NICE RAPID REVIEW

Rapid Economic Review of Public Health Interventions Designed to Improve the Nutrition of Pre-conceptual, Pregnant and Post Part Women

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Introduction to Health Economics

Why should we consider cost-effectiveness in public health?

In a publicly funded health care system with finite resources the efficacy alone of an intervention may not justify its implementation. If it is not possible to provide every possible service that may yield some health benefit with this finite resource then choices need to be made on what should be provided and what should not be. Implicit in the choices made is a sacrifice in terms of what could have been provided instead. Economists refer to this sacrifice as the opportunity cost.

The opportunity costs of a particular use of resources means that the cost-effectiveness or 'value for money' of interventions should also be considered in order to improve population health. Cost-effectiveness is about maximising benefit from scarce resources and not, as perhaps commonly thought, minimising costs.

The process of economic evaluation involves a comparison of two or more alternatives in terms of both their costs AND effects. If the one of the options is both more effective and cheaper then it is unambiguously the preferred option. However, it will often be the case that one of the options is both more costly and more effective and decision makers have to decide whether the additional benefit of the more expensive option represents good value for money.

Clearly, if the cost differences are small and the benefits large then such an option will be considered cost-effective. Conversely, if the additional benefits are minor but the cost implications are significant then this will probably be deemed poor value for money. However, between these extremes how is a decision to be reached?

The preferred method of NICE is to value benefits in terms of the QALY (Quality Adjusted Life Year). The QALY can be treated as a generic measure

of health and it captures the two main objectives of health care; extending life years and improving the health related quality (reducing morbidity). NICE uses £20,000 to £30,000 per QALY as a threshold to assess whether an intervention is cost-effective or “good value for money”.

Sometimes it is not possible to quantify the benefits of an intervention or programme in terms of QALYs. In such circumstances it is still helpful to calculate a cost per effect (e.g. cost per additional breastfeeding mother) but decision makers are probably required to make more valued judgements in using this information.

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 pre-conceptual, pregnant and post partum women.

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 before and during pregnancy, in the post partum period and breastfeeding, and in the early years of life is important to the short and long term health of the mother, the development of the foetus and as a foundation of health for the infants later life. However, there are concerns that nutritional status is sub-optimal, especially in lower socioeconomic groups.

The literature review suggested that there is a paucity of good quality economic studies on public health interventions of this type. Furthermore, much of what is published relates to a non-UK context and the conclusions of such studies may not be readily generalised to a different setting. The review also highlighted the methodological problem of assessing the cost-effectiveness of public health interventions which include some nutritional aspect as just one part of a bigger overall package. With such interventions it can be difficult to attribute the observed effects to each constituent part.

Notwithstanding these caveats, there is some evidence from outside the UK to support the cost-effectiveness of folic acid supplementation. However, there is little published data on the cost-effectiveness of different interventions to increase uptake of folic acid.

One study suggests that home-based nurse lactation consultants are more cost-effective than hospital-based lactation consultants in promoting breast feeding.

Finally, evidence from the US indicates that the provision of supplemental food to low income pregnant, breast feeding and post partum women is cost-effective, especially in black women..

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 preconceptual, pregnant and post-partum women 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 3,032 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 72 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 24 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 Folic acid, vitamin and mineral supplementation

Seven studies were identified for inclusion in the review under this heading:

Postma MJ, Londeman J, Veenstra M et al. Cost-effectiveness of periconceptual supplementation of folic acid. Pharmacy World and Science 2002; 24(1):8-11

Bendich A, Mallick R, Leader S. Potential health economic benefits of vitamin supplementation. Western Journal of Medicine 1997; 166:306-312

De Weerd S, Polder JJ, Cohen-Overbeek et al. Preliminary estimates of costs and effects of smoking cessation and folic acid supplementation. The Journal of Reproductive Medicine 2004; 49:338-344

Chan A, Pickering J, Haan EA et al. “Folate before pregnancy”: the impact on women and health professionals of a population-based health promotion campaign is South Australia. Medical Journal of Australia 2001: 174:631-636

Mills J, Raymond E. Effects of recent research on recommendations for periconceptual folate supplement use. Annals New York Academy of Sciences 1993; 678:137-145

Grosse SD, Waitzman NJ, Romano PS, Mulinare J. Reevaluating the benefits of folic acid fortification in the United States: economic analysis, regulation and public health. American Journal of Public Health 2005; 95:1917-1922

Romano PS, Waitzman NJ, Schleffer RM, Randy D. Folic acid fortification of grain: an economic analysis. American Journal of Public Health 1995; 85:667-676

A paper by De Weerd (2004) aimed to estimate the cost and effects of preconception counselling, with regard to folic acid supplementation and smoking cessation, to all women planning a pregnancy in the Netherlands. Costs were estimated from the perspective of the health care payer and included the costs of preconception consultation, mass media costs and treatment of neural tube defects in the first year of life. Cost data were derived from health care charges in 2002, detailed patient information and extrapolation from other studies. The total annual cost of preconception counselling was estimated at $5.1million for an uptake of 50% (100,000 women) and $7.1million. Using the mean value from a number of large trials, it was assumed that periconception folic acid intake would lead to a 35% risk reduction in the occurrence of neural tube defects. This would reduce the birth prevalence of neural tube defects in the Netherlands from 7.6 per 10,000 to 4.9 per 10,000. The efficacy of counselling was estimated from a study by the Dutch Association for Obstetrics and Gynaecology (2000) which suggested that the uptake of folic acid supplements increased from 44% to 80% after a single preconception consultation. With an uptake of 50% they estimated that 22 cases of neural tube defects could be averted rising to 33 cases averted with an uptake of 75%, with a concomitant reduction in costs of $0.7million (50% uptake) to $1.1million (75% uptake). The counselling intervention being evaluated also included advice on smoking cessation, which is outside the scope of this review. However, there are likely to be economies of scope in combining advice on folic acid supplementation and smoking cessation in a single counselling session. Including the impact of the counselling on smoking related mortality it is estimated that the cost net of savings of the intervention to be between $3.7million and $5.0million could be achieved, yielding a cost-effect ratio of $24,000 per adverse outcome prevented. To know whether this represented a cost-effective use of resources it would be necessary to put a value on an adverse outcome prevented. Another important caveat is that the effectiveness and cost savings reported are predicated on a certain uptake of counselling. The values used were not derived from trial data, representing instead what the authors considered “feasible” and “optimally achievable”. Therefore, this study does not establish the cost-effectiveness of the intervention assessed.

Chan (2001) evaluate a short campaign in South Australia to promote knowledge that taking adequate folate/folic acid in the periconceptual period can reduce the risk of having a baby with a neural tube defect. The authors report that the campaign had a budget of AUD40,000 and that subsequent surveys showed significant increases in women's awareness about periconceptual intake of folic acid.

A review article by Mills (1993) provided a "rough estimate" of the costs and benefits of widespread folate supplementation in the US. Using 1988 population figures they estimate that it would cost $252million to supply all 38.3 million non-sterile, non-pregnant women of childbearing age with standard multivitamins containing sufficient folate. Using the results of an MRC trial in the Lancet (1991) they estimated that this would prevent 2,810 neural tube defects, giving a cost-effect ratio of $89,600 per NTD detected. They then go onto suggest that with lifetime spina bifida costs of $250,000 that supplementation may produce net savings.

Romano (1995) assessed the economic costs and benefits of fortifying grain with folic acid to prevent neural tube defects[1]. Under the assumption that adequate folic acid intake lowers the risk of a neural tube defect pregnancy by 50%, they calculated that there would be a net cost saving of $93.6 million with low-level folic acid supplementation (140μg per 100g) and $251.7million with high-level folic acid supplementation (350μg per 100g). Sensitivity analysis showed a net economic benefit under a variety of alternative assumptions about discount rate, target population, reduction in risk of NTD, necessary folate intake and cost of a surveillance programme. An additional cost-effectiveness approach analysing the promotion of voluntary folate

[1] This review is not intended to include national maternal and child nutrition policies that are already under the remit of the Department of Health and the Food Standards Agency (advised by the Scientific Advisory Committee for Nutrition), such as the establishment of population-based dietary recommendations, national advice on food safety, the nutritional content of infant formula and the fortification of foods. Therefore, this evidence might be considered outside of the scope of this review

supplements suggested that US consumers would need to spend $132,000 per NTD case averted.

In 1996 the Food and Drug Administration required that manufacturers fortify enriched cereal grain products with 140μg of folic acid per 100g of cereal grain product by January 1, 1998[2]. Three studies had projected net cost savings as a result of fortification prior to the FDA requirement. Grosse (2005) aimed to update these analyses using pre-fortification and post-fortification epidemiological data. They estimated the costs of fortification at $3million per year. Using what they termed their CBA approach they used a cost of illness approach to estimate that the combined costs of spina bifida and anencephaly that would be averted with folic acid supplementation. Estimating that 520 spina bifida and 92 anencephaly live births would be averted. With a total cost per birth of $636,000 and $1,020,000 respectively they estimated total benefits of $425million or $422million net of the costs of fortification. Using their CEA approach they estimated that each year $145million costs of care for children born with spina bifida would be averted and $1million for cost of care for children born with anencephaly. This would produce a net cost saving of $142million per year. The authors then perform a worst-case scenario which allows for $25million costs arising from adverse effects, for folic acid fortification to account for only 80% of the NTD reduction and higher fortification costs. They calculate that this would yield a net economic benefit of $312million and cost savings of $88million.

Postma (2002) used a modelling approach to assess the cost per life-year gained of folic acid supplementation in the Netherlands. Costs were calculated from the cost of supplementation less the saving of averted lifetime costs of care of children who would otherwise have been born with NTD. In a figure derived from the literature they assumed that the discounted life years gained per prevented case of spina bifida was 10 years. They used data from the Dutch Central Bureau of statistics to calculate a discounted life-year gain of 25 years per case of anencephaly prevented. In their base case analysis

[2] As with the previous article this may fall outside of the scope of this review

they estimate a cost-effectiveness ratio of NLG 3,900 per life-year gained. Sensitivity analysis suggested that this cost-effectiveness ratio was generally less than NLG 10,000 per life-year gained and that it was cost saving under more favourable assumptions.

A paper by Bendich (1997) examined potential savings in hospitalisation costs of vitamin supplements in a US setting. They looked at the relationships between multivitamins containing folic acid (MVF) on neural tube defects, MVF and zinc (MVF + Z) on preterm delivery/low birth weight and supplements containing Vitamin E and coronary heart disease. A literature search was undertaken to determine the preventable fraction of disease that could be achieved through vitamin supplementation. Hospitalisation costs avoided, based on the preventable fraction of disease, were calculated using 1992 US data on hospital discharges and charges. Using 1995 retail prices they estimated that the annual cost for MVF would be $162million. They estimated that this could be offset by potentially preventable hospital charges of more than $1billion per year arising from a reduction in neural tube and cardiovascular birth defects. They also calculated that (MVF + Z) could lead to a reduction in hospital charges associated with low birth weight babies from $173million to $1.5billion.

2.2 Nutrition Counselling and support

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

Trouba PH, Okereke N, Splett PL. Summary document of nutrition intervention in prenatal care. Journal of the American Dietetic Association 1991; Supplement: S21-S26

Coulston A, Gallagher A, Splett P. Health care reform legislative platform: economic benefits of nutrition services. Journal of the American Dietetic Association 1993; 6:686-690

Bonifield SL. A cost savings analysis of prenatal interventions. Journal of Healthcare Management 1998; 43(5):443-451

Olds DL, Henderson CR, Phelps C. Effect of prenatal and infancy nurse home visitation on government spending. Medical Care 1993; 31(2):155-174

Stevens B, Guerriere D, McKeever P. Economics of home vs hospital breastfeeding support for newborns. Journal of Advanced Nursing 2006; 53(2):233-243

Reece EA, Lequizamon G, Silva J et al. Intensive interventional maternity care reduces infant morbidity and hospital costs. The Journal of Maternal-Fetal and Neonatal Medicine 2002; 11:204-210

Major DA, Allard CB, Cardenas RA. Child health: a legitimate business concern. Journal of occupational Health Psychology 2004; 9(4):306-321

Lieu TA, Wikler C, Capra AM et al. Clinical outcomes and maternal perceptions of an updated model of prenatal care. Pediatrics 1998: 102(6);1437-1444

Morrell CJ, Spiby H, Stewart P. Costs and benefits of community postnatal support workers: a randomised controlled trial. Health Technology Assessment 2000; 4(6)

Wiggins M, Oakley A, Roberts I. The social support and family health study: a randomised controlled trial and economic evaluation of two alternative forms of postnatal support for mothers living in disadvantaged inner-city areas. Health Technology Assessment 2004; 8(32)

A review of nutrition interventions in antenatal care by Trouba (1991) reported that the objectives of studies reporting on the economic aspects of antenatal nutrition services varied widely. Disbrow (1988) estimated that the average costs of nutrition services throughout pregnancy in a low income antenatal

population to be $41 per patient. Splett (1987) reported costs of antenatal nutrition care to be $72 for 3.9 visits at a city health department and $121 for six visits at the county hospital. Furthermore, Disbrow (1988) estimated that the patient would incur indirect costs of $121. The review notes that a study by Mathmatica Policy Research Inc. (1990) noted that participation in the Women, Infants and Children (WIC) programme showed “net benefits attributable to nutrition intervention in pregnancy”.

A report by the American Dietetic Association (1993) noted that Medicaid pays $19,000 per birth for a low birth weight infant compared to $3,500 per birth for a normal weight infant, commenting further that poor nutrition is a major risk factor for low birth weight babies. It states that the US General Accounting Office estimated that every $1 spent on the WIC programme yielded $4.21 in Medicaid savings.

A review by Bonifield (1998) discussed a study by Orstead (1985) which compared a group of women who received intensive nutrition counselling at each antenatal visit with a group of women who attended only one 30-minute nutrition class during their first antenatal visit. Included in the intensive intervention were group classes, individual nutrition planning and reinforcement of dietary messages by an obstetrician. Whilst it was reported that the intensive nutrition counselling intervention cost $44,000 more ($68,000 v $24,000) it was estimated that this could avert $230,000 in neonatal costs. The review also included an economic study of WIC by Buescher (1993) suggesting that Medicaid saved $2.91 for every $1.00 spent on the programme. Sub-analysis suggested that the Medicaid saving per $1 spent on WIC could be $3.75 in a black population. A more recent study of the WIC programme by Avuch (1995) posited net savings of $805million to the federal government.

Olds (1993) undertook a cost analysis of an antenatal and infancy nurse home visitation service in the US as part of a randomised trial. Whilst nutrition was not the primary focus of the study, those in the intervention arm made better use of the WIC nutritional supplementation programme. Their costs

were based on a government perspective on the basis that government would fund any such visitation programme. Discounted costs savings were calculated on the basis of improved maternal and child functioning which was presumed to depend on the programme and would lead to lower government expenditures and higher tax revenue. The authors reported that the net cost of the programme was $1,582 per family but that it produced a net saving of $180 in low income families.

A study by Stevens (2006) compared the incremental costs of home based versus hospital based support for breastfeeding by nurse lactation consultants for term and near-term neonates during the first week of life as part of a randomised controlled trial. The study was undertaken in a Canadian setting and analysed costs from a societal perspective (family and healthcare system). The study showed that term infants who received home support had statistically significant higher post discharge costs. However, there were no statistically significant differences in overall costs between the two groups. Clinical outcomes were reported separately by McKeever (2002) and these suggested better breast feeding outcomes were achieved in those allocated to home breastfeeding support.

Reece (2002) evaluated the Temple Infant and Parent Support Services Programme (TIPSS) in the US. TIPSS is an intensive interventional maternity care programme intended to reduce infant mortality and morbidity in a low-income population. Nutritional care was a component of TIPSS but it also included complete antenatal and delivery care, well-baby care, health education, counselling and psychosocial care. The study design was case control with the control group being women from the same neighbourhood as the intervention group who voluntarily sought care at the Temple University School of Medicine. Among the TIPSS study group, there was a statistically significant reduction in low birth weight (<2500g) infants (5.2% v 11%), the number of preterm deliveries (4.2% v 12%) and admission to a neonatal intensive care unit (2% v 6.6%). The authors report that there is an incremental saving of $5,650 per infant born to mothers in the TIPSS programme, however there is no detailed cost analysis and it isn’t clear how

this figure was derived. It is not possible to attribute the cost and benefits of TIPSS to the nutritional aspect of the programme.

Major (2004) reviewed the literature on organisational initiatives that benefit child health whilst reducing associated costs. Of particular relevance to this review, they included antenatal and lactation programmes. A study by Walden (1996) of 108 employees participating in the Pregnancy Wellness Program found substantial cost savings, with participants having average insurance claim costs 37% less than non-participants. A survey of 100 Fortune 500 companies participating in Health Time, an antenatal programme providing preconception risk appraisal education, support and behaviour modification interventions, reported 53 perinatal mortalities out of 1,000 pregnancies (compared to a national average of 126 per 1,000 births) with an associated cost saving of $468,000. A CIGNA study of pregnancy and childbirth related insurance claims in the 13 months after an antenatal programme suggested a statistically significant reduction of $5,474 per case for employees participating in the scheme. Lactation programmes are designed to encourage mothers to maintain breastfeeding when they return to work. Ball (1995) estimated that the total expenses for lower respiratory tract illnesses, otitis media and gastrointestinal illnesses were between an additional $331,000 to $475,000 per 1,000 in never-breastfed infants compared to breastfed infants. A number of papers report the “success” of the Los Angeles Department of Water lactation programme with the company claiming a $4 to $5 return for each $1 investment. Geisel (1994) attributes this, in part, to the fact that formula-feeding mothers experience absenteeism rates seven times higher than those for nursing mothers. A CIGNA lactation programme resulted in breastfeeding rates of nursing mothers of 73% for children at six months and 36% at one-year (compared to national averages of 21.1% and 10.1% respectively). A company cost analysis reported annual savings of $60,000 from reduced absenteeism, a $240,000 reduction in health care expenses for employees and their children, and lower pharmacy costs with breastfed children having 62% fewer prescriptions.

A double cohort study by Lieu (1998) to evaluate a revised model of antenatal care services. This model involved a new postpartum care centre for routine follow-up of newborns within 48 hours of discharge, moving educational advice form postpartum hospitalisation to the antenatal period and increasing lactation consultant hours. The study reported a reduction in undesirable health events compared to pre-intervention baseline care. However, there was no statistically significant difference in breastfeeding rates. It was calculated that overall costs were reduced under the revised model of care with increased costs of antenatal classes and lactation consultants ($58 per birth) being offset by reductions in planned hospital care, planned follow-up visits and unplanned care costs ($149 per birth).

A HTA report by Morrell (2000) reported a randomised controlled trial in the UK of women who received postnatal support from a community midwifery support worker versus women who did not receive such support. The primary outcome of the study was health status as measured by SF-36 at six weeks. Secondary outcomes included breastfeeding rates. The incremental costs of community midwifery support were £180 per woman. The trial found no evidence of improved health status as measured by SF-36. There were no statistically significant differences in breastfeeding rates at follow up.

Wiggins (2004) produced a HTA report which reported on a RCT and economic evaluation of two alternative forms of postnatal support for women living in disadvantaged inner-city areas in the UK. The two alternatives were a programme of visits from health visitors trained in supportive listening (SHV) and the services of local community support organisations (CGS). Primary outcome measures were child injury, maternal smoking and psychological well-being. Secondary outcomes included health service and household costs and experiences of motherhood and infant feeding. The study found no statistically significant difference in primary outcome measures. At 12 months post randomisation both intervention had greater breastfeeding rates than the control but the difference was not statistically significant. Again the control group were more likely to have introduced solid foods to their babies before the recommended 16 weeks but the difference was not statistically significant.

At 18 months post randomisation the use of health services was generally similar between intervention and control groups. The mean difference in costs between SHV and control at 18 months was £340 per woman [95% CI; -£137 to £829] and for CGS and controls the mean difference in costs was £315 [95% CI; -£294 to £980].

2.3 Alcohol

One study were identified for inclusion in the review under this heading.

Abel EL. Prevention of alcohol abuse-related birth defects – II. Targeting and Pricing. Alcohol & Alcoholism 1998; 33(4):417-420

A paper by Abel (1998) discusses the use of taxation as a public health strategy to reduce the occurrence of fetal alcohol abuse syndrome (FAAS) and alcohol abuse related birth effects (AARBE). He notes that Manning (1995) found that moderate drinkers were the most price sensitive but that Godfrey (1995) differed, finding heavy drinkers to be the most price sensitive. A study by Kenkel evaluated price elasticity according to gender and knowledge of dangers of heavy drinking. He reported that the price elasticity was greater for women (-1.29) than for men (-0.52) and also that elasticity among heavy drinkers who were well informed was -1.65 compared to zero for the least informed. Abel argues that this suggests a combined role for education and price increases in preventing FAAS and AARBE.

2.4 Women, Infants and Children (WIC) Programme

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

Schramm WF. Weighing costs and benefits of adequate prenatal care for 12,023 births in Missouri’s Medicaid program, 1988. Public Health Reports 1992; 107(6):647-652

Buescher PA, Larson LC, Nelson MD, Lenihan AJ. Journal of the American Dietetic Association 1993; 93:163-166

Luke B. Nutrition during pregnancy. Current Opinion in Obstetrics and Gynaecology 1994; 6:402-407

Avruch S, Cackley AP. Savings achieved by giving WIC benefits to women prenatally. Public Health Reports 1995; 110(1):27-34

Reichman NE, Florio MJ. The effects of enriched prenatal care services on Medicaid birth outcomes in New Jersey. Journal of Health Economics 1996; 15:455-476

Gregory PM, de Jesus ML. Racial differences in birth outcomes and costs in relation to prenatal WIC participation. New Jersey Medicine 2003; 100(3):29-36

A study by Schramm (1992) thought to evaluate the costs of ‘adequate’ antenatal care in Missouri’s Medicaid Program and the resulting savings in post partum costs following on from this. They estimated that the cost of ‘adequate’ antenatal care were $233 higher per pregnancy than those in which antenatal care was ‘inadequate’. They calculated that post-partum costs for mothers with adequate antenatal care were $347 less, with reduced medical care costs for newborns accounting for $291 of the savings. Sub-group analysis suggested that the return on the antenatal group was greatest in non-WIC participants.

Buescher (1993) used multivariate logistic regression analysis to evaluate the impact of antenatal WIC participation in North Carolina on low birth weight. It was estimated that participation in WIC led to a $2.91 saving for every $1 spent. Sub-analysis suggested that this return was greater in a black population ($3.75) than a white population ($1.92).

A review by Luke (1994) reported that Splett (1991) estimated the costs of nutrition services throughout pregnancy as $41 with $5 saved for each $1 spent. Also presented is Buescher's (1993) result that every $1 spent on the Special Supplemental Food Program for Women, Infants and Children services resulted in Medicaid savings of $2.91 for the costs of newborn medical care.

A meta-analysis by Avruch (1995) estimated that providing WIC benefits to pregnant women reduces low birth weight rates by 25%, very low birth weight births by 44%. The authors used this data to estimate the excess medical costs of low birth weight babies for their initial hospitalisation and medical costs in their first year of life. They calculate that total first year averted expenditures were $1.19billion or a net saving of $805million when the Federal cost of providing WIC are included.

An econometric study by Reichman (1996) sought to evaluate race-specific effects of participation in New Jersey's HealthStart programme on birth weight and hospitalisation costs in 1989 and 1990. The HealthStart programme was for pregnant Medicaid recipients and offered an increased number of antenatal visits, increased provider reimbursement, case coordination with other social programmes and integrated health support services such as psychological counselling and health education. The HealthStart programme also includes routine referral to local WIC programmes. Regression analysis showed that the HealthStart program increased mean birth weight for blacks by 55.7 grams and reduced newborn hospitalisation costs by 6.9%. For whites there was a smaller and non-statistically significant increase in birth weight for HealthStart participants and no difference in newborn hospitalisation costs. Further analysis demonstrated that the increased birth weight in the black population led to statistically significant reduction in the number of low birth weight and very low birth weight babies born.

A cross-sectional study by Gregory (2003) examined the effect of the antenatal participation in the Special Supplemental Nutrition Program for WIC on birth outcomes and the costs of infant hospitalisation at birth for black and

non-black Medicaid recipients. Three levels of antenatal WIC participation were identified; those who cashed at least one food voucher during pregnancy (*WIC participants*), those who had enrolled but had not cashed any food vouchers (*WIC enrollees*), those not eligible or enrolled in the WIC programme (*non-WIC clients*). In analyses adjusted for maternal characteristics, black non-WIC clients had greater odds of low birth weight when compared with WIC participants than did other WIC enrolees. In non-blacks non-WIC clients and WIC enrolees had similar but elevated odds of low birth weight outcomes relative to WIC participants. However, it was only in the black population that significantly greater adjusted odds of neonatal and infant mortality for non-WIC clients were observed. The adjusted mean total cost (cost of infant hospitalisation, WIC administrative and food voucher costs) was significantly lower for WIC participants than for non WIC-clients. The cost differential was greater for blacks ($1,132) than for non-blacks ($305). Mean total costs were lower for WIC participants than other WIC enrolees but the difference was not statistically significant.

3. Conclusions from this Review

There are a number of caveats which need to be considered when interpreting the evidence presented in this review. Firstly, very few studies meet the criteria of a full economic evaluation. Many studies do not take an incremental approach to the measurement of costs and effects and do not use sensitivity analysis to address uncertainty. Indeed a lot of the studies presented here are costing studies and even if a “cost-benefit” terminology is employed, benefits are often measured in terms of cost savings. Few of the included studies, attempt to value health benefits arising from the intervention. Nevertheless, if a study can demonstrate cost savings and the health outcome of the intervention is unambiguously positive, then the cost-effectiveness of the intervention is established.

A second limitation with many of the studies is that they relate to a non-UK context and therefore the findings may not be generalisable to a different setting. Not only will the costs of the intervention differ but the efficacy of the programme itself may be highly contingent on the setting and context in which it is implemented.

Finally, some of the studies focus on fairly complex interventions in which the nutritional aspect represents just a part, often quite minor. Determining the cost-effectiveness of the nutritional part of the programme is therefore problematic especially if there are difficulties attributing nutritional outcomes to the nutritional part of the intervention.

(i) Counselling with regard to folic acid supplementation

This review hasn’t found any evidence to demonstrate the cost-effectiveness of this as a public health intervention. However, there is good evidence on the relationship between folic acid intake and associated risk reduction for neural tube defects. There is also data on the effectiveness of counselling on folic acid intake. The cost-effectiveness of

any such intervention is likely to be influenced by the uptake of any such counselling as suggested by de Weerd's (2004) 'what if' result.

(ii) Folic acid, vitamin and mineral supplementation

A number of papers present evidence suggesting that folic acid supplementation reduces neural tube defects with a concomitant reduction in costs of hospitalisation, which at least partially offsets the intervention costs. When lifetime treatment costs (e.g. of Spina Bifida) are taken into account then the intervention is even more likely to generate a net cost saving. One paper also suggested that large savings in hospitalisation costs would be realised by daily use of folic acid and zinc-containing multivitamins, due to a reduction in low birth weight babies and neural tube defects.

(iii) Nutrition Counselling and support

Two UK evidence studies found no evidence that post natal support led to statistically significant increases in breastfeeding.

One Canadian study suggested that home-based nurse lactation consultamts could achieve higher breast feeding rates than hospital-based nurse lactation consultants at no additional cost.

There is US evidence that some companies can achieve cost savings by offering their employees antenatal and lactation programmes.

(iv) Alcohol

There is conflicting evidence about which groups of drinkers are most price sensitive but taxation may have a role in reducing fetal alcohol abuse syndrome and alcohol abuse related birth effects.

(v) Women Infants and Children Programme

The evidence suggests that the Special Supplemental Food Program for Women Infants and Children is cost-effective and that it may produce net cost savings. The evidence also suggests that it is most cost-effective in a black population.

4. Evidence Tables: Included Studies

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
Author(s): Avruch S;Cackley AP; 1995 Jan {101}	Study Type: Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes: low birth weight		Currency: USD Year of Costing: 1992 Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: The First-year Federal Medicaid savings based on the estimate for all evaluations -364million- offset the Federal Cost of peoviding WIC recipients. State first-year aveted expenditures were 1.19 billion, compared with a federal program Investmentof $389 million- or total net savings of $805 million. Comments and limitations:
Author(s): Bendich A;Mallick R;Leader S; 1997 May {29094}	Study Type: Cost analysis Model or Clinical Trial: Perspective of Analysis: Health care system	Source of Utility Values: Primary Clinical Outcomes:	all women in childbearing age	Currency: USD Year of Costing: 1995 Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Estimated savings of about 5 billion a year as result of reduced CHD hospitalizations associated with vitamin E supplementation. Comments and limitations:

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Author(s): Bonifield SL; 1998 Sep {29095}	Study Type: Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes:		Currency: Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Orstead et al(1985): Comparing the $44,500 difference in cost between the experimental and control groups to the predicted $230,700 in averted neonatal costs indicated that the program was a cost-effective option. Buescher et al.(1993) : a cost benefit analyis revealed that for every dollar spent on WIC program, both administrative and food costs, Medicaid costs , medicaid saved $2.91 overall. For the White population , Medicaid was able to save $1.92 for each dollar spent on WIC benefit, while participation in the programme by the black population was able to reduce Medicaid costs by$3.75 for each dollar spent on WIC benefits. Avruch and Cacckley 1995: Federal government was able to avoid expenditures of $1.19 billion while spending only $389 million on the WIC programme, with an overall savings totalling $805 million. Comments and limitations:

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Author(s): Chan A;Pickering J;Haan EA;Netting M;Burford A;Johnson A;Keane RJ; 2001 {29100}	Study Type: Model or Clinical Trial: 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: With a limited budget $40,000 there were significant increases in the knowledge about folate. After campaign the proportions of women taking periconceptional folic acid supplements, and of health professionals advising women planning a pregnancy about folate, also increased significantly, and folic acid tablet sales doubled. Total prevalence of NTD declined between 1966 and 1999 from a baseline of 2.0 per 1000 births to 1.1 per 1000 births Comments and limitations:
Author(s): Coulston A;Gallagher A;Splett P;Story M;Mullis R;Colaizzo-Anas T;Hofmeister L;Young E;Connell B;Diemand E;Levihn J;Schleinker E;Haughton B;Bonam S;Tin	Study Type: Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes:		Currency: USD Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: In 1992, the US General Accounting Office estimated that every $1 spent on The WIC program for pregnant women yield up to $4.21in Medicaid savings. Comments and limitations:

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
1993 {29102}					
Author(s): de WS;Polder JJ;Cohen-Overbeek TE;Zimmermann LJI;Steegers EAP; 2004 {29107}	Study Type: Cost-effective analysis Model or Clinical Trial: Clinical trial Perspective of Analysis: Health care system	Source of Utility Values: Primary Clinical Outcomes: NTD, low-birth-weights, very-low-birth-weight, perinatal deaths	all women palnning pregnancy	Currency: USD Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: The total yearly costs of nationwide preconception counselling, assuming uptake by 100,000(50%) and 150,000 (75%) of women planning pregnancy, were estimated at $5.1 and $7.2 million, respectively.Total potential savings amount to $1.5 and $2.2 million for the adverse outcomes considered in this preliminary evaluation, resulting in net costs of $3.7 and $5.0. This translates into cost savings balance of $24,000 per adverse outcome prevented. Comments and limitations:

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
Author(s): Gregory PM;de Jesus ML; 2003 Mar {29110}	Study Type: Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes: low birth weight very low birth weight infant deaths		Currency: Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Comments and limitations: This research, examines birth outcomes and cost for infnat hospiatlization at delivery for black and non-black Mediaid clients in relation to the level of prenatal participation in the Special Supplemental Nutrition Program for Women, Infants, and Children (WIC) lead to the conclusion that prenatal WIC participation was associated with lower costs to Medicaid and better birth outcomes, particularly for Blacks.
Author(s): Grosse SD;Waitzman NJ;Romano PS;Mulinare J; 2005 Nov {29111}	Study Type: Cost-effective analysis Model or Clinical Trial: Perspective of Analysis: Health care system	Source of Utility Values: Primary Clinical Outcomes:		Currency: uSD Year of Costing: 2002 Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Ex post economic evaluation of Folic acid Fortification Base case Total economic benefit from reduction in the number of NTDs after folic acid fortification is estimated to be $425 million per year.Subtracting fortification cost of $3 million per yea, the net monetary benefit is $422million. On the base case results, we estimated averted costs of care for children born with spina bifida of $145 million per year. Subtracting $3 million for fortification yields

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					net cost savings $142 million per year. Best case scenario cost savings would be reduced by $25 million Worst-case scenario the net benefit was calculated to $312 million and cost savings amounted to $88 million Comments and limitations:
Author(s): Luke B; 1994 Oct {801}	Study Type: Cost-benefit analysis Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes:		Currency: USD Year of Costing: 1987 Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Cots and Benefits of nutrition Care Services project focusingon 4 areas.:burns and surgery, prenatal care, diabetes and obesity. Estimated costs for nutrition services throughout pregnancy for a low income prenatal population were estimated (in 1987 US dollars) to be $40.87, with $5.0saved per $1.00 spent on nutrition services. In 19993, for each US$ 1.00spent on Special Supplemental Food Programm for Women, infants and Children services, Medicaid Savings in costs for newborn medical care were US$2.91

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
					Comments and limitations:
Author(s): Major DA;Cardenas RA;Allard CB; 2004 Oct {29119}	Study Type: Cost-consequence analysis Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes:		Currency: USD Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: lactation programs Ball and Wright(1999): assessement of the relationship between breastfeeding, child helath,and associated health care costs for three more common infant illnesses: lower respiratory tract illnesses ,otitis media, and gastrontestinal illness.Compared with exclusively brestfed infants in the first year of life, never breastfed infants experiences 2,033 excess dictor's office visits, 212 excess days of hospitalization, and 609 excess prescriptions for the three illnesses per 1,000

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
					infants.Using medical costs during 1995, the total expenses for these three illnesses per 1,000 never-brestfed infant were estimated to be from $331,000 to $475,000 greater than expenses pre 1000 brest fed infants. LADWP lactation program $30 per month paid for each pump, other initila startup costs, and the approximate $500 cost per participating employee , LADWP claims that the program provided a $4 to $5 return for each $1 it cost. This cost savings is attributed in part to the fact that formula-feedi
Author(s): Mills JL;Raymond E; 1993 Mar 15 {29120}	Study Type: Model or Clinical Trial: Perspective of Analysis: Health care system	Source of Utility Values: Primary Clinical Outcomes:		Currency: USD Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Cost-benefit analysis of widespread use supplementation Cost per NTD Case Prevented by type of supplement Used and target population: Population:all nonsterile women multivitamins $89,600per NTD prevented, folate (4mg) retail price $797,000 per NTD averted , folate (4mg) wholesale price $76,200 per NTD averted sexually active, non pregnant, not using effective contraceptives, multivitamins: $30,800 per NTD case

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					prevented , folate (4mg) wholesale price $274,000 per NTD case averted ,folate (4mg)wholesale price $26,200 per NTD averted Comments and limitations: The analysis is very simplified and leave out many considerations. For instance if mass supplementation were to be accomplished by adding folate to food or water, the costs of the process by which it was added would have to be taken into account. It is diificult to draw conclusions regarding the cost-benefit of folate supplements because critical info is lacking regarding dose, method of delivery, prices, target population, and costs

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
Author(s): Olds DL;Henderson CR;Phelps C;Kitzman H;Hanks C; 1993 Feb {29126}	Study Type: Cost analysis Model or Clinical Trial: Clinical trial Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes:		Currency: USD Year of Costing: 1980 Discount rate(s) used for costs: 3% Discount rate(s) used for benefits:	Results: net cost of the home-visitation program from the restrospective government spending was $3,246 per family in 1980 for the sample as a whole, and $3,133 for low-income families. The children were 4 years of age , government savings were $1,772 for the sample as a whole, and $3,498 for low-income families. Within the 2 years after the program ended, after discounting, the net cost of the progam for the sample as a whole was $1,582 per family. For low-income families, the cost of the program was recovered with a dividend of $180 per family. Comments and limitations:

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
Author(s): Postma MJ;Londeman J;Veenstra M;De Walle HEK;de Jong-van den Berg LTW.; 2002 {29129}	Study Type: Cost-effective analysis Model or Clinical Trial: Modelling Perspective of Analysis: Health care system	Source of Utility Values: Primary Clinical Outcomes: Life years gained resulted from comapring life-years last with and withoout periconceptional folic acid supplementation		Currency: NLG Year of Costing: 2000 Discount rate(s) used for costs: 4% Discount rate(s) used for benefits:	Results: Base case : CE of periconceptional supplementation of folic acid is NLG 3900 (Euro 1800) per dicounted life years gained Sensitivity analysis: Effectiveness 30%: NLG 9700 per discounted life years gained Effectiveness 70%: NLG 1400 per dicounted life years gained Folic acid costs NLG 55: NLG 2200per discounted life years gained Folic acid costs NLG 75: NLG 5600 per dicounted life years gained Costs of care for SB NLG 150,00: NLG 5700 per disounted life years gained costs of care for SB NLG 250,000: NLG 2100 per discounted life years gained Multivariate sensitivity analysis Maximum NLG 14,200 per disounted life years gained Minimum cost saving probabilistic sensitivity anlysis 90%-simulation interval NLG 450-9600 maximum NLG 12, 900 per discounted life years gained minimum cost saving Comments and limitations:

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
					The cost-effectiveness estimates are conservative as gains in quality of life due to prevention of spina bifida were not taken into account.Also, some other benefits
Author(s): Reichman NE;Florio MJ; 1996 Aug {29131}	Study Type: Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes:		Currency: USD Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Comments and limitations: The results indicate significant and favorable effects from participation in the HealthStart program on the birthweight, newborns costs and rates of low low birthweight and very low birthweight of Black Medicaid recipients. There appear to have no corresponding birthweight or cost benefits for white, although the program was associated with reduced prenatal care delay for both blacks and whites. The significantly worse outcomes for blacks, together

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					with the beneficial effects of HelthSrart on black birth outcomes, warrant the aggressive targeting of this program to blacks.
Author(s): Romano PS;Waitzman NJ;Scheffler RM;Pi RD; 1995 {29133}	Study Type: Cost-benefit analysis Model or Clinical Trial: Modelling Perspective of Analysis: Third party payer	Source of Utility Values: Primary Clinical Outcomes: Reduction in neural tube defects	US women in pre-conception and antenatal period	Currency: USD Year of Costing: 1991 Discount rate(s) used for costs: 4.0% Discount rate(s) used for benefits:	Results: Net Benefit of $93.6m (low level fortification); $251.7m (high level) Comments and limitations:

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
Author(s): Schramm WF; 1992 Nov {29136}	Study Type: Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes: birth weight		Currency: USD Year of Costing: 1988 Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Prenatal costs were $233 higher for pregnancies with adequate prenatl care than for those in which prenatal care is inadequate.Newborn and post-partum costs startin within 60 days after the birth were $347 lower for the adequate prenatal care pregnancies, resulting in a savings of $1.49 for ecah extra $1 spent on prenatal care. Comments and limitations:
Author(s): Stevens B;Guerriere D;McKeever P;Croxford R;Miller K;Watson-MacDonell J;Gibbins S;Dunn M;Ohlsson A;Ray K;Coyte P; 2006 {29140}	Study Type: Cost-minimisation analysis Model or Clinical Trial: Clinical trial Perspective of Analysis: Societal	Source of Utility Values: Primary Clinical Outcomes: Jaundice; Dehydration; Hospital readmission	Mothers who delivered a live, singleton infant within as least 12 hours, >21 yrs, resided in defined zone; English speaking; had a telephone; newborn deliverd >35 GA; breastfeeding at discharge; no major congenital anamolies or morbidities	Currency: CAD Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Costs for 'home' group (n=48) for term newborns = 4973CAD (1652CAD) Costs for 'hospital' group (n=40) for term newborns = 4854CAD (1321CAD) p = 1.00 Costs for 'home' group for near term newborns = 4814CAD (853CAD) Costs for 'hospital' group for term newborns = 3462CAD (5968CAD) p = 0.95 Comments and limitations:

Bibliographic Information	Study Details	Outcomes	Population Characteristics	Analysis Details	Results and Comments
Author(s): Trouba PH;Okereke N;Splett PL; 1991 Nov {1289}	Study Type: Model or Clinical Trial: Perspective of Analysis:	Source of Utility Values: Primary Clinical Outcomes:		Currency: USD Year of Costing: Discount rate(s) used for costs: Discount rate(s) used for benefits:	Results: Direct cost for nutrition services throughout pregnancy for low-income prenatal population were estimated to average $40.87 per client.Costd to the clinic amounted to $36.48 per client for approximately six visits. Splett et al reported the 1987 costs of prenatal nutrition care delivered at a city health department to be $72.00 for 3.9 visits and $121.00 for six visits at the county hospital. Disbrow estimated indirect costs to be $21.37 per client. Comments and limitations: