is US$20. The second scenario is to add both hardware and software. Both hardware and software are assumed to be paid out of the health sector budget. This type of intervention is not cost-effective compared with theUS$150 per DALY criterion recommended in the *World development report.* The cost per DALY saved is US$413, while cost per case averted is US$60.58. The cost per death averted of US$14523 is comparable with to Wash &Warren's estimate of US$3400-US$4000 per infant death averted in 1975 prices. Even with optimistic assumptions, this intervention is not a cost-effective investment for the health sector aiming to improve infant and child health. The third scenario is to add hardware alone and this is the least cost-effective of all the scenarios. The cost –effectiveness is US$ 168.81 per case averted, US$39720 per death averted, and US$ 1152 per DALY saved. The last scenario is to provide is to provide software alone. The costs per DALY and per life saved are US$ 44 and US$1520, respectively. This qualifies software alone as a cost-effective intervention compared with the *World development report* criterion. The cost-effectiveness of oral rehydration therapy (ORT) is US$ 24 per DALY saved and US$800 per death averted. The presence of WSS does not change the cost-effectiveness of ORT. It does, however, reduce the total number of cases that have to be treated and therefore the total budget required to cover the whole population.

Duff B. S *et al* (2003) evaluated the cost-effectiveness of a targeted disinfection program in household kitchens to prevent food borne illnesses in the United States, Canada, and the United Kingdom. In the primary analysis, the model estimated that approximately 80,000 infections could be prevented annually in U.S households, resulting in $138 million in direct medical costs savings (e.g physicians office visits and hospitalizations avoided), 15,845 quality-adjusted-life-years (QALYs) gained , $788 million in program costs, and favourable cost-effectiveness ratio of $41,021/QALY gained. Results were similar for households in Canada and the UK (Can$ 21,950/QALY gained and £86,341/QALY gained, respectively.)When the implementation of the programme was evaluated only in US households with high-risk members (those less than 5 years of age, greater than 65 years of age, or immuno-

compromised) , the cost-effectiveness ratio was more favourable ($10,163/QALYgained). Results were similar for households in Canada and the United Kingdom (Can$ 1,915/QALY gained and £ 28,158/QALY gained, respectively).

3. Conclusions from this Review

There is very limited evidence on the cost-effectiveness of public health interventions designed to improve the nutrition of children aged 0-5 years. Most of the studies included in this review would not be considered to be full economic evaluations. Furthermore, many of the papers here report what the cost savings would be in a given “what if” scenario rather than the actual cost consequences of a particular intervention.

(i) Oral health

This review highlights that there is very little evidence on the cost-effectiveness of nutritional interventions designed to improve the oral health of children aged 0-5 years. One of the studies suggests that, under certain assumptions about efficacy, a counselling intervention which includes nutritional advice may be cost-effective although it does not place a value on a carious service averted.

(ii) *Breastfeeding*

There is evidence to suggest that increased breastfeeding is likely to produce cost savings. However, there is little evidence on the cost-effectiveness of interventions intended to increase breastfeeding rates. One UK study reported on a breast feeding peer support intervention which achieved an increase in the initiation rate for breast feeding in a socially deprived area. By extrapolating from other studies on the cost savings from increased breast feeding, it was reported that the intervention was approximately cost neutral.

(iii) Food safety

There is extremely limited evidence on the cost-effectiveness of nutritional interventions to improve food safety.

4. Evidence Tables: Included Studies

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
Author(s): Battersby S;Aziz M;Bennett K;Sabin K; 2004 {29323}	Study Type: Cost-effective analysis Model or Clinical Trial: Modelling Perspective of Analysis: Health care system	Source of Utility Values: Primary Clinical Outcomes:		Currency: £ Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Breastfeeding cost-effectiveness The evaluation of the BIBS project identified that there have beeb an increase in the initiation rate of breasfeeding. It has been calculated that in the first year of the baby's life, as result of breastfeeding, the reduced incidence of gastroenteritis and admission to hospital alone produces health gains to NHS of £4000 per average health district per 1% icrease in breastfeeding. For Sheffield is about a £ 57.1 saving per baby per year. There were 57 extra women who breastfed in the SURE Start area alone in one year, with an expected saving to the NHS of £3,254.7 However, ehen 3 illnesses are considered-gastoenteritis, resporatoryinfections and otitis media -Ball and Wright(1999) estimated that the cost of not being breastfed was between £206-296 per infant in the first year of life. When considering the Sure Start data , 57 extra babies breastfed in the area would have an expected

					average yearly saving of between £11742-£16872. This sum is roughly equal to the costs of the intervention
Author(s): Duff SB;Scott EA;Mafilios MS;Todd EC;Krilov LR;Geddes AM;Ackerman SJ; 2003 Nov {29341}	Study Type: Cost-utility analysis Model or Clinical Trial: Modelling Perspective of Analysis: Societal	Source of Utility Values: In order to obtain utilities for each of the 13 possible health states in our analysis (specifically, three acute infections at three levels of sevrity and four possible chronic sequelae), we provided a narrartive describing the usual symptoms associated with each health state to our panel of five clinical and food safety experts. The panelists assigned distress and disability ratings to each health state, as well as to the average duration of each health state, and utilities were calculated by published methodologies. Primary Clinical Outcomes:		Currency: Can $, USD, £ Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Primary analysis: all households The resulting cost-effectiveness ratios for USA, Canada and UK are the following: US$ 41,021/QALY gained, Can $21,950/QALY,and £86,341/QALY gained. Secondary analysis: households with High-risk members The incremental cost effectiveness ratio sfor three countries were US $ 10,163/QALY gained, CAN $ 1,915/QALY gained, and £28,158/QALY gained. Comments and limitations: Comments The difference between relative economic outcomes in

					the UK and US or Canada primarily is due to large intercountry variation in published foodborne illness incidence rates and underreporting factors. Limitations With a ny prevention program, education is key to achieving the intended results. When quantifying the incremental cost of household targeted disinfection program over current cleaning practices, we did not explicitly include additional costs for advertising and educational programs. Another limitation of the study is that, in order to simplify the analysis, we incl
Author(s): Escobar GJ;Braveman PA;Ackerson L;Odouli R;Coleman-Phox K;Capra AM;Wong C;Lieu TA; 2001 Sep {29343}	Study Type: Cost analysis Model or Clinical Trial: Clinical trial Perspective of Analysis: Health care provider	Source of Utility Values: Primary Clinical Outcomes: rehospitalization emergency department use,occurrence of maternal depressive symptoms, disconituation of breastfeeding	The target population consisted of low-risk mothers and newborns who delivered at the Kaiser Hospital in Santa Clara,	Currency: USD Year of Costing: 1998 Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: The estimated cost of postpartum home visit to the mother and the newborn was $265. In contrast, the cost of the hospital-based group visit was $22 per mother-infant apir; the cost of an individual 15-minute visit with a registered nurse was $52; the cost of a 15-minute individual pediatrician visit was $92; and the cost of a 10-minute visit with an obstetrician was $192. Comments and limitations: Comments It is both disappointing and discouraging that

					breastfeeding discontinuation was high in both arms of the trial. This suggests that to improve breastfeeding rates, future studies should not focus simply on the type of any single postpartum visit; rather, it may be more useful to study what knowledge mothers actually absorb in any given educational context, how this knowledge is applied,and how much one can expect from a single encounter.
Author(s): Lee JY;Rozier RG;Norton EC;Kotch JB;Vann WF; 2004 {29363}	Study Type: Cost analysis Model or Clinical Trial: Modelling Perspective of Analysis: Health care provider	Source of Utility Values: Primary Clinical Outcomes: expenditures related to the provision of dental services	children up to five years	Currency: USD Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: The total Medicaid dollar reimburesement for dentally related services for the cohort includeed in the study was$1,603,399, of which $433,960 was for those had some care in the hospital and $1,169,439 was for those who had care in a primary care setting. Children who participate in WIC as an infant or at age 1 year had significantly fewer dentally related expenditures than those who did not participate. Children who participate in WIC in younger ages had overall decresed dentally related expenditures than those who did not participate in WIC during those earlier years.

					Comments and limitations: Limitations First, we did not limit our cohort study to those who were continuously enrolled in Medicaid for the observation period Another limitation is the potential of the selection bias. The design might have stronger if a random assignment of WIC could have been accomplished; however, the pracrical problem of implementing this strategy in a community-based setting would be daunting and such
Author(s): Quinonez RB;Stearns SC;Talekar BS;Rozier RG;Downs SM; 2006 Feb {29376}	Study Type: Cost-effective analysis Model or Clinical Trial: Modelling Perspective of Analysis: Other	Source of Utility Values: Primary Clinical Outcomes: month without cavities	children aged 9 to 42 months	Currency: USD Year of Costing: 2003 Discount rate(s) used for costs: Discount rate(s) used for benefits: 3%	Results: Base case Cost - effectiveness analysis for FVN and FVA ICER (cost per Cavity-free months) is $7.18.Our analysis also showed that using FVA would cost medicaid $203.00(beyond treatment and intervention costs) for 1 treatment averted (hospital and non hospital) over 42-month simulation period sensitivity analysis The base case values are multiplied by multiplier values. When FV effectiveness was 1.25 times greater than our base case of 35.4% average caries reduction for 6 months. A sensitivity analysis was

					conducted to reflect the biannual application regimen reflected in the dental literature starting at the 9-month WCOS.Using this protocol the total number of FV applications increased to 4 to 6 times. Results indicated effectiveness only greater than the base case schedule at 1.87 cavity-free months, but with an ICER of $15.59per cavity-free month gained, an additional $8.41 when compared with the base case results. The results were sensitive to the overall probability of receiving treatm
Author(s): Riordan JM; 1997 {29380}	Study Type: Cost analysis Model or Clinical Trial: Modelling Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes:	All infants	Currency: USD Year of Costing: 1991 Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Additional annual cost national health care cost, incurred for treatment of 4 medical condition in infant who were not breastfed were estimated. Infant diarrhea in nonbrestfed infants costs $291.3 million; respiratory syncytial virus, $225 million; insulin-dependent diabtes mellitus, from $9.6 to $124.8 million; otitis media;$660 million. These four medical diagnoses alone create just over $1 billion extra health cre cost each year.It was calculated that an additional $2,662,715 in federal funds is needed yearly in order for WIC to provide infant formula to non brestfeeding mothers. For the average family, the cost of purchasing

					formula is twice the cost of supplemental food for the breastfeeding mother. Comments and limitations: Breasfeeding education and suppor should be an integral part of health care , especially under managed care which rewards the prevention of health problems nad reduced use of health services.
Author(s): Varley RCG;Tarvid J;Chao DNW; 1998 {29391}	Study Type: Cost-effective analysis Model or Clinical Trial: Modelling Perspective of Analysis: Third party payer	Source of Utility Values: Primary Clinical Outcomes: cases averted, deaths averted, DALYs	children under 5 years old	Currency: USD Year of Costing: Discount rate(s) used for costs: 3% Discount rate(s) used for benefits:	Results: Results of CE model to the four WSS scenarios and ORT are the following: Scenario I Software added to hardware : Under the conservative assumptions adopted in this analyisis , the effect of adding hygiene software to existing hardware (i.e of establyshing hygiene education programmes in areas where WSS infrastructure already exists or is being built) is to reduce cases by 20%, i.e the difference between 30% effectiveness for hardware and software combined and 10% for hardware alone. Using these figures, the cost per case averted is $2.93 the cost per death averted is $689, and the cost per daly saved is $20. The gross cost of the intervention ($600000)

					is partly offset by savings in ORT of $102000, resulting in a net cost to the health sector budger of $498000. Scenario II.hardwarw and software combined: It is assumed that both hardware and software cost are paid out of the health sector budget. The hardware for this example is an intermediate tecnology, which could cost $ 72 per household or$14.4