

The University of Sheffield



**Economic outcomes of early years programmes and interventions designed to promote cognitive, social and emotional development among vulnerable children and families.**

## **Part 2 – Economic model**

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## **1.0 Introduction**

In this report the economic consequences of early years programmes and interventions designed to promote cognitive, social and emotional development among vulnerable children and families is examined. It comprises a systematic review of the literature on economic evaluations of such interventions, as well as a report describing the methods and results from an economic model developed to estimate the long term consequences of early years programmes for vulnerable children.

The systematic review was undertaken to identify any economic analyses of early years programmes designed to promote cognitive, social and emotional development among vulnerable children and families in the UK. Long term outcomes are of particular interest, and as these were not available in any of the UK studies, an overview of the literature of similar interventions from other developed countries was also conducted, based primarily on reviews, but supplemented with more recent primary papers.

The economic model builds on work described in two companion reports. Evidence for the effectiveness of UK interventions is taken from studies identified in an accompanying report “Systematic review of UK evaluation studies of the effectiveness of early years programmes and interventions designed to promote social and emotional wellbeing of preschool vulnerable children (0-5 yrs)”.<sup>1</sup> An econometric model, described in “Part 1 - Econometric analysis of UK longitudinal data sets”<sup>2</sup> was used to estimate adult outcomes from child cognitive and behavioural characteristics at age 5 years. The economic analysis was conducted from the perspective of the UK public sector and includes the costs of the interventions, tax and National Insurance, educational costs, social security benefits and the costs of crime. All costs and benefits are discounted at a rate of 3.5% to birth.

## **2.0 Systematic review of economic analyses of early years programmes designed to promote cognitive, social and emotional development among vulnerable children and families**

### **2.1 Methods**

A systematic search of key health and medical databases including MEDLINE, EMBASE EconLit and the Cochrane Library was undertaken for articles relating to economic evaluation studies of early years programmes and interventions designed to promote cognitive, social and emotional development among vulnerable children and families. An example of the search strategy can be found in Appendix 1, and the list of databases searched is given in Appendix 2.

The search strategy included a broad set of terms relating to child age, intervention and vulnerable population. A date restriction was applied: limited to 2000-2010 to be consistent with the intervention review. No restrictions were placed in terms of study type or country of origin. Only articles published in English were included. In addition, references were suggested by an expert reference group.

The inclusion and exclusion criteria were the same as the systematic review of UK interventions as far as the population and interventions are concerned.<sup>1</sup> In summary the population of interest is children (aged 0-5 years) and their families who are deemed to be at risk, or showing early signs of having cognitive, social and emotional difficulties. The review includes two types of interventions:

- ‘Progressive’ interventions which provide additional support at home, including home visiting and family-based activities.
- ‘Progressive’ early education and childcare interventions, including communication and language development and activities to prepare children for school.

Additionally studies had to report economic outcomes in terms of cost benefit or cost-effectiveness. Studies reporting just programme costs were excluded, as well as papers presenting summary results reported elsewhere.

Two separate reviews of the economic literature were conducted.

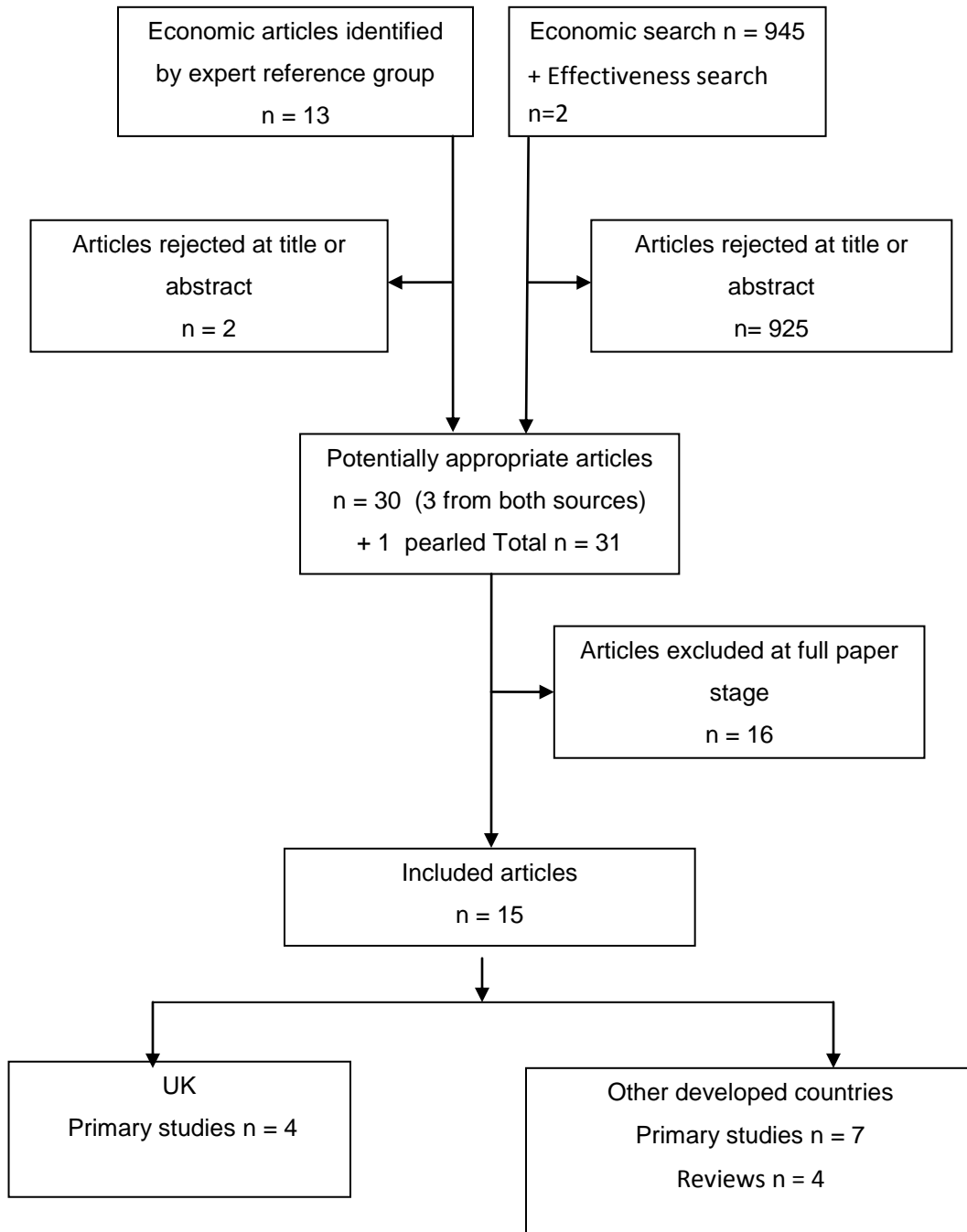
1) A systematic review of primary economic evaluation studies. These were quality assessed using the checklist in the methods guide for public health guidance published by the National Institute for Health and Clinical Excellence (NICE).

2) Due to the limited number of UK economic studies and the lack of any long term outcomes (> 18 months) an overview of the literature from other developed countries is also reported. Data was extracted primarily from reviews, supplemented by primary studies where they provided longer follow-up or interventions not included in the reviews. No quality assessment of reviews or primary studies was undertaken.

### **Study Identification**

The results of the sifting process are shown in Figure 1.

**Figure 1 QUOROM diagram for the economic review.**



As well as the papers identified in the economic literature search two additional papers were identified by the effectiveness review (McAuley<sup>3</sup>, Wiggins<sup>4</sup>), and a further study identified from pearling (Aos).<sup>5</sup> Note three studies were identified by both the expert panel and the economic literature search.

## **2.2 Economic Evidence from UK studies**

The key characteristics, as well as outcomes, of the four studies identified are summarised in Table 1.

**Table 1 Economic studies of interventions in the United Kingdom.**

<b>Study</b>	<b>Intervention/ Control</b>	<b>Population &amp; Follow- Up</b>	<b>Primary study outcomes</b>	<b>Perspective</b>	<b>Economic outcomes and results</b>
<b>Mujica Mota,R., et al. 2006.</b> <sup>6</sup>  Based on the RCT reported by Toroyan 2003 <sup>7</sup>	Out of home day care / standard child care arranged by the family.	137 families with a child of between 6 months and 3.5 years  18 month programme and follow up.	The proportion of mothers in education or paid employment 18 months after randomisation.  Other effectiveness outcomes included in trial	Societal (2000)	Intervention cost saving by £837
				Public sector (2000)	Incremental cost £5,064.  ICER £38,550 per additional woman in education or paid employment (NS outcome)
<b>McIntosh,E., et al. 2009.</b> <sup>8</sup>  Based on the RCT reported by Barlow 2007 <sup>9</sup>	Weekly home visiting / standard care.	131 women identified antenatally at risk of abusing or neglecting their infants.  Intervention started 6 months antenatally. 18 month programme and follow up.	Mother - infant interaction using maternal sensitivity and infant cooperativeness elements of the CARE index.  Other effectiveness outcomes included in trial	Public sector (2004)	Incremental cost £3,246  ICER £2,723 per unit of maternal sensitivity and £2,033 per unit of infant cooperativeness. ICER per child removed from potentially abusive home environment £55,016 (NS outcome)
				Health service (2004)	Incremental cost £2,2,95



Table 1 Continued

<b>Study</b>	<b>Intervention/ Control</b>	<b>Population &amp; Follow- Up</b>	<b>Primary study outcomes</b>	<b>Perspective</b>	<b>Economic outcomes and results</b>
<b>Wiggins., et al. 2004.</b> <sup>4</sup>	Monthly health visitor/ standard care.	731 women living in deprived London districts.	Maternal depression childhood injury and maternal smoking.	Public sector (2000)	Incremental cost £374. No difference in effectiveness outcomes
	Community group support (varying intensity)/ standard care.	12 month programme with 12 and 18 month follow up.		Societal (2000)	Incremental cost £319
				Public sector (2000)	Incremental cost £368 No difference in effectiveness outcomes
				Societal (2000)	Incremental cost £291
<b>McAuley,C., et al.2004.</b> <sup>3</sup>	Weekly volunteer visits (“Home- Start”)/ standard care.	177 families under stress with ≥ 1 child <5 years  12 month programme & follow up.	Parental stress, maternal mental health, maternal social support, maternal self- esteem and child development.	Societal (year not stated)	Incremental cost £8,857 (including cost of volunteer time)  No difference in outcomes thus no ICER calculated.
				Public sector	Incremental cost £3,058

Four studies trialling 5 different interventions were identified.<sup>4;6;8;10</sup> Three of the four studies were economic analyses conducted alongside RCTs (Mujica Mota, McIntosh, Wiggins), and all compared the novel intervention with standard care. The duration of the programmes varied between 12 and 18 months, and the follow-up period likewise. One intervention provided day care for children<sup>6</sup>, three provided home visits<sup>3;4;8</sup> and one put mothers in contact with community support groups which provided drop-in sessions, home visiting and/or telephone support<sup>4</sup>. The home visiting interventions were delivered by various personnel: trained home visitors,<sup>8</sup> health visitors trained in supportive listening,<sup>4</sup> and volunteers.<sup>3</sup> The intensity of home visits varied from weekly,<sup>3;8</sup> to monthly.<sup>4</sup> The quality assessments for the studies are reported in Appendix 3. Key limitations of the literature are highlighted in the following discussion.

All studies included parental outcomes, but these were quite varied: employment<sup>6</sup>, maternal sensitivity to child,<sup>8</sup> parental stress,<sup>3</sup> maternal mental health,<sup>3;4</sup> maternal social support,<sup>3</sup> maternal self-esteem,<sup>3</sup> maternal smoking.<sup>4</sup> Three studies included child outcomes: infant cooperativeness,<sup>8</sup> child development,<sup>3</sup> childhood injury<sup>4</sup>. In the McIntosh<sup>8</sup> study the outcomes used in the economic study were selected on the basis of statistical significance from the many outcomes measured in the trial. A further exploratory analysis was undertaken on an outcome of particular importance to child welfare (removal of child at high risk of abuse or neglect from its home), although not statistically significant. All studies reported outcomes from a societal perspective as well as from a more limited perspective (NHS, NHS and social care, public sector, individual).

From a societal perspective one study (Mujica Mota) found the intervention (day care) to be cost saving, although the result is highly uncertain (95% confidence interval: -£12,440, £10,767).<sup>6</sup> This study includes estimated differences in maternal and partner wages in the intervention and control group. Income was estimated from hours worked based on average (gender and manual/non-manual specific) wages, and furthermore partner employment was not measured at baseline, hence the considerable uncertainty in this outcome. From a public sector perspective the incremental cost of the

intervention was an additional £7,000, which was reduced to £5,000 if the (uncertain) additional tax revenue was considered. The other four interventions all resulted in additional costs, the lowest from Wiggins (£368 for community group support from a public sector perspective, £291 from a societal perspective).<sup>4</sup> The highest cost reported from a public sector perspective was from the study by Mujica Mota, already mentioned, but McAuley reports a total cost of £8,900 when volunteers time is included in the calculation (societal perspective).<sup>3</sup> These additional costs include not only the interventions themselves but also in general an increase in the use (and costs) of other support services.

In terms of cost-effectiveness, two studies,<sup>3;4</sup> found no difference in maternal or child outcomes, so cost-effectiveness ratios were not applicable. Mujica Mota<sup>6</sup> found day care cost saving, taking into account maternal and partner earnings, so from a societal perspective the intervention is cost-effective, although, as already discussed, there was considerable uncertainty in this result. From a public sector perspective the intervention cost an additional £5,064 (95% confidence interval -£2,052, £12,180), giving an ICER for an additional mother in employment or education at 18 months of £38,550 (85% confidence interval -£1,273, £416,172). Sensitivity analysis on two key uncertain parameters (partner employment, average versus minimum wage) gives ICERs between £31,630 and £52,997.<sup>6</sup>

McIntosh<sup>8</sup> reports ICERs for two significant outcomes of a home visiting intervention: maternal sensitivity and infant cooperativeness, both components of the CARE index. From a societal perspective an additional unit of maternal sensitivity costs £2,723, and a unit of infant cooperativeness £2,033. These costs are 20% less from a health service perspective. An exploratory analysis on the statistically non-significant outcome measure of infants removed from the home due to abuse or neglect was also performed. There were 4 cases from 67 children in the intervention arm, none in the control arm. It is argued by the authors that removal from the home is a desirable outcome as it prevents abuse and neglect. The ICER per child removed from the home

for abuse or neglect is £3,246, or assuming the neglect would have been otherwise identified at age 5, £1,691 per month of child exposure to abuse or neglect.<sup>8</sup>

In conclusion these UK studies provide little evidence of cost-effectiveness of interventions to improve the wellbeing of infants and their parents. In fact two studies found no evidence of effectiveness (McAuley, Wiggins).<sup>3;4</sup> One study found a day care intervention increased maternal participation in paid employment or education (although this outcome did not quite reach the 95% significance level) but at a public sector cost per additional mother in paid employment or education of £38,550 at 18 months.<sup>6</sup> From a societal perspective the intervention was potentially cost saving due to increased parental earnings. A further study reports ICERs for unit increases in maternal sensitivity and infant cooperativeness.<sup>8</sup> These outcomes were chosen on the basis of statistical significance: given the number of other outcome measures in the study it is possible that their statistical significance is due to chance. The costs per unit increase in these outcomes is relatively modest (<£3,000 from a societal perspective), but as the value or long term significance of these outcomes is unclear it is uncertain whether the intervention should be considered cost-effective. A more compelling case is made by the cost of prevention of abuse or neglect of the child, although the estimated difference in the number of children affected is very uncertain due to the small number of cases.

The interventions in all these studies are of low intensity compared to some of the interventions tried in other developed countries, and are of limited duration. Follow-up was a maximum of 18 months, which is far too short to derive potential economic and non-economic benefits from changes to childrens' lives. So whilst these studies provide little evidence of cost-effectiveness of interventions to improve the wellbeing of infants and their parents, equally they do not show that such interventions are not cost-effective.

## **2.3 Economic Evidence from other developed countries**

### **2.3.1 The literature**

A total of 11 studies were identified including 6 primary studies and 4 reviews, of which two were systematic reviews (Penn<sup>11</sup>, London Economics<sup>12</sup>). A further paper was a primary economic analysis based on a systematic review and meta-analysis of the effectiveness literature for youth intervention studies, some of which were relevant to this review (Aos).<sup>5</sup> All of the primary studies relate to three longitudinal studies of pre-school education in the United States, the Perry High Scope, Chicago Parent Centres (CPC) and Abecedarian. These studies also comprise those discussed in the systematic review on the economic impact of centre-based early childhood interventions by Penn. The systematic review by London Economics examines the cost benefits of interventions with parents.<sup>12</sup> A small number of the parental involvement and home visitation interventions were relevant to this review, but all the economic results reported for these were sourced from Aos, which is considered separately. Aos et al. conducted a systematic review and meta-analysis of intervention programs for youths, and then applied a common methodology to estimation of the cost benefits of different interventions.<sup>5</sup> Some of the interventions are relevant to this review, although as only limited details of each are reported it is not always entirely clear. The two reviews by Karoly (2005)<sup>13</sup> and Karoly (2001)<sup>14</sup> also include results from the Perry High Scope, Chicago Parent Centres (CPC) and Abecedarian programmes, as well as for more recent programmes (Karoly 2005)<sup>13</sup>, the latter results sourced from Aos. All the intervention studies were conducted in the United States. The literature will be discussed in two sections: the first covering the three centre based interventions which are the subject of the Penn review and the majority of the literature identified, and the second other studies, the results principally drawn from Aos.<sup>5</sup> A list of studies that met the inclusion criteria are in Appendix 4.

### **2.3.2 Centre based pre-school education**

Key characteristics of the studies are shown in Table 2. All three studies provided high quality care, with trained staff, high adult to child ratios and offering a detailed, educationally based curriculum.<sup>11</sup> The trial populations are all relevant to this review in

being vulnerable, but all are African-American, so the particular social context makes the results of limited applicability to vulnerable UK populations. Two of the interventions included a group parenting element (CPC,Perry), and some participants in the CPC received additional support in their elementary school years.

Two of the studies were RCTs (Abecedarian, Perry) and one had a matched comparison group (Chicago). The randomization process for the Perry study was not entirely satisfactory<sup>11</sup> and one economic study attempts to account for this in their analysis (Heckman 2010)<sup>15</sup>.

**Table 2 Study characteristics of centre based pre-school education interventions**

Study Characteristics		Abecedarian	Chicago Parent Centres	Perry High/ Scope
<b>Intervention</b>	<b>Children</b>	Day care/ education during working hours	½ day pre-school term time + summer programme	½ day pre-school
	<b>Parents</b>	Informal support for mothers	Weekly classes	Weekly meetings + weekly home visit
	<b>Duration</b>	5 years	Mean 1.6 years (pre-school part)	1-2 years
	<b>Max. follow up age</b>	21 years	21 years	40 years
<b>Population</b>		112 African-American children at risk of retarded development, Age 0-5 Carolina	1539 African-American (>90%) children from low income families, age 3-5 Chicago, Illinois	128 African-American children from disadvantaged families, age 3-5 Ypsilanti, Michigan
<b>Selected outcome measures*</b>	<b>Education – High School completion</b>	I = 67%, C = 51% (age 19)	I = 50%, C = 39% (age 21)	I = 49%, C = 39% (age 21)
	<b>Crime</b>	Crime rate age 16-21 No stat. sig. difference	Juvenile court petitions age <18 I = 16%, C = 26%	Ever arrested by age 27 I = 57%, C = 69%

\* Data from Penn 2006<sup>11</sup>

The net incremental benefit per child from a societal perspective, expressed in pounds sterling are shown in Table 3. The studies included in the table use the latest results (longest follow-up) of each of the three intervention studies. Reported economic results were inflated to 2010 using the US CPI rate prior to being converted from US dollars to pounds sterling.<sup>16;17</sup> Note the methods used in the different studies for estimating economic benefits vary and are therefore not entirely comparable.

**Table 3 Incremental net societal benefits of pre-school education programs (£ 2010)**

Study	Age of child at follow-up	Cost	Benefit	Net Benefit	Source
Abecedarian	21	£48,100	£119,900	£71,800	Barnett 2007 <sup>18</sup>
Chicago Parent Centres (pre-school programme)	21	£5,600	£39,900	£34,300	Reynolds 2002 <sup>19</sup>
Perry High/ Scope	40	£12,000	£193,700	£181,700	Milagros 2005 <sup>20</sup>
	40	£12,000	£103,300	£91,300	Heckman 2010 <sup>21</sup>
- Inclusive of intangible crime costs	27	£11,000	£96,000	£85,000	Karoly 2005 <sup>13</sup>
- Exclusive of intangible crime costs	27	£11,000	£56,600	£45,600	Karoly 2005 <sup>13</sup>

Several estimates of societal net benefits are shown for the Perry High/Scope study to illustrate how varying assumptions can lead to very differing estimates of programme net benefit, although all studies report a positive net benefit. Karoly 2005 shows estimates including and excluding intangible crime costs, showing their inclusion (at analysis age 27) almost doubles the estimated net benefit per child.<sup>13</sup> Heckman (2010) conducted a de novo economic analysis of the Perry High/Scope results to take into account perceived failings in the previous analyses including accounting for the study randomization process, missing wage data, and using local rather than national data.<sup>21</sup> The estimate of net benefit is approximately half that of Milagros, although based on the same study data, and also including intangible costs



of crime. The costs of avoided crime comprise 70% of the total net benefit in Milagros, but only 44% for Heckman, with earnings representing 26% and 51% of the total net benefits respectively.<sup>20;21</sup> In fact the absolute benefit in earnings is similar for the two studies. Crime rates in both the intervention and control arm were very high in the Perry High/Scope study: 95% of males and 65% of females in the control arm were arrested at least once, with the rates in the intervention arm 82% and 56% respectively.

In contrast the Abecedarian study found no significant difference in crime rates between the intervention and control. A possible explanation is that crime rates were much lower in the area where the Abecedarian study took place compared to the Perry High/Scope study, so there was less crime to prevent.<sup>18</sup> The net benefits for the Abecedarian study were principally derived from increased maternal earnings (53%) and child participant earnings (29%). In this study maternal earnings were recorded at three time points between the ages of 32 and 41, so the estimated additional earnings of \$3000 per year is relatively robust, but the assumption that the earnings differential is maintained up to age 60 less so.

The results shown in Table 3 for the Chicago parent centres are for the pre-school element of the programme only, those relevant to this review. In fact the costs and benefits of the school age programme were small, and make little difference to the overall costs and net benefits of the overall programme. In this study projected child participant gross earnings comprise the greatest proportion of the financial benefits of the programme (58%) and crime 28%.<sup>19</sup> Follow up is only to age 21 so participant earnings were estimated from high school graduation rates at this age.

### **2.3.3 Other Studies**

The review, meta-analysis and economic analysis by Aos reports cost-benefit results for several different interventions of apparently of relevance, although as only limited details of each are reported it is not always entirely clear.<sup>5</sup> The advantage of this analysis is that common methods for the estimation of economic benefits have been used for the different interventions, and as the authors claim, is a more objective analysis compared to studies where the authors are involved in the intervention trial. However there is some difficulty in interpretation of the results as it is not stated what

the range of follow-up is for the different interventions, which may have a significant impact on the results. Some of this data is reported by Karoly (2005), and is shown in Table 4, where available.<sup>13</sup>

Factors considered include: crime (parent/child), education and its impact on earnings (parent/child), welfare payments (parent/child), child abuse and neglect, teen births, use of licit and illicit drugs. The societal economic costs, benefits and net benefits of relevant programs are shown in Table 4. Costs were inflated to 2010 and converted to pounds sterling as previously described.

**Table 4 Cost benefit results of interventions for vulnerable infants reported by Aos<sup>5</sup> (£ 2010) (Supplementary data Karoly 2005)<sup>13</sup>**

Programme	Intervention	Cost	Benefit	Net Benefit
<b>Pre-school educational programmes</b>				
<b>Early Childhood Education for Low Income 3- and 4-Year-Olds*</b>	Enhanced preschool for low income 3 & 4-year-olds. Some programs are small-scale pilot studies and some are widespread programs such as the Head Start program. Max. follow-up age - various	£5,267	£12,409	£7,142
<b>HIPPY (Home Instruction Program for Preschool Youngsters)</b>	For families with 3-year-olds whose parents have limited education. In biweekly home visits parents are given books and toys and taught how to make their home more conducive to child learning. The program continues until the child completes kindergarten. Max. follow-up age 6	£1,325	£2,390	£1,065
<b>Early Head Start</b>	For low income pregnant women or with a child < 2 years. Families may receive services until the child is three years old. Programs vary & may offer home-visit services, center-based services, or a combination.	£15,128	£3,439	-£11,688

<b>Child welfare/ home visitation programmes</b>				
<b>Programme</b>	<b>Intervention</b>	<b>Cost</b>	<b>Benefit</b>	<b>Net Benefit</b>
<b>Nurse Family Partnership for Low Income Women</b>	The program is for low income, at-risk pregnant women bearing their 1 <sup>st</sup> child. Intensive home visiting by nurses during pregnancy and the first 2 years after birth. The goal is to promote child development and provide support and instructive parenting skills to the parents. Max. follow-up age 15	£6,577	£18,970	£12,393
<b>Home Visiting Programs for At-risk Mothers and Children*</b>	Focuses on mothers at risk for parenting problems, e.g. maternal age, marital status and education, low income, lack of social supports. Depending on the program, the content of the home visits consist of instruction in child development and health, referrals for service, or social and emotional support. Some programs provide additional services, such as preschool.	£3,529	£7,913	£4,384
<b>Healthy Families America</b>	At risk mothers enrolled antenatally or soon after birth. The intervention involves home visits by trained paraprofessionals who provide information on parenting and child development, parenting classes, and case management.	£2,391	£1,480	-£911
<b>Comprehensive Child Development Program</b>	For disadvantaged new parents. Home visitors provided case management and early childhood education, starting with child's <1 year to age 5. Biweekly home visits provided case management and early education. The program also brokered services for families. Max. follow-up age 5	£26,970	-£6	-£26,977

\* These interventions are comprised of several different similar interventions, whereas the rest are particular programs.

Note Healthy families America and HIPPY are both described as universal programmes by London Economics<sup>22</sup>, but described as restricted to at risk families by Aos (see Table 4).<sup>23</sup> The programmes may have been implemented differently in varying locations. As Aos is the source of the economic results they have been included.

The “early childhood education for low income 3 and 4 year olds” includes the three centre-based studies discussed in the previous section, as well as other programmes such as Head Start.<sup>5</sup> It is noticeable that whilst these interventions are shown to be cost-effective in the analysis by Aos, and the most cost-effective of the pre-school educational interventions, the net benefit is considerably less than those shown in Table 3. In the analysis by Aos avoided crime comprises 28% of the total benefits, with improved educational outcomes making the greatest contribution.<sup>5</sup>

Of the child welfare/ home visitation programs of relevance it is the NFP that Aos shows to be most cost-effective. In this analysis 55% of the societal benefits are derived from avoided criminal activity *by the mother*, with a further 6% from crime by the child.<sup>5</sup> However there are also benefits to the child in avoided abuses and neglect which comprise 22% of the monetary benefits. The costs of avoided child abuse and neglect include not only the costs to public services, but also estimated financial gains to quality of life, and also uses evidence to link child abuse with long term outcomes such as crime, educational outcomes and drug use.<sup>5</sup> Karoly (2005) presents an estimate of the net benefit per child for the NFP programme for “high risk” families of over £25,000, compared to £1,400 for low risk families, but the risk categories are not defined (£ 2010).<sup>13</sup> On the basis of their analysis Aos et al. conclude that some forms of targeted home visiting programs are cost-effective, as is early childhood education for low income 3- and 4-year-olds.<sup>5</sup>

#### **2.3.4 Discussion**

The three longitudinal studies of pre-school education (Perry High Scope, Chicago Parent Centres (CPC) and Abecedarian) all show considerable net societal financial benefits, although the financial benefits are primarily realized from different sources in the different studies: child participant crime, maternal earnings and child participant earnings. Two of the studies are very small, and therefore do not necessarily demonstrate what can be achieved in a real world setting. The meta-analysis by Aos of pre-school educational interventions weighted effect sizes for individual programmes to account for study design quality and size, and also includes other programmes. It confirms the positive net societal benefit of some pre-school educational programmes, although at a considerably reduced level.

Aos also reports positive net financial benefits for some home visiting programs, including the Nurse Family Partnership (NFP).<sup>5</sup> The greatest proportion of financial benefit from the NFP was from avoidance of maternal crime, but in the meta-analysis of other home visiting programmes the financial benefits were realised from estimated benefits from improved school test scores. In the UK evaluation of the NFP programme no difference in crime has been reported. Other programmes Aos categorises as home visiting, Healthy Families America and Comprehensive Child development programme currently show insufficient financial benefits to justify their cost, but as Karoly 2005 notes they have as yet only a few years follow up, and it is the longer term outcomes such as crime and earnings which are more readily monetised.<sup>13</sup>

The literature from the US indicates that preschool education and/or home visiting programmes for at-risk populations may be cost-effective. There is however little consistency in where the financial benefits are realised, illustrating the heterogeneity of the interventions, study designs and contexts. Drawing conclusions from these studies on the likely cost-effectiveness of such interventions to temporally and geographically distant populations is even more difficult. In relation to the applicability to the UK of the results of the Perry High Scope, Chicago Parent Centres and Abecedarian studies Penn raises issues of differing attitudes to discipline, the role of mothers, and the context of the racist attitudes which were prevalent at the time at which these studies of African-American children took place, as well as current increased prevalence of drug use.<sup>11</sup> A high proportion of the financial benefits realised in many studies arose from avoidance of crime either in the mother or child, but one study found no significant difference, possibly due to the relatively low level of crime in the area, illustrating how results are not necessarily transferable to different contexts.

A more general issue of cost benefit analysis in the evaluation of programmes aimed at improving infants social and emotional wellbeing is that the outcomes that can be used to generate financial benefits is limited. Improvements to children's cognitive ability, behaviour and other elements of social and emotional wellbeing are not readily monetized, and therefore are excluded from financial analysis. Furthermore other potential benefits such as avoided child neglect and improved socio-economic

outcomes for descendants of participants are also generally not included in economic evaluations.<sup>13</sup>

### **3.0 The Economic Model**

The economic modelling comprised two principal activities:

1. Using the results of the econometric analysis<sup>2</sup> to predict the outcomes of interventions to improve the social and emotional wellbeing of infants at age 5 and in adult life, and
2. to conduct an economic analysis of interventions to improve the social and emotional wellbeing of infants, from a public sector perspective

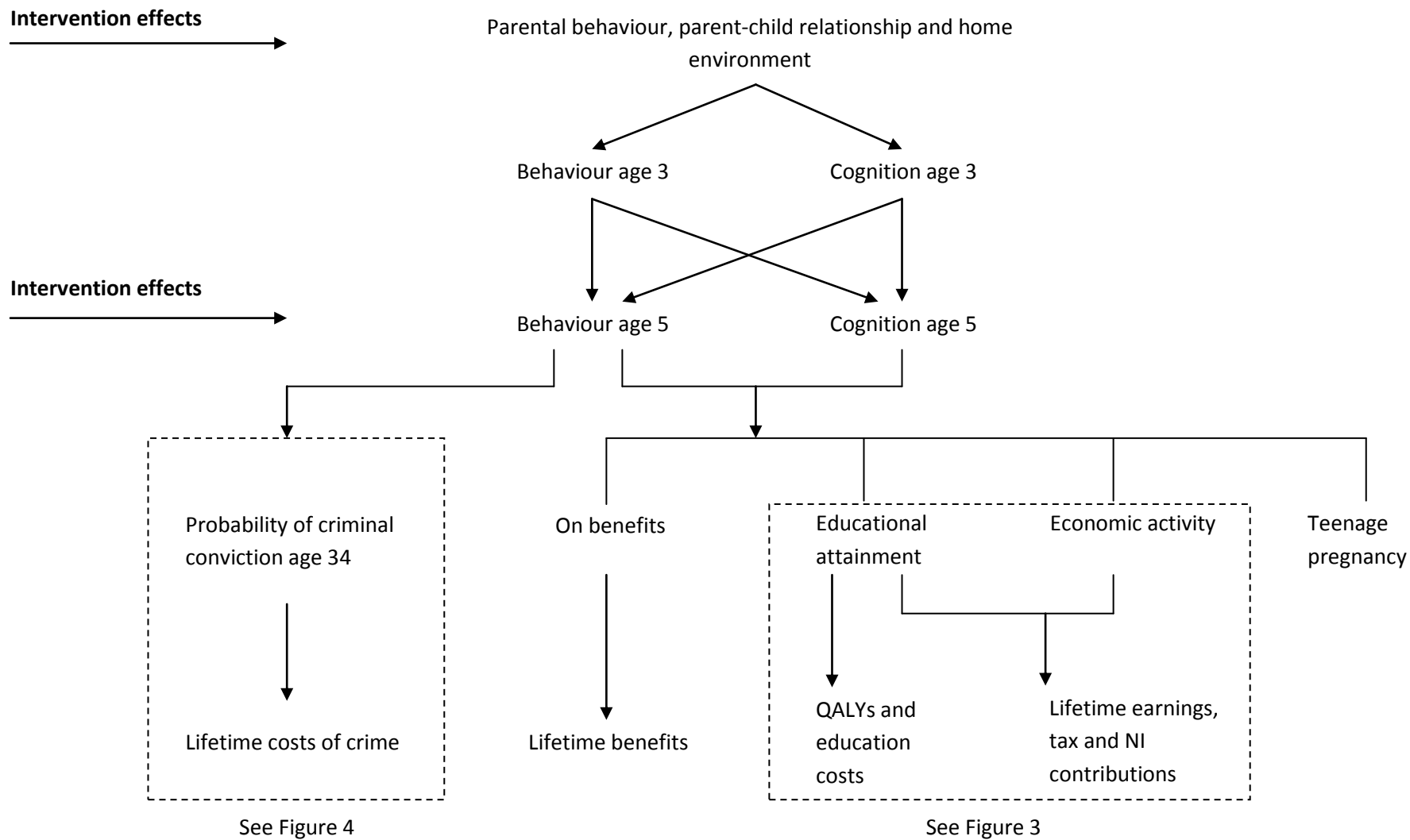
Of the UK literature reviewed<sup>1</sup> the only intervention studies reporting quantitative data on effect size (an essential requirement for including in the modelling) were Sure Start (Melhuish 2005, 2008),<sup>24;25</sup> a pre-school educational intervention delivered to a Sure Start cohort (Ford 2009),<sup>26</sup> and home visiting (Barlow 2007).<sup>8;9</sup> Scenarios using individual outcome measures from these studies were modelled, as well as composite scenarios for Sure Start. As quantitative outcomes from the UK literature was limited further scenarios were developed using outcomes from a review of intervention studies undertaken in the United States.<sup>13</sup> Details of the scenarios modelled and the estimation of the outcome effect sizes are described below.

#### **3.1 Predicting outcomes of interventions to improve the social and emotional wellbeing of infants at age 5 and in adult life**

The econometric analyse of the MCS cohort described in Part 1 of the report<sup>2</sup> yielded a set of equations that allow cognitive and behavioural outcomes of children to be estimated at age 3 and 5, dependent on a range of variables that are potentially affected by interventions, including parental behaviour and child behaviour and cognition. The analysis of the 1970 British Cohort Study (BCS70) data allows outcomes in later life (educational achievement, receipt of benefits, economic activity (males only), and teenage pregnancy (females only) to be predicted, and their economic consequences estimated. An overview of the structure of the economic model is illustrated in Figure 2.



**Figure 2 Structure of the economic model**





In order to predict adult outcomes of interventions in infants it was necessary to map variables in the Millenium Cohort Study (MCS) to those in the BCS70, as different measures were used. Details are provided in Appendix 5. Clearly additional uncertainty is introduced into the analysis from the mapping process, particularly as outcomes from the MCS are estimated at age 5 years, but measured in the BCS70 at age 7 years. The equations, shown in Appendix 2 of Part 1 of the report, were programmed in the mathematical language R.

### **Estimation of the Effect Size of the Interventions**

A systematic review of interventions promoting the social and emotional wellbeing of vulnerable pre-school children aged 0-5 was undertaken, reported elsewhere.<sup>1</sup> The review focussed on the effectiveness of specific progressive interventions: home visiting and family based interventions; and early education and child care interventions.<sup>1</sup> No meta-analysis was reported due to the heterogeneity of the interventions and populations. However, in order for long term outcomes of the interventions to be estimated the intervention effects must be quantified. The approach is outlined below, with further details reported in Appendix 6.

Quantitative data on measures of effectiveness was collated from the studies included in the literature review. Measures comprised aspects of parenting (parent-child relationship, acceptance, negative parenting), home learning environment, positive and negative child behaviour, and cognition. Although many studies did not report all outcomes quantitatively, there was a bias in favour of reporting statistically significant outcomes, so there is likely a positive bias in the analysis. Furthermore the results for the subgroup of mothers (non-teenage mothers) in the Belsky 2006 study were included, although in teenage mothers the intervention appeared to have some negative effects.<sup>1</sup> As outcome measures within outcome categories varied between studies, and also differed from the measures used in the MCS data, intervention effect sizes for the purposes of modelling were estimated in terms of

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<sup>1</sup> Statistically significant negative effects were on children's verbal ability, social competence and poor behaviour. The authors suggest the more socially deprived parents may have found the extra attention stressful.<sup>27</sup>

absolute effect size relative to the population distribution i.e. the standardised mean difference (SMD).

Table 5 shows the estimated intervention effect sizes, together with the MCS variables on which they are assumed to have an effect. Note this represents an additional mapping step and uncertainty into the analysis. Note there are no measures of positive behaviour in the BCS70, so it was not possible to estimate long term effects of changes to this parameter. Additional scenarios using effect sizes from a meta-analysis of US home visiting and combined early education and home visiting interventions on cognition and behaviour at age 5 have been added.<sup>13</sup>

Some scenarios are based on changes to individual outcome measures of the intervention studies (scenarios 1-8), two of which represent particular intervention studies (scenario 1 – McIntosh<sup>8</sup>, scenario 8 - Ford<sup>26</sup>). Scenarios 2 to 7 are all based on outcome measures of Sure Start interventions. Scenario 9 represents a Sure Start intervention to age 3, including all outcome measures. The Ford study reports a pre-school intervention given to a cohort of Sure Start children, so Scenario 10 represents a standard Sure Start intervention to age 3, together with a pre-school intervention (“Total Sure Start”).

Given the variation in the results of the Sure Start studies a scenario based on the best outcomes from Sure Start was modelled (Scenario 11). Scenario 12 adds the pre-school intervention to the previous scenario, thus representing “Best total Sure Start”.

The remaining scenarios are based on evidence from studies in the United States. Scenarios 13 to 15 use maximal values to explore the upper limits of possible effectiveness. Scenarios 16 and 17 are more representative of the US literature, based on meta-analyses of outcomes for home visiting interventions (Scenario 16) and combined home visiting and early educational interventions (Scenario 17).<sup>13</sup>

Those scenarios which represent average results (as opposed to best) from complete interventions are shown in bold in Table 5, and are sometimes referred to as “key” scenarios in the text. Some results tables include only these key scenarios

as there are limited differences in long term or financial outcomes between the many scenarios.

**Table 5 Intervention effect sizes**

Scenario Number	Scenario Descriptor	Effect size (SMD)	MCS variable affected	Age
	<b>UK data</b>			
1	<b>Parent-child relationship</b>	0.39	PPS, NPS-	3
2	Harsh discipline – a. smacking	-0.82	smack	3
3	Harsh discipline – . smacking- & shouting	-0.82	smack, shout	3
4	Composite parenting no shout	-0.29	PPS+, NPS, smacking, regbed+	3
5	Composite parenting with shout	-0.29	PPS+, NPS, smacking, shouting, regbed+	3
6	Home learning with pread	0.17	mread, paint, alph, pread	3
7	Home learning excl. pread	0.17	mread, paint, alph	3
8	<b>Cognition (Ford)</b>	0.64	3* BAS	5
9	<b>Scenario 4+6 (Mean Sure Start age 3)</b>			3
10	<b>Scenario 8+9 (Total Sure Start)</b>			3&5
11	Mehuish 2008 (Best Sure Start age 3)			
	Composite parenting no shout	-0.52	PPS+, NPS, smacking, regbed+	3
	Home learning with pread	0.17	mread, paint, alph, pread	3
12	<b>Scenario 11+8 (Best Total Sure Start)</b>			3&5
	<b>US (all from Karoly 05)</b>			
13	Max negative behaviour from US (NFP age 6)	-0.25	hyper, emot, cond, peer	5
14	Max cognition age 5 (Perry)	0.97	3* BAS	5
15	13+14			5
16	<b>US home visit</b>			
	Negative behaviour from US	-0.20	hyper, emot, cond, peer	5
	Cognition age 5	0.17	3* BAS	5
17	<b>US early education + home visit</b>			
	Negative behaviour from US	-0.09	hyper, emot, cond, peer	5
	Cognition age 5 mean	0.43	3* BAS	5

The abbreviations for the MCS variables are as follows:

- PPS/NPS                      Positive/negative Pianta scale (parent – child relationship)
- Smack/shout                parenting disciplinary behaviour
- Regbed                        Regular bedtime
- Mread/pread                mother/father reads to child
- Paint                         child paints/draws at home
- Alph                          parent helps child learn alphabet
- 3\*BAS                        Three British Ability Scales (Naming Vocabulary, Picture Similarity, Picture Construction) (cognition)

Hyper, emot, cond, peer: Negative behaviour measures from the Strength and Difficulties Questionnaire (hyperactivity, emotion symptoms, conduct problems, peer problems)

Note a plus or minus sign against a variable in Table 5 indicates that the sign of the effect size is reversed. For example in scenario 1 it is assumed the intervention has a positive effect on positive parenting (PPS) and a negative effect on negative parenting (NPS).

## **3.2 Economic analysis methods**

### **3.2.1 Estimation of model parameters**

#### **3.2.1.1 Intervention Costs**

Table 6 shows the costs of different interventions taken from the UK literature. All costs have been inflated to 2010 values using the HCHS inflation indices. Only the McIntosh study of home visiting<sup>8</sup> found a significant difference in child outcomes and was included in the modelling of the long term outcomes of interventions. Note the focus of most interventions was a particular child or the mother following the birth of a particular child, but the intervention by McAuley was for mothers with any number of pre-school children. Clearly any of the interventions, even if directed at a particular child, may influence parental behaviour with other children, and so the benefits may be greater than those measured for a single child.

**Table 6 Costs of interventions trialled in the UK (£, 2010)**

	Mujica Mota (2006)	McIntosh (2009)	Wiggins (2004)	Wiggins (2004)	McAuley (2004)
<b>Intervention</b>					
Care	Educational day care	Home visits by trained visitor	Home visit by health visitor	Community group support (voluntary/charitable sector)	Volunteer home visits
Intensity	Full or part time	Weekly	Monthly	Varied by group	Weekly at first but decreasing in intensity
Duration	18 Months	18 Months	12 Months	12 Months	12 Months
<b>Intervention costs</b>					
Public sector					
Intervention	£15,182	£186	£671	£41	£2,769
Health & social care	£1,493	£8,169	£1,859	£2,482	£3,344
<b>Total public sector costs</b>	<b>£16,675</b>	<b>£8,355</b>	<b>£2,530</b>	<b>£2,523</b>	<b>£6,113</b>
Other costs					
Individual	£3,930		£780	£866	
Voluntary community groups			£680	£580	
Volunteer time (including informal care)	£955		£68	£56	£6,805
<b>Total other costs</b>	<b>£4,884</b>	<b>£0</b>	<b>£1,528</b>	<b>£1,502</b>	<b>£6,805</b>
<b>Total public sector and other costs</b>	<b>£21,559</b>	<b>£8,355</b>	<b>£4,058</b>	<b>£4,025</b>	<b>£12,918</b>
<b>Standard care costs</b>					
Public sector					
Care (similar to intervention)	£6,827	£48			
Health & social care	£1,104	£4,498	£2,068	£2,068	£2,524
<b>Total public sector costs</b>	<b>£7,931</b>	<b>£4,546</b>	<b>£2,068</b>	<b>£2,068</b>	<b>£2,524</b>
Other costs					
Individual	£4,410		£847	£847	
Voluntary community groups			£692	£692	
Volunteer time (including informal care)	£1,103		£57	£57	
<b>Total other costs</b>	<b>£5,513</b>		<b>£1,596</b>	<b>£1,596</b>	<b>£0</b>
<b>Total public sector and other costs</b>	<b>£13,444</b>	<b>£4,546</b>	<b>£3,664</b>	<b>£3,664</b>	<b>£2,524</b>
<b>Difference (Intervention - standard care)</b>					
Public sector					
Intervention	£8,355	£138	£671	£41	£2,769
Health & social care	£388	£3,671	-£209	£414	£820
<b>Total public sector cost difference</b>	<b>£8,744</b>	<b>£3,809</b>	<b>£462</b>	<b>£455</b>	<b>£3,589</b>
Other costs					
Individual	-£480		-£67	£19	
Voluntary community groups			-£12	-£112	
Volunteer time (including informal care)	-£148		£11	-£1	£6,805
<b>Total other cost difference</b>	<b>-£628</b>		<b>-£68</b>	<b>-£94</b>	<b>£6,805</b>
<b>Total difference public sector and other costs</b>	<b>£8,116</b>	<b>£3,809</b>	<b>£394</b>	<b>£361</b>	<b>£10,394</b>

References: McAuley 2004<sup>3</sup>, McIntosh 2009<sup>8</sup>, Mujica Mota 2006<sup>6</sup>, Wiggins 2004<sup>4</sup>

Some issues need to be considered in the interpretation of these costs. Mujica Mota et al. included parental earnings in their analysis, as well as tax benefits to the public purse arising from these earnings. The estimate of earnings is somewhat unsatisfactory (See Appendix 3), and it is not clear how their total public sector and societal costs are obtained. The costs shown in the above table therefore do not include these benefits. If included, from a public sector perspective the cost differential between the intervention and control is approximately £5,000 (2010), and is cost saving by approximately £900 from a societal perspective.<sup>6</sup>

Several studies in the intervention review other than those associated with economic studies included in Table 6 reported significant increases in service use from intervention participants, compared to the control.<sup>4;25;28;29</sup> Four of the five economic studies have higher health and social service costs than their control: the exception is Wiggins' health visitor intervention where the difference is non-significant.<sup>4</sup>

The incremental public sector costs attributed to the intervention are much higher from Mujica Mota et al<sup>6</sup> than for the other interventions, but the intervention was very different, with day care places being provided to infants, whereas the others involved at most a weekly home visit. The costs of providing volunteer home visits, as reported by McAuley<sup>3</sup>, also seem high in comparison to the costs of similarly frequent home visits by paid staff reported by McIntosh.<sup>8</sup> McAuley comments that the relatively high mean costs of the intervention may be due to the small scale of many of the groups providing the intervention, leading to high administrative costs. However the author also notes that as the scheme relies on close links with the populations served economies of scale are not necessarily possible.<sup>3</sup> McIntosh did not include any administrative costs, but merely costed the time of the health visitors themselves.<sup>8</sup>

It should be noted that only two of the four studies found statistically significant differences in parental or child outcomes between the intervention and control groups (Mujica Mota<sup>6</sup> and McIntosh<sup>8</sup>), and in both these two studies they represented the minority of outcomes measured. Thus the costs of these interventions do not necessarily represent those required to provide interventions that will improve the social and emotional wellbeing of vulnerable infants.

The model of weekly to monthly home visits for a period of 12 to 18 months was common to many studies in the intervention review.<sup>1</sup> Other studies looked at the effectiveness of Sure Start programmes.<sup>24;25;27</sup> The content of Sure Start programmes is variable, and not specified in these studies. Their costs were however reported as part of the national evaluation of Sure Start, covering the first 260 programmes.<sup>30</sup> Converted to 2010 the average cost per child per year on an established scheme was £1,100, with a range from £430 to £3,020. The authors note that the costs “seem to reflect different choices about which services to offer and at what level” rather than differences in the existing level of services. Strong evidence of economies of scale was found however, with smaller schemes spending more per child than medium and large programmes. Deprived areas also spent slightly more per child, with average cost per child per year of £1,170 (estimated 95% confidence interval £1,080 – £1,272 assuming the variance in costs for the deprived areas is the same as that for all areas). Approximately half of programmes also had the free use of premises belonging to other organisations. All the studies which reported outcomes of Sure Start interventions did so at a maximum infant age of 3 years, so it may be assumed that these children have had 3 years of programme, at a total average cost per child of £3,510.<sup>24;25;27</sup>

To conclude, from the limited data available, the *annual* public sector costs of interventions for infants are as follows.

- Day care costs approximately £5,800 per year, but if the provision of flexible day care allows increased parental employment the net cost to the public sector may be reduced £3,300 (assuming average earnings). The intervention from which these costs were derived was provided for 18 months.<sup>6</sup>
- The cost estimates of home visiting vary considerably, depending on whether the visitors are paid or volunteers, the inclusion of administrative costs and the resulting additional health and social care costs. They vary from £2,500 to £10,400 per year for weekly visits. Intervention duration was usually 12-18 months. The costs reported by Wiggins for monthly visits are not considered



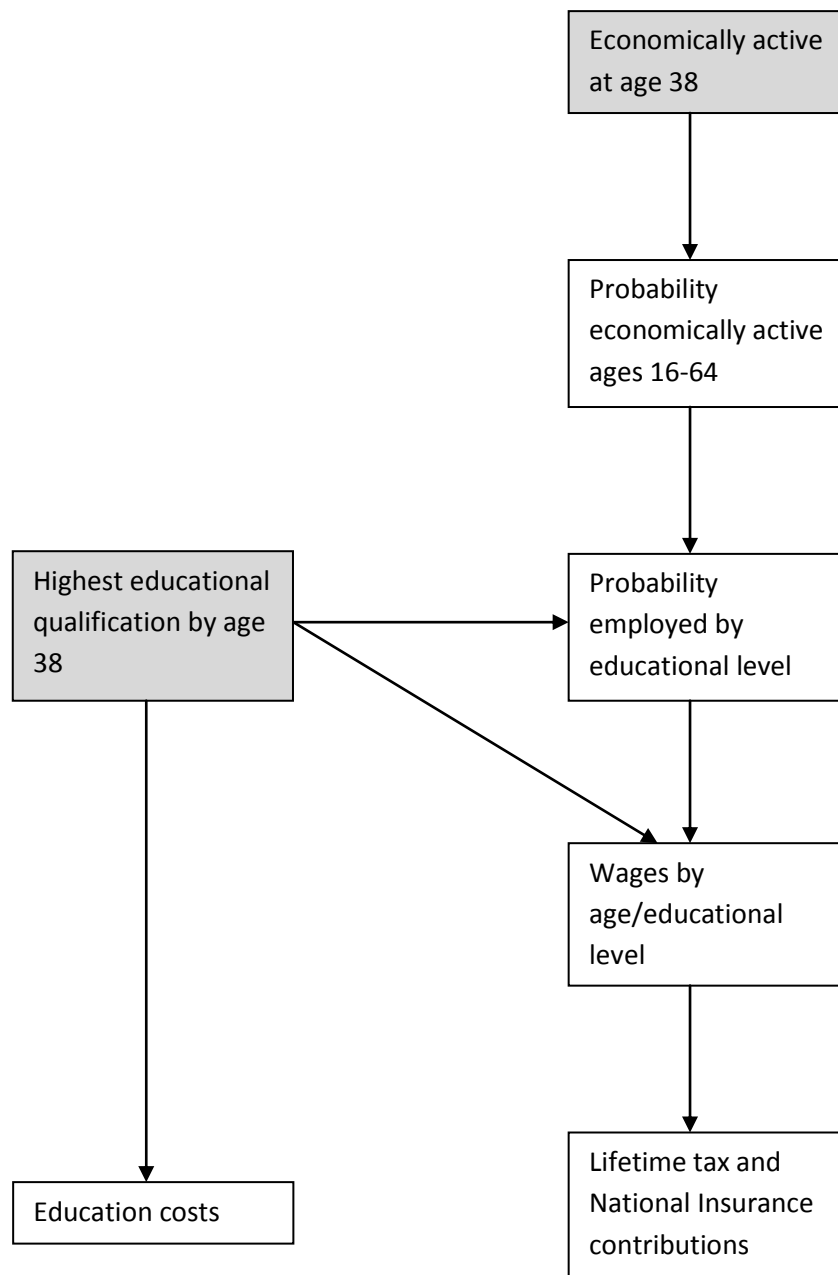
relevant, as have those for voluntary groups, as there is no evidence that these models of care are effective.<sup>4</sup>

- Established Sure Start programmes, as provided in their initial incarnation, cost an average of £1,170 per year per child in a deprived area.<sup>30</sup> Most intervention outcomes appeared to be based on children who had had three years of the programme, therefore at a total estimated cost of £3,520 (discounted £3,400). Five years of programme costs £5,850 ((discounted £5,480).

### **3.2.1.2 Estimation of lifetime earnings**

The method of estimation of lifetime earnings and consequent tax and National Insurance contributions are illustrated in Figure 3.

**Figure 3** Diagram illustrating the estimation of lifetime earnings and taxes paid from economic activity at age 38 and highest educational qualification achieved



Data on economic activity and unemployment by age and educational qualification is lacking or poor, and with educational qualifications changing over time there is a level of approximation in interpretation of the data available. The probability of being economically active for different age groups relative to age 38 was not specific to educational level<sup>31</sup>, but the age of commencement of economic activity was adjusted for those with higher educational qualifications (age 18 NVQ level 3 (A level or equivalent level), age 22 NVQ level 4/5 (degree/higher degree or equivalent)). The probability of being unemployed if economically active was adjusted for educational level, but not age. Data from 2008 showed that unemployment ranged from 12.5% for those with no qualifications to 2.5% with a degree.<sup>32</sup> The overall employment rate was 5.6%, but time series data for unemployment over the last 40 years shows that average unemployment was 7.3% (derived from ONS data<sup>33</sup>). Unemployment rates for all levels of academic achievement in 2008 were increased by 7.3% - 5.6% = 1.7% (absolute) to take into account the historically relatively low unemployment rate in 2008.

The relative effect of age and education on wages could be estimated from ONS data (2000)<sup>34</sup>, but this data gives no indication of income distribution, which is highly skewed. Income distribution for 2010/11 was obtained from HRMC, as was data on the average amount of tax paid by different income groups.<sup>35</sup> The relative income weights for age and educational attainment derived from the ONS data were applied to samples from the HRMC income distribution data. The proportion of income paid in tax by income group was found to fit a power model:

Proportion of income paid in tax =  $a \cdot (\text{tax group})^b$ ,

where “a” determines the overall percentage of income paid in tax, and “b” the relative proportions paid by different income groups. Income groups are defined in Appendix 7.

A simplified model of National Insurance contributions for both employees and employers was implemented. Rates for employees that will come into force in 2011 were used.<sup>36</sup> It was assumed all contributors are employees (as opposed to self-employed workers), payments made by employees between the lower earnings limit and the threshold for primary class 1 contributions were ignored, as was the small discrepancy (£3) in the threshold for primary class 1 contributions for employees

and employers that has been introduced from 2011. The rates and thresholds are shown in Appendix 8.

### **3.1.1.3 Benefits**

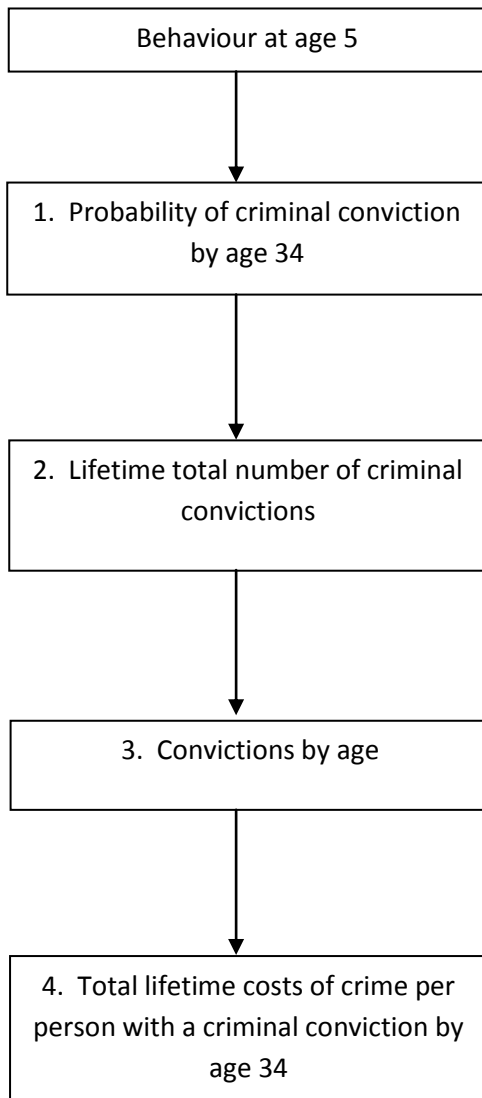
The sums paid of different benefits (including tax credits) to “non-retired” households was obtained from an Office for National Statistics publication “The effects of taxes and benefits on household income 2008/9”.<sup>37</sup> Non-retired households are defined as those where the combined income of retired persons is less than half of household income. The average number of adults and retired people per household is also shown. Average benefit per household was calculated exclusive of child benefit (as a universal benefit until very recently it was excluded from the BCS70 category “on benefits”), and also exclusive of pension payments. This total was divided by the average number of adults in a household excluding retired persons, to give an estimate of the average level of cash benefits per year for those of working age (£1319 inflated to 2010 values). Note the model predicts whether an individual will be resident in a household in receipt of benefits at age 38, and for costing purposes it is assumed that such a person will be resident in such a household all their adult life (age 16-64).

### **3.1.2.4 Estimation of the probability of having a criminal conviction by age 30-34, and the lifetime costs associated with a conviction**

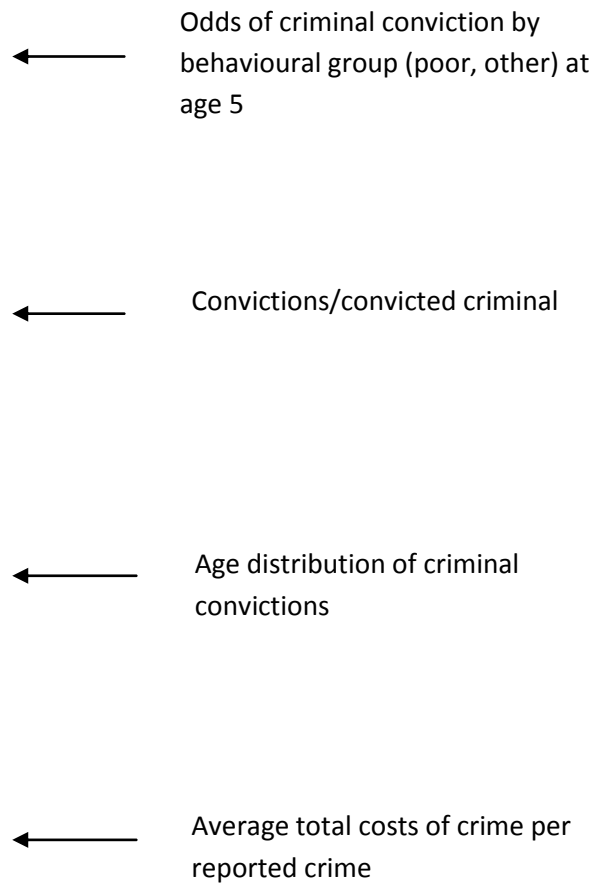
The estimation involved several steps, which are illustrated schematically in Figure 4, and described in more detail below.

**Figure 4 Estimation of Crime Costs**

**Crime model structure**



**Additional data requirements**



## 1. Estimation of the effect of social and emotional wellbeing on the probability of having a criminal conviction at age 38 years

The wave of BCS70 data (age 38) used in the econometric analysis had no information regarding criminal convictions, and crime was not included in the econometric model. However an analysis by Murray et al. using data from the waves at ages 30-34 years in the BCS70 data shows conduct problems at age 5 are associated with the probability of having a criminal conviction in early adulthood (ages 16 to 30/34 years).<sup>38</sup> Children at age 5 were dichotomised such that those with the highest 13% of conduct problem scores were compared with the rest. In the whole cohort 24% of men and 4% of women had a criminal conviction. The odds of having a criminal conviction with poor conduct at age 5 were 1.9 for men and 2.4 for women.<sup>38</sup> This data allowed the probability of a conviction to be calculated for men and women with and without poor conduct at age 5, which were 35% and 22% respectively for men and 8.0% and 3.5% for women.

In order to use this data in the economic model conduct disorder had to be similarly defined within the MCS data. The top 13.2% of scores for conduct problems at age 5 were for scores in the range 4-10, which was therefore used to define those at increased risk of committing crime in adulthood. The baseline prevalence of poor conduct was 15% in boys and 11% in girls in the overall population, but 23% and 20% respectively in the low income group.

## 2. Estimation of the age of participation in criminal activity

A report from the Home Office shows a graph of the age of convicted or cautioned offenders by age and gender for 1997.<sup>39</sup> Using the trapezium rule the area under the curve was estimated for males for the age groups used in the model, allowing the proportion of crime committed by different age groups to be estimated. This indicates that for males aged 16 or more, those aged 16-24 years commit 58% of crimes, ages 25-34 years 26%, ages 35-44 11% and aged 45 or more (implemented in the model as age 45-54 years) 5%. The conviction rates for females is much lower, so it is more difficult to accurately estimate the areas, and as the shape of the curve was similar to that for men the same distribution by age was used.

### 3. Estimation of the lifetime number of criminal convictions for those with a criminal conviction at age 38 years

Data from the Home Office shows that for the cohort of males born in 1953 the prevalence of the number of court appearances for males up to their 40<sup>th</sup> birthday.<sup>39</sup> From this data it was possible to estimate the average number of court appearances for men who had at least one appearance, which was used as an estimate of the number of convictions per convicted criminal. As the data discussed in the previous section indicates, approximately 10% of crime is committed by those aged over 40, so the original estimate was uplifted by this factor, giving the mean number of convictions per male with a criminal conviction of 4.4. The potential participation of criminals in crimes for which they were not convicted is taken into consideration in the average cost per crime, as described in the next paragraph.

### 4. The costs of crime

The incidence and costs of different types of crime are available from Home Office reports. Brand and Price looked at the incidence and costs of all types of crime in 1999.<sup>40</sup> Data on crimes against individuals and households was updated in 2003 by Dubourg et al.<sup>41</sup> Both report the actual number of recorded incidents and the estimated total number of incidents; the total costs being based on the latter. The data in the two reports allowed the average cost per crime to be calculated from both the public sector and societal perspective. Public sector perspective costs are principally comprised of criminal justice system costs (including the police service, but also include victim and health service costs). Costs to the public sector arising from crime prevention or being the victim of crime are not available separately from the commercial sector, so these costs are only included in the societal perspective. Both Brand and Dubourg<sup>40;41</sup> cost the emotional and physical impact on victims, but as this comprises a very small proportion of the total costs of crime (which are dominated by offences against the commercial and public sectors for which no emotional or physical impact on victims was assumed) they make a negligible difference to the average cost per crime, and were ignored.

The Home Office uses multipliers on the numbers of recorded crimes to estimate the effects of unrecorded crime on total costs. These multipliers vary from 1 for homicide to 100 for theft from a shop. These multipliers result in a considerable difference

between the average cost per crime and the average cost per recorded crime: from a public sector perspective the former is £44 compared to £445. As we only know about recorded crimes, and the conviction data used in the model will relate to these, the average cost per recorded crime is expected to better reflect the true cost of crime. However, the underlying assumption in using the larger figure is that all crimes are committed by individuals convicted of at least one crime, which is likely to lead to some overestimate of the costs of crime attributed to convicted criminals.

See Appendix 9 for a summary of the incidence and cost data. All costs were updated to 2010 using the Consumer Price Index.<sup>42</sup> The average cost per recorded crime to the public sector and society indexed to 2010 are £445 and £5,101 respectively. Brand and Price discuss the difficulties in the estimation of the costs of crime, and their imprecision.<sup>40</sup> Their applicability over several decades is even more uncertain.

### **3.1.2.5 Costs of Education**

Costs of education include the costs of education itself, and also potential loss of earnings for the duration of the educational course. As school is compulsory until age 16 no additional costs have been considered for qualifications normally acquired by age 16 (GCSE, or NVQ level 2).

Schools and FE colleges are funded on the basis of standard learner numbers (SLNs) for post-16 education, which are worth approximately £2,900 each.<sup>43</sup> The maximum allowance per student is 1.75 SLNs.<sup>43</sup> A student studying 4AS levels plus some tutorial time equates to 1.6 SLNs, giving a cost of £4,640.<sup>43</sup> This cost is similar to that reported as the average cost per pupil per year for secondary education in 2008/9 of £4,890.<sup>44</sup> It is assumed that students require two years to acquire NVQ level 3 (A-level) qualifications.

Resource cost estimates for the provision of undergraduate degrees vary by degree type. The Higher Education Funding Council for England (HEFCE) calculate their “standard resource” for full time students for classroom based subjects is £4,000 per year, £5,140 for subjects with some laboratory, studio or field work, £6,720 for laboratory based subjects and almost £16,000 for clinical subjects.<sup>45</sup> Additional



funds are allocated for widening participation, teaching enhancement, part-time students and London weighting, amounting to an additional 20% of their baseline teaching grant allocation. The University and College Union (UCU) claim that on average universities will have to charge around £6,800 for predominantly classroom based subjects under new funding arrangements to break even with their previous funding arrangements.<sup>46</sup> A figure of £6,000 was assumed for the annual cost of higher education. Whilst previously a high proportion of the cost was borne by the public sector, current policy is that most students should pay fees of that order. It has been arbitrarily assumed that individuals will bear 75% of the costs, and the public sector 25%.

For students studying to NVQ level 3 two years potential lost earnings for those with NVQ level 2 qualifications (age 16-24) are assumed, and a further three years lost earnings for those with NVQ level 3 qualifications is estimated for those taking a degree. Loss of earnings takes into account the proportion of the age group with those qualifications who are actually employed.

### **3.1.2.6 Teenage Pregnancy**

A recent systematic review<sup>47</sup> found that after controlling for both observable and unobservable characteristics which might predispose a young woman to teenage motherhood, all studies suggested “that teenage motherhood is associated with smaller long term negative outcomes than previous literature has suggested.” One of studies identified in the review showed that girls who had a teenage pregnancy were more likely to partner men who suffer from unemployment (assessed when the mother is age 30 years), are less likely to own a home at age 30 years and may have a small increase in receipt of Income Support. However, the study also suggests that teenage birth per se is unlikely to affect qualifications, employment, earnings and social class of the mother at age 30 years. (Ermich 2003) This analysis was also based on the BCS70 data. In the economic model that accompanied the systematic review the long term negative benefits of teenage birth were incorporated by assuming that women who have a teenage birth are more likely to receive benefits than women whose first birth is between 20 and 35 years.<sup>48</sup> In the economic model for this study the probability of being on benefits is predicted independently,

so already taken into account. Thus no economic outcomes were attached to teenage pregnancy.

### **3.1.2.7 Quality Adjusted Life Years (QALYs)**

The total number of QALYs an individual will have depends both on their longevity and their health-related quality of life expressed as preference based utility values. Both have been shown to be associated with educational attainment.<sup>49;50</sup> A previous report identified studies showing how the relative risks of death are reduced for those with higher educational achievement.<sup>49</sup> The literature search was repeated (14/12/2010) but no additional references were identified. Educational achievement is also associated with higher incomes, and for the purposes of the model was most simply accounted for through educational achievement, so estimates of relative mortality rates that had not been controlled for income were required. Four studies provided such estimates, from which a simple mean was taken, giving a relative mortality rate of 0.64 for persons with a degree compared to those with no qualifications.<sup>51-54</sup> Applied in the model (from the age of 21 years) to annual probabilities of death from ONS data<sup>55</sup> this gave a difference in lifespan of 4.5 years between those with the highest academic qualifications and those with none, which seems a reasonable estimate given that life expectancy between professionals is seven years greater than that for unskilled workers<sup>56</sup>, and academic achievement, whilst associated with social class, is not synonymous with it.

In common with previous work<sup>49</sup> it was assumed that the relationship between the reduction in relative risk of mortality was linear with increasing level of educational achievement, so for example the relative risk of mortality for an individual with GCSEs (NVQ level 2) is  $1 - (1 - 0.64) / 2 = 0.82$ . Utility values by highest educational attainment were taken from Kind et al.<sup>50</sup> Their analysis shows that on average utility (on a scale of 0 representing death, 1 perfect health) is 0.94 for those with a degree compared to 0.78 for those with no qualifications.

For ease of reference the assumptions around the economic parameters used in the model are summarised in Appendix 10, together with the parameter values.

### 3.3 Results

#### 3.3.1 Effects of interventions on adult outcomes

The modelled effects of interventions in vulnerable pre-school children on adult outcomes are shown for key scenarios in Table 7. Male and female outcomes have been averaged except for outcomes which were only estimated for males or females (economically active and teenage pregnancy), and for criminal activity where the proportions are very different. The baseline proportions for each outcome are shown and the absolute change in that proportion for each scenario.

In the interpretation of the results it must be noted that the effect sizes could only be calculated on the basis of studies that reported them, and that as authors generally did not report those which were not significant, it is highly probable that the meta-analysis of effect sizes is biased in favour of larger effect sizes than the overall literature suggests. Most of the data on effect sizes is derived from Sure Start evaluations when children were all aged three years (Meluish 2008<sup>57</sup>, Meluish 2005<sup>24</sup>, Belsky<sup>27</sup>), with one evaluation of home educational activities. when children are age five (Ford).<sup>26</sup> Additional data was derived from Barlow (home visiting effect on parent-child relationship – scenario 1).<sup>58</sup> Additionally two scenarios based on average outcomes from US studies are shown (scenarios 16 and 17). See Table 5 for effect sizes and variables influenced in key scenarios of complete sets of outcomes for each intervention.

**Table 7 Modelled effects of interventions on adult outcomes**

Scenario	Baseline	Absolute % change					
		1	8	9	10	16	17
<b>Intervention</b>			Home learning (cognition year 5)	Sure Start	Sure Start (effects scenarios 8&9)	US home visiting	US home visiting and early education
<b>Duration (years)</b>		1.5	1	3	5		
<b>Outcomes</b>							
No educational qualification	10.25%	-0.41%	-4.11%	-0.89%	-4.29%	-1.40%	-3.00%
At least GCSE or equivalent	82.32%	0.60%	6.24%	1.31%	6.53%	2.06%	4.50%
Degree or higher degree	42.57%	0.91%	10.86%	2.01%	11.45%	3.23%	7.47%
Benefits	44.02%	-0.36%	-3.59%	-0.77%	-3.88%	-1.18%	-2.53%
<i>Male outcomes</i>							
Economically active	94.80%	0.15%	0.67%	0.26%	0.82%	0.42%	0.58%
Crime	25.02%	-1.55%	0.00%	-1.55%	-1.55%	-1.55%	-1.55%
<i>Female outcomes</i>							
Teenage pregnancy	3.13%	-0.10%	-0.62%	-0.25%	-0.76%	-0.29%	-0.49%
Crime	4.38%	-0.62%	0.00%	-0.62%	-0.62%	-0.62%	-0.62%

The model shows that interventions in very young children (aged <3 years) have the potential to increase educational attainment, economic activity, reduce benefit claimants and the proportion of adults with a criminal conviction (scenarios 1 and 9). However an intervention aimed at improving cognition prior to entry to primary school (scenario 8) had a much greater effect, particularly on the highest levels on educational achievement (11% additional adults with a degree). Scenario 10 combines the intervention effects of scenarios 8 and 9 and shows slightly greater effects than scenario 8 alone. Scenario 17, based on data from US studies which included enhanced pre-school education, did not show as great effects on adult outcomes as scenarios 8 and 10 due to the lesser assumed effect on cognition at age 5 (SMD 0.43 compared to SMD 0.64 in scenarios 8 and 10).

### **3.3.2 Economic outcomes - Evidence of effect from UK trials**

#### **3.3.2.1 Incremental financial benefits of programmes for vulnerable infants**

Note all the tables of incremental financial benefit reported in this section are benefits to the public sector per child and **are exclusive of the cost of the intervention itself.**

The results of the first seven scenarios are shown in Table 8. All these scenarios relate to the parent-child relationship and parental behaviour with regard to discipline, routine (“home chaos”) and home learning environment. The variables in the MCS data that we could vary to reflect changes in these behaviours were the positive and negative Pianta scales (parent-child relationship), parental smacking and shouting (discipline), child regular bed times (home chaos), parents reading to child, painting and helping child learn alphabet). For ease of reference the scenarios are summarised:

- 1 Improved parent-child relationship
- 2 Reduced harsh discipline (applied to smacking variable only)
- 3 Reduced harsh discipline (applied to smacking and shouting variables)
- 4 Improved composite parenting measure (excluding shout variable)
- 5 Improved composite parenting measure (including shout variable)
- 6 Improved homed learning environment including paternal reading variable
- 7 Improved homed learning environment excluding paternal reading variable.

More complete information on the scenarios is shown in Table 5.

**Table 8 Incremental public sector benefits per child scenarios 1-7**

Scenario	1	2	3	4	5	6	7
<b>Incremental financial benefits</b>							
<b>MALES</b>							
Tax & NI	£991.33	£52.09	-£560.84	£1,045.58	£830.02	£1,194.40	£1,048.88
Education costs	-£33.29	-£1.67	£20.89	-£35.99	-£28.06	-£42.54	-£37.31
Benefits	£34.32	£1.74	-£21.26	£36.97	£28.90	£59.36	£54.05
Crime	£11.37	£9.45	£6.64	£11.37	£11.37	£10.57	£7.64
<b>Total</b>	<b>£1,003.73</b>	<b>£61.61</b>	<b>-£554.56</b>	<b>£1,057.93</b>	<b>£842.23</b>	<b>£1,221.79</b>	<b>£1,073.26</b>
<b>FEMALES</b>							
Tax & NI	£1,152.40	£64.86	-£566.61	£1,178.59	£956.88	£1,172.15	£1,017.77
Education costs	-£44.97	-£2.47	£23.84	-£46.73	-£37.50	-£47.20	-£40.89
Benefits	£83.10	£4.88	-£36.07	£82.91	£68.52	£73.39	£63.07
Crime	£1.38	£1.15	£0.81	£1.38	£1.38	£1.28	£0.93
<b>Total</b>	<b>£1,191.90</b>	<b>£68.41</b>	<b>-£578.03</b>	<b>£1,216.15</b>	<b>£989.28</b>	<b>£1,199.62</b>	<b>£1,040.87</b>
<b>Incremental QALYs</b>							
Males	0.0280	0.0014	-0.0177	0.0303	0.0236	0.0357	0.0314
Females	0.0357	0.0020	-0.0191	0.0371	0.0298	0.0375	0.0325

An obvious feature of these results is that, whether positive or negative, the magnitude of effect on net benefits, both financial and QALYs, is relatively small. The intervention effect sizes were all applied at age three years, the age at which the studies used to estimate effect size reported outcomes, with the exception of scenario 1 (Barlow)<sup>58</sup>, which reported outcomes at child age one year. It was originally envisaged that the scenarios would be repeated assuming that the effects on parental behaviour were maintained to age 5. However the part of the econometric model of age 5 outcomes dependent on parental and family characteristics at age 5 was poorly specified, with almost all co-efficients non-significant and many acting in apparently the “wrong” direction. (See economic report Part 1). Using this part of the model to assume the maintenance of benefits to parental behaviour acquired by the child age of three to child age 5 has some resultant negative effects, which given the lack of significance of the model co-efficients can not be justified.

All the scenarios result in reduced crime, resulting in small financial benefits to the public sector from avoided crime, due to the effect of the interventions on reducing poor behaviour. Scenarios which increase educational attainment show a negative entry on educational costs reflecting the costs of provision of post-compulsory

education, although these are more than balanced by increased tax and National Insurance revenue from higher earnings.

Scenarios two and three are similar, showing the effects of reducing harsh discipline. Harsh discipline in the effectiveness studies included scolding, spanking, and restraining. In scenario 2 it was assumed just smacking was reduced, whereas in scenario 3 both smacking and shouting were assumed to be influenced. In fact in the econometric analysis shouting had a positive influence on cognition, and negative influence on poor behaviour, so financial benefits are reduced if it is assumed that the intervention affects shouting behaviour.

Scenarios 4 and 5 are for composite parenting measures which include parent-child relationship, discipline and “home chaos”. The latter is represented in the model by “regular bed time”. Scenario 5 is the same as scenario 4, but includes shouting, thereby showing lower benefits than for scenario 4 (see discussion scenarios 2 and 3).

Scenarios 6 and 7 show the effects of interventions which encourage home learning. The difference between scenario 6 and 7 is that “father reading to child” is included in scenario 6 but not in scenario 7. None of the interventions showed any effect in paternal involvement with the child<sup>1</sup>, but if the father is already involved it is plausible that paternal reading to the child may be influenced by an intervention as well as maternal reading to the child. The slightly greater benefits realised from scenario 6 compared to scenario 7 reflect the additional benefit of paternal involvement in child reading. However the effect may be a proxy more generally for paternal involvement. Of these seven scenarios 6 and 7 show the greatest net benefit, reflecting both the positive effects of home learning activities on cognitive skills, and generally negative effect on poor behaviour.

Scenario 8 shows the effect of a Sure Start intervention primarily aimed at improving cognition at age 5, whereas scenarios 9 to 12 show the net result of Sure Start interventions (Table 9). The scenarios are summarised for ease of reference: further details are shown in Table 5.

Summary scenario details scenarios 8 to 10:

- 8 Improved cognition (age 5)
- 9 Mean of Sure Start to age 3 (scenarios 4 and 6)
- 10 Total mean Sure Start (scenarios 8 and 9) (Sure Start programme to age 3 years, followed by a home learning intervention prior to school entry at the age of 5)
- 11 Best Sure Start to age 3 (Melhuish 2008)
- 12 Total best Sure Start (scenarios 8 and 11).

Scenario 11 and 12 were added to reflect the best Sure Start results, based on those of Melhuish 2008<sup>25</sup>, as the results of the Sure Start interventions were quite heterogeneous. The scenario results are shown in Table 9.

**Table 9 Incremental public sector benefits per child scenarios 8-12**

Scenario	8	9	10	11	12
<b>Incremental financial benefits</b>					
<b>MALES</b>					
Tax & NI	£11,527.04	£2,240.17	£12,223.60	£3,090.91	£12,339.58
Education costs	-£425.99	-£78.51	-£446.83	-£107.79	-£447.35
Benefits	£431.14	£96.21	£468.68	£126.14	£462.06
Crime	£0.00	£11.37	£11.37	£11.37	£11.37
<b>Total</b>	<b>£11,532.20</b>	<b>£2,269.24</b>	<b>£12,256.82</b>	<b>£3,120.63</b>	<b>£12,365.66</b>
<b>FEMALES</b>					
Tax & NI	£11,556.74	£2,349.16	£12,324.25	£3,305.43	£12,610.58
Education costs	-£482.10	-£93.82	-£509.04	-£131.67	-£517.36
Benefits	£749.22	£156.28	£805.53	£223.76	£835.73
Crime	£0.00	£1.38	£1.38	£1.38	£1.38
<b>Total</b>	<b>£11,823.86</b>	<b>£2,413.00</b>	<b>£12,622.12</b>	<b>£3,398.89</b>	<b>£12,930.33</b>
<b>Incremental QALYs</b>					
Males	0.3433	0.0657	0.3594	0.0899	0.3601
Females	0.3656	0.0741	0.3850	0.1035	0.3909

Scenario 8, based on Ford's study of a home learning intervention prior to school entry focussed on academic and self regulation skills,<sup>26</sup> was successful in increasing cognitive scores in children at age 5, which is reflected in higher educational achievement and hence higher tax contributions from higher wages. There is also reduced dependency on benefits and reduced costs of crime. The financial benefits to the individual from higher wages, and to society through reduced costs of crime will be greater. It should also be noted that this study also found a significant effect on positive social behaviour at age 5, but as there was no variable in the BCS 70

data for positive behaviour (only negative) it was not possible to estimate if any additional long term benefits were derived from this effect.

Scenarios 9 and 11 show the effects of Sure Start interventions to age 3. Scenario 9 is based on a meta-analysis of the results of three studies; scenario 11 on the most positive. Scenarios 10 and 12 add the effect of a learning intervention on cognition at age 5, showing that financial benefits are principally derived from the latter.

### 3.3.2.2 Incremental net financial benefits and incremental cost effectiveness ratios (ICERs)

The incremental cost-effectiveness ratios for key scenarios are shown in Table 10. The assumptions regarding the intervention, and hence intervention costs are identified in the Table. Except for scenario 1 for which the costs of the specific intervention were available, the intervention costs are based on assumptions derived from the mean annual cost of provision of the Sure Start programme, and duration. Note all intervention costs have been discounted to be consistent with the estimation of financial benefits arising from the interventions, which is why the Sure Start costs for different scenarios are not simple multiples of each other.

**Table 10 Incremental benefits and ICERs for key scenarios**

Scenario	1	8	9	10
Intervention	Weekly home visits	Sure Start (year 5)	Sure Start	Total Sure Start
Intervention duration (years)	1.5	1	3	5
Financial benefits	£1,098	£11,678	£2,341	£12,439
Intervention cost	£3,809	£1,022	£3,400	£5,480
Net financial benefits	-£2,711	£10,656	-£1,059	£6,959
QALYs	0.032	0.354	0.070	0.372
Cost/QALY	£85,097	cost saving	£15,148	cost saving

In interpreting these results it should be noted that the QALYs are calculated from differences in lifespan and adult health related quality of life related to childrens' eventual educational outcomes, and therefore do not take into account potential intervention effects on child or parental wellbeing. This is particularly relevant to Scenario 1, which is based on the trial reported by Barlow et al,<sup>9</sup> with the intervention costs from the related economic study (McIntosh).<sup>8</sup> The study found an improvement in maternal-child relationship, the long term effects of which have been modelled.



However the study also reported a (statistically non-significant) difference in the proportion of children identified as being at risk of abuse. Three percent of children in the intervention arm were removed from parental care in the intervention arm (and not returned) compared to none in the control arm. To illustrate the potential effect of prevention of abuse/neglect on the net QALY gain a calculation based on the following assumptions was made.

Years abuse/ neglect prevented: 5 (assumption as McIntosh<sup>8</sup>)

Utility decrement associated with child abuse/neglect: 0.5

Incremental QALY gain from prevention of child abuse/neglect =  $0.03 \times 5 \times 0.5 = 0.075$

Thus the total QALY gain from the intervention would be 0.107, which gives an ICER of £25,300. This calculation is clearly only illustrative, but demonstrates the considerable uncertainty around the ICER estimates. Variation of the mean intervention cost to the 95% confidence intervals gives an ICER range of £26,000 to £142,000. However the costs of another home visiting programme (McAuley)<sup>10</sup> were considerably higher than those reported by McIntosh.<sup>8</sup> Use of these higher costs would obviously increase the cost per QALY even further.

In Scenario 8 the effects at age 5 are sourced from an intervention to improve cognitive skills in the months prior to school entry (Ford<sup>26</sup>). It was successful, delivering on average an SMD of +0.64 in cognition. In the economic model improved child cognitive skills yield financial benefits to the public sector in the long term through increased taxes raised from adults with higher educational qualifications, which are greater than the assumed cost of the intervention. There is also a small QALY gain derived from the greater health related quality of life of those with higher academic attainment and greater longevity.

Scenario 9 is a Sure Start intervention for infants aged 0 to 3 years. The effects were derived from a meta-analysis of Sure Start studies with reported effects on parental behaviour including discipline and encouragement of child learning. These effects were modelled to have positive effects on child cognition and negative effects on poor behaviour at age 5, which led to improved adult outcomes. The estimated cost

per QALY of £15,000 is within the £20,000 NICE threshold for new health interventions.

Scenario 10 assumes a 5 year Sure Start programme with the combined effects derived of scenarios 8 and 9. As for scenario 8 it is cost-saving.

### **3.3.3 Economic outcomes - Evidence of effect from US trials**

Given the limited data on effect sizes from UK trials some “what if” analyses were run to see if the standardised mean effect sizes derived from studies in the US at age 5 could be achieved in the UK, what are the estimated benefits? This was implemented using the same model developed for the UK analysis, but with different intervention effect sizes. There is an issue of the transferability of results, but less of one than directly using the long term results of the US studies, as the effects of child characteristics on their life course is estimated from UK data. The effect sizes however are likely to be influenced by the population characteristics of those included in the trials, and their context, where standard services may have been less than the UK. Also, many of the interventions involved several elements including group parenting which is outside the scope of this analysis. The effect sizes were taken from Karoly 2005, who reports a comprehensive review of programmes for infants, with an emphasis on those at risk, but does not claim to be a systematic review, and does not present a formal meta-analysis of effects on behaviour and cognition at age 5.<sup>13</sup> For all these reasons the results presented below should be considered as exploratory. Table 11 summarises the results. Again for ease of reference the scenarios are summarised:

- 13 Maximum effect on negative behaviour US interventions
- 14 Maximum effect on cognition US interventions
- 15 Maximum effect on negative behaviour and cognition (scenarios 13 and 14)
- 16 Typical effect on negative behaviour and cognition US home visiting interventions
- 17 Typical effect on negative behaviour and cognition US interventions with early education and home visiting.

**Table 11 Incremental public sector benefits per child scenarios 13-17**

Scenario	13	14	15	16	17
<b>Incremental financial benefits</b>					
<b>MALES</b>					
Tax & NI	£493.90	£17,349.15	£17,811.80	£3,493.75	£7,976.28
Education costs	-£8.69	-£637.26	-£645.63	-£121.32	-£290.82
Benefits	£1.82	£641.38	£651.58	£116.14	£287.26
Crime	£11.37	£0.00	£11.37	£11.37	£11.37
<b>Total</b>	<b>£498.40</b>	<b>£17,353.27</b>	<b>£17,829.12</b>	<b>£3,499.94</b>	<b>£7,984.09</b>
<b>FEMALES</b>					
Tax & NI	£874.57	£17,358.65	£18,144.84	£3,858.44	£8,212.24
Education costs	-£27.52	-£719.58	-£743.48	-£153.78	-£339.06
Benefits	£85.50	£1,147.89	£1,224.43	£272.21	£542.65
Crime	£0.00	£0.00	£0.00	£0.00	£0.00
<b>Total</b>	<b>£932.55</b>	<b>£17,786.96</b>	<b>£18,625.78</b>	<b>£3,976.87</b>	<b>£8,415.83</b>
<b>Incremental QALYs</b>					
Males	0.0077	0.5031	0.5093	0.1014	0.2381
Females	0.0219	0.5333	0.5499	0.1206	0.2608

Scenarios 13 and 14 represent maximal effect sizes on behaviour and cognition respectively. The maximal effect on negative behaviour (SMD -0.25) is considerably greater than that reported in any of the UK trials (SMD -0.05).<sup>24</sup> One reason for this may be that none of the UK studies report effect on behaviour at age 5, where there may be greater potential for effect. The maximal effect on cognition (SMD 0.97) is approximately 50% greater than that reported by Ford (SMD 0.63), and used in scenarios 10 and 12. The latter though is somewhat higher than the mean effect on cognition reported by Karoly 2005 for all interventions (SMD 0.43).<sup>13;26</sup>

Reducing poor child behaviour has a greater effect on adult outcomes for women compared to men, as the influence of poor behaviour is greater on both educational outcomes and benefit receipt for women than for men, although only the coefficient for educational outcomes for women is significant at the 95% level.

Scenario 14 shows that if cognition at age 5 can be increased by almost one standard deviation financial benefits to the public sector (exclusive of intervention costs) are around £17,500. Scenario 15 applies maximal effects to both behaviour and cognition at age 5, but as financial benefits are principally derived from improved cognition the results are only slightly higher than for scenario 14.

Whilst scenarios 13 to 15 show the outcomes based on maximal effects from the US studies, scenarios 16 and 17 use effect sizes representative of the literature, as

presented by Karoly 2005.<sup>13</sup> Scenario 16, of home visiting interventions, and 17 of combined home visiting and pre-school education, both show financial benefits to the public sector, but, as expected, are more modest. In order for these interventions to be considered cost-effective at a willingness to pay threshold of £20,000 the home visiting intervention in Scenario 16 would have to have an incremental cost of less than £1,500, and the home visiting and early education intervention (Scenario 17) an incremental cost of less than £3,200.

Note the same figure for the benefits derived from avoided crime are the same for scenarios 13 to 17, despite varying the effect size on poor behaviour at age 5. This is due to a threshold effect resulting from the modelled probability of involvement in crime being derived from a dichotomous model of high and low risk based on a threshold in the behavioural conduct variable at age 5. It should also be noted that the costs of crime shown in the tables are the costs to the public sector. Costs to society are approximately 11 times greater.

### 3.3.4 Other Outcomes

#### Positive Behaviour

Some studies reported direct effects on positive behaviour at either age 3 or age 5 years. Our model predicts the effects of changes in parental behaviour on child positive behaviour at age 3, and one study reports a direct effect at age 5. Whilst changes to negative behaviour are reflected in the adult outcomes and financial benefits, the lack of a measure of positive behaviour in the BCS 70 data prevented it being used as an explanatory variable in the long term outcomes.

#### Maternal depression

Some of the intervention studies looked at the effects of interventions on maternal postnatal depression, but there was little evidence of an effect.<sup>1</sup> No studies reported effects on chronic depression. Maternal depression is an explanatory variable in both the pre-school model and in the long term model, but no intervention effects were assumed.

One possible mechanism for the effect of postnatal depression on child outcomes is through the parent-infant relationship. In scenario 1 the effect of improving this relationship was tested. The study from which the effect size was sourced (Barlow)<sup>7</sup> however found no significant difference in maternal mental health resulting from the intervention.

#### Teenage Pregnancy

No financial outcomes were attached to teenage pregnancy as a recent report suggested they were limited to benefit receipt, which is calculated independently in the model.<sup>47</sup> Some quite large relative changes in teenage pregnancy are seen (for Sure Start scenarios 9 and 10 -8% and -24% respectively, but as the baseline rate is small these represent small absolute differences (0.2% and 0.8% respectively).

#### Health

A global health measure was predicted in the econometric model, the sum of all health problems. None of the potentially variable co-efficients were significant, and

some acted in apparently the wrong direction. The model could not therefore be used to predict changes in health resulting from the interventions.

#### **4.0 Conclusions and discussion**

##### Strengths and limitations of the analysis

In this study the effects of interventions on vulnerable infants, measured in infancy, have been used to estimate the effects on lifetime outcomes. The advantage of this approach is that long term outcomes can be estimated immediately from recent trials, rather than waiting several decades for outcomes, by which time the relevance of the outcomes to the new population of infants is questionable. Nevertheless such an analysis clearly involves many assumptions, including reliance on historical data to predict relationships between child and adult outcomes, and in attaching economic outcomes to the latter.

Effect sizes were derived from studies identified in a systematic review, but many studies did not report actual effect sizes, merely those outcomes that were significant or not. Most studies had several outcome measures, so selective reporting of statistically significant (and likely greater) effect sizes is probable. The estimated effect sizes used in the model are therefore likely to overestimate the effects from the totality of the literature.

Due to the differences in instruments used to measure similar parameters in the different intervention studies and the MCS data standardised mean difference (ratio of absolute difference between intervention and control and the population standard deviation) had to be used as a common currency of effect sizes. The implicit assumption is that the different instruments are measuring the same outcome, and that differences in standard deviation are a result of differing instruments rather than real differences in population variance between the studies and the MCS population. All the studies were in children considered at risk or vulnerable in some way, but the criteria varied. The analysis in the MCS data was restricted to children identified as being in “poor” families, and therefore similar to those in the intervention studies. Nevertheless some of the differences in population standard deviations are likely to

have arisen from differences in the populations themselves, which will affect the effect size estimates, but it is not possible to identify what these effects are.

The econometric model to predict child cognitive and behavioural outcomes at age 5 years from exogenous (primarily parental) variables at age 5 was not well specified, with almost all co-efficients non-significant and many acting in apparently the “wrong” direction. (See economic report Part 1). This may be because important factors in the prediction are not available, such as the Pianta scales of parent-child relationship (available at age 3 but not at 5), or factors outside the home. It meant that this part of the model could not be used. In fact none of the interventions reported effects on parental variables at child age 5, so this limitation did not prevent analysis of any of the results of the intervention studies. However, it was originally envisaged that the scenarios where parental variables were influenced at child age 3 years would be repeated assuming that the effects on parental behaviour were maintained to age 5. None of the studies present evidence for this, but it seems likely that parental behaviour would continue to be influenced to a certain extent once the intervention finishes. This analysis was not possible for the reason discussed above.

“Joining” the MCS and BCS70 data also involved mapping the model variables in the MCS cohort on to those used in the BCS70. For a few there were direct or near direct equivalents, but for cognition, a key variable, the mapping was done in terms of the cumulative distributions. There was no variable in the BCS70 data for positive behaviour (only negative), so it was not possible to estimate if any additional long term benefits were derived from this effect.

The BCS70 data that was used to model long term outcomes is from a cohort that was born in 1970. The relationships between child and adult outcomes are likely to differ somewhat to those for current infants. Inevitably in any longitudinal analysis there is a balance between length of follow up and potential temporal differences between the original population and current populations for whom results need to be inferred. The BCS 70 cohort was used as it reported outcomes well in to adult life (to age 38), when the life course is likely to be well established. Longer term outcomes are available from the 1958 National Child Development Study, but clearly their

experience will be even more different to those for current children. Even the BCS70 cohort reflects the experience of children born 40 years earlier.

Equally the estimated economic outcomes from predicted educational attainment, economic activity, unemployment etc are based on historical data. The financial returns to different levels of educational attainment are likely to vary over time as supply and demand for different skills change.

Economic activity was only modelled for males. There was insufficient time to develop the more complex model required to account for the generally more varied choices women make around economic activity and family commitments. The relatively small data set is likely also to limit the reliability of a more complex model. It was therefore assumed in the economic model that women's economic activity was predicted by the same equation as that for males i.e. the relationship between the explanatory variables and economic activity was the same for females as for males, but adjusted for relative female to male economic activity levels by age.

A global health measure was predicted in the econometric model, the sum of all health problems. Such measures, although heterogeneous, represent an accumulation of deficits and have been found to be associated with mortality in adults.<sup>59</sup> It may be that age 38 is too young for major differences in health problems to emerge. None of the variable co-efficients were significant, and some acted in apparently the wrong direction. The model could not therefore be used to predict changes in health resulting from the interventions. Health related quality of life was estimated in the economic model using education-related differences in mean utility.<sup>50</sup> Education-related mortality differences were also applied, allowing the effects of the interventions on quality-adjusted life years (QALYs) to be estimated. This model associates health related quality of life uniquely with educational attainment, and therefore cannot estimate any possible independent effects of interventions on child social and emotional well being and adult wellbeing other than those mediated by educational attainment.

The results are not conclusive as to the cost-effectiveness of interventions to improve the social and emotional wellbeing of vulnerable pre-school children.



Interventions which improve child cognition have the potential to be cost-saving to the public sector through improved educational outcomes, higher wages and tax revenue. However only one UK study included in the effectiveness review reported intervention effects on child cognition, and the effect size (SMD 0.64) is rather higher than the average of US studies reported by Karoly 2005 (SMD 0.43).<sup>60</sup>

Modelled long term effects of child behavioural changes yielded more modest financial benefits. Reduction in child poor behaviour improves adult educational outcomes, reduces the probability of being on benefits, being economically inactive and being involved in criminal activity, all of which yield cost savings to the public sector, but the sums are relatively small compared to the effects of improved cognition. The estimates of the effect of reduction in poor behaviour on the costs of crime are clearly subject to threshold effects. The model uses the results of an analysis which dichotomised children into poor and normal behaviour, with the odds of being involved in criminal behaviour greater for the former group. A model with poor child behaviour as a continuous variable, and other explanatory variables would be more sensitive.

The estimation of incremental QALYs is based entirely on differences in educational outcomes in adults. Not only does this ignore any potential effects of the interventions on adult wellbeing independent of those mediated by educational attainment, it does not take into account potential differences in childhood quality of life. Incorporation of such differences would reduce cost-utility ratios. No intervention studies reported direct effect sizes on measures of child well-being, other than child behaviour. Some studies reported variables which are likely to impact child well-being such as parent-child relationship, and harsh discipline, but are not in themselves measures of well-being. The econometric model developed from the MCS data allowed behavioural as well as cognitive outcomes to be estimated from parental behaviour and family characteristics. There was no variable in the MCS data for parent-child relationship at age 5, nor a similar measure in the BCS 70 data. This meant that the effect of the parent-child relationship at age 5 on adult outcomes in could not be explored. However, no studies reported effect sizes for this parameter at age 5. Changes in the parent child relationship by age 3 are modelled though to adulthood via changes in behaviour and cognition at ages 3 and 5. A

greater limitation, given that effects on positive behaviour at age 5 are shown in at least one study (Ford)<sup>26</sup>, is that, as previously noted, there was no variable in the BCS 70 data for positive behaviour (only negative), so it was not possible to estimate if any additional long term benefits were derived from this effect. Positive behaviour might be considered, of the variables available the MCS data, that most associated with social and emotional wellbeing.

## **Conclusion**

The economic analysis has shown that there is potential for interventions in vulnerable pre-school children to be cost-effective, or cost saving, even without quantifying benefits to child wellbeing, although there is considerable heterogeneity in the reported effectiveness of such interventions. The evidence for the effectiveness of interventions is weak, and the results of this economic analysis are likely to be biased in favour of interventions by limited reporting of non-statistically significant outcomes. Furthermore, financial benefits to the public sector were principally driven by improvements to childrens' cognitive skills at age 5. Interventions which were cost saving included elements specifically aimed at improving cognition in pre-school children. The model of the effect of child behaviour on adult outcomes may have shown greater effects if it had been possible to include a variable for positive behaviour as well as poor behaviour in the long term model.

## Appendix 1 Example of literature search strategy for Medline

### MEDLINE(R) and MEDLINE(R) In-Process & Other Non-Indexed Citations: Ovid. 1950 to Present

1. exp Infant/
2. Child, Preschool/
3. infant\$.ti,ab.
4. ("0" or "1" or "2" or "3" or "4") adj year\$ old\$.ti,ab.
5. ((one or two or three or four) adj year\$ old\$.ti,ab.
6. (toddler\$ or preschool\$ or pre-school\$.ti,ab.
7. (under adj (five\$ or "5")).ti,ab.
8. (baby or babies or newborn).ti,ab.
9. or/1-8
10. "Early Intervention (Education)"/
11. early intervention\$.ti,ab.
12. ((progressive or targeted) adj (intervention\$ or program\$)).ti,ab.
13. or/10-12
14. home visiting.ti,ab.
15. family based.ti,ab.
16. early education.ti,ab.
17. child care.ti,ab.
18. ((health or family) adj support).ti,ab.
19. (outreach service\$ and support).ti,ab.
20. or/14-19
21. (program\$ or intervention\$ or postnatal).ti,ab.
22. 20 and 21
23. 9 and (13 or 22)
24. vulnerable.tw.
25. sensitive.tw.
26. disadvantaged.tw.
27. at risk.tw.
28. low birth weight.tw.
29. child-parent attachment.tw.
30. ((cognitive or social or emotional\$) and poor).tw.
31. (behavio?r adj2 (poor or difficult)).tw.
32. (low income or poverty).tw.
33. (unemployed or jobless\$.tw.
34. single parent\$.tw.
35. (teen\$ adj2 parent\$.tw.
36. (substance abuse\$ and parent\$.tw.
37. or/24-36
38. 23 and 37

39. limit 38 to yr="1990 -Current"
40. limit 39 to english language
41. exp "Costs and Cost Analysis"/
42. Economics/
43. exp Economics, Hospital/
44. exp Economics, Medical/
45. Economics, Nursing/
46. exp models, economic/
47. Economics, Pharmaceutical/
48. exp "Fees and Charges"/
49. exp Budgets/
50. budget\$.tw.
51. ec.fs.
52. cost\$.ti.
53. (cost\$ adj2 (effective\$ or utilit\$ or benefit\$ or minimi\$)).ab.
54. (economic\$ or pharmaco-economic\$ or pharmaco-economic\$).ti.
55. (price\$ or pricing\$).tw.
56. (financial or finance or finances or financed).tw.
57. (fee or fees).tw.
58. (value adj2 (money or monetary)).tw.
59. quality-adjusted life years/
60. (qaly or qalys).af.
61. (quality adjusted life year or quality adjusted life years).af.
62. or/41-61
63. 40 and 62

## Appendix 2 Literature search databases and records identified

### Search limits

Date: 1990 to present  
 Language: English  
 Filter: cost-effectiveness filter  
 Country: None

Database (Host)	Records
1. MEDLINE and MEDLINE in Process & Other Non-Indexed citations (Ovid)	94
2. EMBASE (Ovid)	46
3. British Nursing Index (Ovid)	1
4. EconLit (Ovid)	9
5. PsycINFO (Ovid)	38
6. Health Management Information Consortium (Ovid)	5
7. Cochrane Library (Wiley): Cochrane Database of Systematic Reviews Cochrane Central Register of Controlled Trials NHS Health Economic Evaluation Database Health Technology Assessment Database Database of Abstracts of Review of Effects	105
8. Health Economics Evaluations Database (Wiley)	-
9. ASSIA (CSA)	9
10. Sociological Abstracts (CSA)	22
11. ERIC (CSA)	149
12. Social Services Abstracts (CSA)	27
13. British Education Index (Dialogue Datastar)	0
14. CINAHL (EBSCO)	113
15. Web of Science (Web of Knowledge): Expanded Science Citation Index Social Sciences Citation Index Conference Proceedings index	310
16. Proquest Education Journals (ProQuest)	2
17. Campbell Collaboration reviews <a href="http://www.campbellcollaboration.org/">http://www.campbellcollaboration.org/</a>	15
18. EPPI-Centre database <a href="http://eppi.ioe.ac.uk/cms/">http://eppi.ioe.ac.uk/cms/</a> Database of Promoting Health Effectiveness Reviews Database of Educational Research	- -
19. Social Care Online <a href="http://www.scie-socialcareonline.org.uk/">http://www.scie-socialcareonline.org.uk/</a>	-
Total	945

### Appendix 3 Quality appraisal checklists for UK economic evaluation studies

Author(s)	Mujica Mota, R., M., Lorgelly, P., K., Mudford, M., Toroyan, T., Oakley, A., Laing, G., Roberts, I.	
Title	Out of home day care for families living in a disadvantaged area of London: Economic evaluation alongside a RCT	
Year of Publication	2006	
Section 1: Applicability (relevance to the specific topic review question(s) and the NICE reference case).		
Criteria	Decision*	Comments
1.1 Is the study population appropriate for the topic being evaluated?	Yes	
1.2 Are the interventions appropriate for the topic being evaluated?	Yes	
1.3 Is the system in which the study was conducted sufficiently similar to the current UK context?	Yes	A randomised controlled trial conducted in the UK.
1.4 Was/were the perspective(s) clearly stated and what were they?	Yes	A societal perspective and separately a public sector perspective.
1.5 Are all direct health effects on individuals included and are all other effects included where they are material?	Partly	Health and non-health effects considered relevant to the trial design were included.
1.6 Are all future costs and outcomes discounted appropriately?	Partly	Costs and financial benefits were discounted at 6% per annum.
1.7 Is the value of health effects expressed in terms of quality adjusted life years	No	
1.8 Are costs and outcomes from other sectors fully and appropriately measured and valued	Partly	Costs incurred by society during the study period are included.
Section 2: Study limitations (the level of methodological quality)		
Criteria	Decision*	Comments
2.1 Does the model structure adequately reflect the nature of the topic under investigation?	N/A	Yes
2.2 Is the time horizon sufficiently long to reflect all important differences in costs and outcomes?	No	The study has a time horizon of 18 months following randomisation.

2.3 Are all the important and relevant outcomes included?	Partly	As completely as the time horizon and the design of the trial allows.
2.4 Are the estimates of baseline outcomes from the best available source?	Partly	The majority of outcomes from the control arm considered relevant to the trial design were measured
2.5 Are the best estimates of relative treatment effect from the best available source?	Yes	From trial on which study based
2.6 Are all important and relevant costs included?	Yes	Costs considered relevant to the trial design were included.
2.7 Are the estimates of resource use from the best available source?	Yes	Yes
2.8 Are the unit costs of resources from the best available source?	Yes	But baseline wages of participants are likely overestimated – see below
2.9 Is an appropriate incremental analysis presented or can it be calculated from the data?	Yes	
2.10 Are all important parameters whose values are uncertain subjected to appropriate sensitivity analysis?	Partly	As the evaluation is based on trial data non-parametric boot strapping was used. Assumption regarding wages tested.
2.11 Is there any potential conflict of interest?	Unclear	
<p>Overall assessment: minor limitations .potentially serious limitations/very serious limitations</p> <p>Very serious limitations, due to non-significance in differences in employment measures on which the majority of cost savings are derived, lack of baseline employment data leading to potential bias in the analysis, and the assumption that additional hours worked accrue wages at average levels despite the relatively poor area in which the intervention took place. The latter was subject to sensitivity analysis. The calculation of public sector gains to income tax and VAT are not explained, so it is not clear how these are derived. It is not possible to sum the reported benefits to achieve the reported totals.</p> <p>The economic evaluation was performed to determine the costs and cost savings obtained from an intervention designed to provide high quality out of home day care to families living in a deprived area of London. The evaluation was performed from both from a societal perspective and separately from the perspective of the public sector for the eighteen month period of the trial upon which the evaluation is based. The comparator intervention was child care that was arranged independently by families. The evaluation determined the costs and cost-savings and determined an</p>		

incremental cost-effectiveness ratio for the intervention and presents cost-effectiveness acceptability curves for various univariate sensitivity scenarios from the public sector perspective. The primary outcome was the proportion of mothers in paid employment or education or paid employment eighteen months following randomisation. The cost and cost savings considered relevant include the costs of child care, health service use by the mother and child and an increase in hours in education and or paid employment by the mother and an increased in the hours of paid employment by her partner.

The hours worked by the mother and her partner are measured using questionnaires at nine and eighteen months following randomisation but not at randomisation. The increase in household income and thus the increase in tax revenue are determined using typical hourly earnings for full time employees in London adjusted of gender and level of occupation. Indeed the results show that the difference between costs for the intervention arm and costs for the control is not statistically significant at the 95% level from either the societal perspective or the public sector perspective.

The authors state that the results are highly dependent on the inclusion of the partners' income and the use of the average wage rather than the national minimum wage. The results may also be dependent on any differences that may have existed between families allocated to the intervention arm and families allocated to the control arm in terms of hours worked at randomisation. This was not measured and thus it is unclear as to whether randomisation eliminated any possible bias for this characteristic of the study population.

The study answered the question addressed, however, significant levels of uncertainty exist around the results and suggest that results of this study should be viewed with caution.

Other Comments.

Note

\* The decision can be made between the following choice: Yes/partly/no/unclear/not appropriate.



Author(s)	McIntosh, E., Barlow, J., Davis, H., Stewart-Brown, S.	
Title	Economic evaluation of an intensive home visiting programme for vulnerable families: A cost effectiveness analysis of a public health intervention.	
Year of Publication	2009	
Section 1: Applicability (relevance to the specific topic review question(s) and the NICE reference case).		
Criteria	Decision*	Comments
1.1 Is the study population appropriate for the topic being evaluated?	Yes	
1.2 Are the interventions appropriate for the topic being evaluated?	Yes	
1.3 Is the system in which the study was conducted sufficiently similar to the current UK context?	Yes	A randomised control trial conducted in the UK.
1.4 Was/were the perspective(s) clearly stated and what were they?	Yes	A societal perspective and separately a health service perspective.
1.5 Are all direct health effects on individuals included and are all other effects included where they are material?	Yes	Health and non-health effects considered relevant to the trial design were included..
1.6 Are all future costs and outcomes discounted appropriately?	Yes	Costs and benefits were discounted at 3.5% per annum
1.7 Is the value of health effects expressed in terms of quality adjusted life years	No	
1.8 Are costs and outcomes from other sectors fully and appropriately measured and valued	Partly	Costs incurred by society during the study period are included.
Section 2: Study limitations (the level of methodological quality)		
Criteria	Decision*	Comments
2.1 Does the model structure adequately reflect the nature of the topic under investigation?	Yes	Evaluation mainly based on trial, but some modelling.
2.2 Is the time horizon sufficiently long to reflect all important differences in costs and outcomes?	No	The study has a time horizon of 18 months following randomisation.

2.3 Are all the important and relevant outcomes included?	Partly	As completely as the time horizon and the design of the trial allows.
2.4 Are the estimates of baseline outcomes from the best available source?	Yes	From trial. Note outcome selected from several on basis of statistical significance.
2.5 Are the best estimates of relative treatment effect from the best available source?	Yes	From trial
2.6 Are all important and relevant costs included?	Yes	
2.7 Are the estimates of resource use from the best available source?	Yes	
2.8 Are the unit costs of resources from the best available source?	Yes	
2.9 Is an appropriate incremental analysis presented or can it be calculated from the data?	Yes	
2.10 Are all important parameters whose values are uncertain subjected to appropriate sensitivity analysis?	Partly	As the evaluation is based on trial data non-parametric boot strapping was used
2.11 Is there any potential conflict of interest?	Unclear	
<p>Overall assessment: minor limitations .potentially serious limitations/very serious limitations</p> <p>Minor limitations The analysis is in itself of good quality, but the fact that the outcome measure used was selected on the basis of statistical significance from several others leads to the possibility that statistical significance was achieved by chance.</p>		
<p>Other comments: This economic analysis is based on the intervention study reported by Barlow et al</p>		

Note

\* The decision can be made between the following choice: Yes/partly/no/unclear/not appropriate.

Author(s)	Wiggins,M., Oakley,A., Roberts.I., Rajan,L., Austerberry,H., Mujica,R., Mugford,M.	
Title	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.	
Year of Publication	2004	
Section 1: Applicability (relevance to the specific topic review question(s) and the NICE reference case).		
Criteria	Decision*	Comments
1.1 Is the study population appropriate for the topic being evaluated?	Yes	
1.2 Are the interventions appropriate for the topic being evaluated?	Yes	
1.3 Is the system in which the study was conducted sufficiently similar to the current UK context?	Yes	Randomised controlled trial conducted in the UK.
1.4 Was/were the perspective(s) clearly stated and what were they?	Yes	The perspectives assessed include the providers of the services used by mothers and the perspective of the mothers themselves
1.5 Are all direct health effects on individuals included and are all other effects included where they are material?	Yes	Health effects considered relevant to the trial design were included.
1.6 Are all future costs and outcomes discounted appropriately?	Yes	Costs were discounted at either 6% per annum.
1.7 Is the value of health effects expressed in terms of quality adjusted life years	No	
1.8 Are costs and outcomes from other sectors fully and appropriately measured and valued	Partly	Costs incurred by services included in each perspective during the study period are included.
Section 2: Study limitations (the level of methodological quality)		
Criteria	Decision*	Comments
2.1 Does the model structure adequately reflect the nature of the topic under investigation?	N/A	No modelling element in the study.
2.2 Is the time horizon sufficiently long to reflect all important differences in costs and outcomes?	No	The study has time horizons of 12 months and 18 following

		randomisation.
2.3 Are all the important and relevant outcomes included?	Partly	As completely as the time horizon and the design of the trial allows.
2.4 Are the estimates of baseline outcomes from the best available source?	Yes	Outcomes considered to be appropriate to the trial design were measured.
2.5 Are the best estimates of relative treatment effect from the best available source?	Yes	Efficacy of each programme and the effects of the control intervention are reported for all outcome measures
2.6 Are all important and relevant costs included?	Yes	
2.7 Are the estimates of resource use from the best available source?	Yes	
2.8 Are the unit costs of resources from the best available source?	Yes	
2.9 Is an appropriate incremental analysis presented or can it be calculated from the data?	No	
2.10 Are all important parameters whose values are uncertain subjected to appropriate sensitivity analysis?	Partly	The discount rate and the valuation of volunteer time were the subject of univariate sensitivity analysis. Non-parametric bootstrapping was used to obtain confidence intervals around the mean results
2.11 Is there any potential conflict of interest?	No	
<p>Overall assessment: minor limitations .potentially serious limitations/very serious limitations  Minor limitations</p> <p>The publication is a Health Technology Assessment (HTA) reporting the outcomes of the Social Support and Family Health randomised controlled trial and performing an economic evaluation of the trial results. The trial evaluated the costs and the effectiveness of two programmes the supportive health visitor programme and the community group support programme, both programmes being evaluated against a</p>		

standard care control group. The primary outcomes that are measured are the rate of child injury, maternal; smoking and maternal psychological wellbeing measured using the Edinburgh postnatal depression score, all outcomes being measured at 12 and 18 months. The authors' acknowledge that a limitation is that resource use was measured at two distinct time points and not throughout the eighteen month period. Other studies report that resource use is greater in the initial period of support and this feature may have been missed by carrying out the first follow up at 12 months post randomisation. The authors' also acknowledge that although their initial intention had been to carry out an incremental cost-effectiveness analysis the lack of any clear difference between primary outcomes in the control population and primary outcomes in either of the intervention programmes meant that this was not achievable and thus they limited their economic analysis to the determination of the incremental cost between either programme group and the control group.

The publication answers the question addressed finding that there is no significant difference between the effects of the programme compared to standard care and limited differences between costs of the programmes compared to standard care.

Other comments:

Note

\* The decision can be made between the following choice: Yes/partly/no/unclear/not appropriate

Author(s)	McAuley,C., Knapp,M., Beecham,J., McCurry,N., Slead,M.	
Title	Young families under stress: Outcomes and costs of Home-Start support	
Year of Publication	2004	
Section 1: Applicability (relevance to the specific topic review question(s) and the NICE reference case).		
Criteria	Decision*	Comments
1.1 Is the study population appropriate for the topic being evaluated?	Yes	
1.2 Are the interventions appropriate for the topic being evaluated?	Yes	
1.3 Is the system in which the study was conducted sufficiently similar to the current UK context?	Yes	Case controlled trial in the UK.
1.4 Was/were the perspective(s) clearly stated and what were they?	No	An explicit statement is not made. Public sector and societal results reported.
1.5 Are all direct health effects on individuals included and are all other effects included where they are material?	Partly	Health effects considered relevant to the trial design were included.
1.6 Are all future costs and outcomes discounted appropriately?	N/A	All costs and outcomes fall within a twelve month period.
1.7 Is the value of health effects expressed in terms of quality adjusted life years	No	
1.8 Are costs and outcomes from other sectors fully and appropriately measured and valued	Yes	Relevant costs incurred during the study period
Section 2: Study limitations (the level of methodological quality)		
Criteria	Decision*	Comments
2.1 Does the model structure adequately reflect the nature of the topic under investigation?	N/A	No modelling
2.2 Is the time horizon sufficiently long to reflect all important differences in costs and outcomes?	No	The trial assesses the effects of a 12 month programme at the start and the end of a 12 month period.
2.3 Are all the important and relevant outcomes included?	Partly	All outcomes appropriate to the trial design are included.

2.4 Are the estimates of baseline outcomes from the best available source?	Yes	From trial
2.5 Are the best estimates of relative treatment effect from the best available source?	Yes	From trial
2.6 Are all important and relevant costs included?	Yes	
2.7 Are the estimates of resource use from the best available source?	Yes	
2.8 Are the unit costs of resources from the best available source?	Yes	
2.9 Is an appropriate incremental analysis presented or can it be calculated from the data?	Partly	See overall assessment for comments.
2.10 Are all important parameters whose values are uncertain subjected to appropriate sensitivity analysis?	No	Scenario analysis is conducted on the cost of the volunteers who deliver the programme.
2.11 Is there any potential conflict of interest?	Unclear	
<p>Overall assessment: minor limitations .potentially serious limitations/very serious limitations</p> <p>Potentially serious limitations – trial not randomised so susceptible to bias</p> <p>The study aims to determine whether the home start support programme has any effect on the outcomes and costs of supporting families with children in which either the mother or the family unit as a whole are experiencing stress. The outcomes of interest are maternal mental health, maternal physical health, maternal isolation or loneliness, family stresses associated with multiple births or multiple young children and family stresses associated with children having special needs. The outcomes were measured as soon as possible after identification of the families receiving either the home start support programme or the standard care, control, programme and again between ten and twelve months later. Thus the resource is based on two discrete points in time and not measured across the trial. No differences in effectiveness were found so no incremental cost-benefit ratio could be calculated.</p> <p>An additional concern is that the study is not a randomised controlled study rather two groups of families who had already been allocated to either the home start support programme or the standard care, control, programme. The authors' state that all families met the criteria for allocation to the home start support programme and that families allocated to the standard care, control, programme came from areas that did not have a home start support programme in place. However, this raises concerns that there may have been baseline differences between the two populations.</p> <p>The publication answers the question addressed finding that there is no significant</p>		

difference between the effects of the programme compared to standard care.

Other comments:

Note

\* The decision can be made between the following choice: Yes/partly/no/unclear/not appropriate



## **Appendix 4 List of references meeting inclusion criteria for review of international evidence on the cost-effectiveness of programmes to improve the cognitive, social and emotional wellbeing of vulnerable infants**

### **Primary analyses of individual trials**

Barnett, W. S. Comparative Benefit--Cost Analysis of the Abecedarian Program and Its Policy Implications. *Economics of Education Review* 2007; **26** 113-125.

Heckman, James J. The Rate of Return to the HighScope Perry Preschool Program. *Journal of Public Economics* 2010; **94** 114-128.

Masse, Leonard N. and Barnett, W. Steven A Benefit Cost Analysis of the Abecedarian Early Childhood Intervention. 2002

Milagros, Nores, Clive, R. Belfield, Barnett, W. Steven, and Lawrence, Schweinhart Updating the Economic Impacts of the High/Scope Perry Preschool Program. *Educational Evaluation and Policy Analysis* 2005; **27** 245-

Reynolds, Arthur J., Temple, Judy A., Robertson, Dylan L., and Mann, Emily A. Age 21 Cost-Benefit Analysis of the Title I Chicago Child-Parent Centers. Discussion Paper. 2002

Schweinhart, Lawrence J. Benefits, Costs, and Explanation of the High/Scope Perry Preschool Program. 2003;

### **Primary economic analysis of meta-analyses of intervention effects**

Aos, S, Lieb R, Mayfield J, Miller M, Pennucci A. Benefits and costs of prevention and early intervention programmes for youth. Olympia, WA, USA: Washington State Institute for Public Policy. 2004.

### **Systematic Reviews**

Penn, H, Burton, V, Lloyd, E, Mugford, M, Potter, S., and Sayeed, Z What is Known about the Long-term Economic Impact of Centre-based Early Childhood Interventions? 2006

London Economics. Cost Benefit Analysis of Interventions with Parents. London Department for children, schools and families. Research report DCSF-RW008 (2008)

### **Other Reviews**

Karoly, LA., Kilburn, M. R, and Cannon, JS. Early Childhood Interventions: Proven Results, Future Promise. *RAND Corporation* 2005

Karoly, Lynn A., Kilburn, M. Rebecca, Bigelow, James H., Caulkins, Jonathan P., and Cannon, Jill S. Assessing Costs and Benefits of Early Childhood Intervention Programs: Overview and Application to the Starting Early Starting Smart Program. 2001

## Appendix 5 Mapping of MCS variables to those in the BCS70

Variable	Millennium cohort variable	British Cohort Study 1970 Variable
Mother malaise/ psychological distress	Kessler Psychological Distress Scale (K6) Scale, with 6 questions. The score goes from min of 0 to max of 24; a score of 12 and above is considered as 'high risk', so that was the cut-off point used to generate a 0/1 dummy as in BCS.	Malaise inventory, coded as 0/1 dummy, coded 1 if score 7 or more on malaise
Mother reads to child	Same variable as in MCS as BCS70. BCS70 had very low frequency of the value "1" (less than 1/week). "1" was coded to 0 (not at all) in both data sets.	
Mother's education	Mother's education: this is a dummy variable, taking value 1 if the mother has an NVQ level 4 or above; 0 otherwise. Oversees education is coded as 0.	Mother's education: Dummy = 1 if degree + or certificate of education (teaching qualification),
TV watching	Same variable as in MCS as BCS70	

Variable	Millennium cohort variable	British Cohort Study 1970 Variable
Child Behavioural measures	Strengths and difficulties questionnaire (SDQ) 5 sub-scales each scored from 10: conduct problems, emotional symptoms, hyperactivity, peer problems, prosocial	Rutter scale –score range 0-38 (BCS70 userguide age 5)
	Goodman 1997 <sup>61</sup> - high correlation (overall 0.88 on 3 equivalent scales) between SDQ and Rutter scores on 3 similar scales (conduct problems, emotional symptoms, hyperactivity). There is no equivalent of peer problems and prosocial scale in Rutter. Scaled MCS behavioural problem score (sum conduct problems, emotional symptoms, hyperactivity) *38/30.	
Cognitive measures	<p>There are 3 British Ability Scale (BAS) tests:</p> <p>Picture similarities – non-verbal reasoning</p> <p>Naming vocabulary – expressive language</p> <p>Pattern construction - non-verbal reasoning and spatial visualization</p> <p>All normalized scores (mean 5, SD 1). A combination cognitive score was calculated as the sum of scores, with normal distribution mean 15, SD <math>\sqrt{3}</math></p>	<p>EVPT (English picture vocabulary test) score -similar to the BAS naming vocabulary test, but whereas the BAS asks the child to name what's in a picture the EVPT asks the child to choose a picture to match a word.</p> <p>Also CDT (Copying Design Test) (the child copies a picture) which measures visual-motor co-ordination.</p> <p>Neither of the scales have desirable statistical distributions: for the EVPT 16% of children achieved maximum score, the CDT is almost uniform.</p>
	<p>The cumulative percentile distribution was calculated for each EVPT and CDT score in the BCS70 data. The equivalent cut point was then calculated for the BAS combination distribution (normal, mean 15, SD <math>\sqrt{3}</math>). When these were plotted against each other they gave a linear trend. Linear regression yielded the equation which was used to estimate EVPT and CDT scores from the BAS combination score:</p> <p>EVPT = -12.9 + 1.1212* BAS score</p> <p>CDT = 76.202 + 7.7181 * BAS score</p>	

## Appendix 6 Estimation of Intervention Effects

The table shows, for each outcome domain the constituent measures from the different studies, and the estimated overall effect size. Intervention effect size was estimated as the ratio of the mean difference (intervention-control) divided by the standard deviation (SD) of the combined population, known as the standardised mean difference (SMD). The Hedge's g formulation was used which adjusts for small sample biases. Note the results from Belsky 2006 for non-teenage mothers have been included. The intervention had a no or negative effect on teenage mothers, so the values in the table are more favourable than the overall study results suggest.

Some studies reported behavioural outcomes at age 3, as well as changes to parental behaviour variables. The econometric model predicts changes to child behavioural and cognitive outcomes dependent on these variables, so the behavioural outcomes at age 3 were not included as it would mean double counting of benefits. At age 5 all reported effect sizes were on behavioural and cognitive measures, rather than parental variables, so these direct effects on child ability were used. Ford reported several measures of cognition: the average SMD for all cognitive tests was used. (0.64 at age 5)<sup>26</sup>

## Effect sizes from UK trials

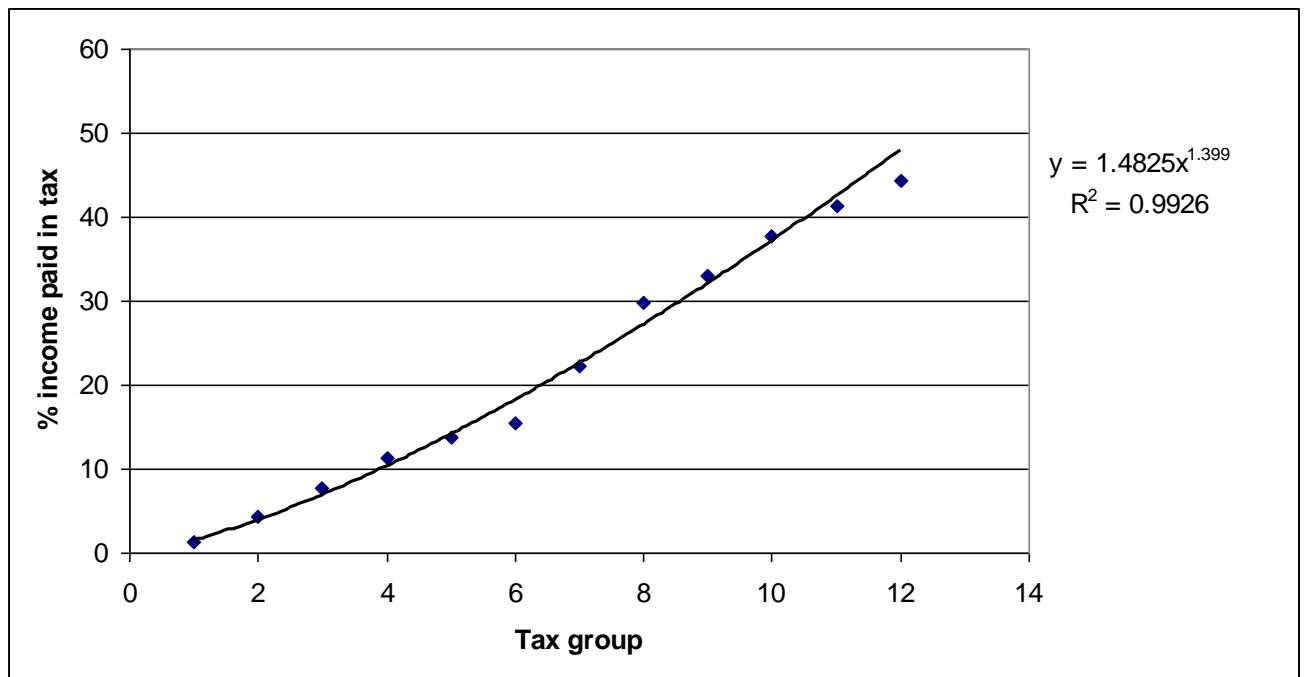
Domain/ Study	Measure	Measure description	Effect size (Intervention- control)/SD	SE	mean (weighted by 1/variance)	Comment
<b>Parenting / Parent-child relationship</b>						
<b>- Parent-child relationship</b>						
McIntosh/	maternal sensitivity		0.356	0.183	0.386	
Barlow 2007	infant co- operativeness		0.416	0.184		
<b>- Smack/ shout</b>						
Meluish 2005	Acceptance	Avoidance of scolding, spanking, restraining	2.186	0.046		
Belsky 2006	Acceptance	avoidance of scolding, spanking, restraining	0.067	0.034	0.816	
<b>- Parenting risk/ negative parenting</b>						
Meluish 2005	Negative parenting	Composite parent child conflict/closeness, harsh discipline, household chaos	-0.082	0.039	-0.287	
Meluish 2008b	Parenting risk	As above	-0.520	0.027		
Belsky 2006	Negative parenting- NON TEEN MUMS ONLY	Composite parent child conflict/closeness, harsh discipline, household chaos	-0.032	0.036		
Shute 2005	HOME score	Similar to parenting risk index/home learning. High score indicates better environment.	0.052	0.070		Measure of both parenting and home learning, non-significant result. Not included - would reduce effect size if included in either.
<b>Home Learning</b>						
Meluish 2008b	Home learning environment	Taken to library, helped to learn or play with alphabet, helped to learn or play with numbers, child read to, taught songs and rhymes, child paints and draws	0.167	0.027		

## Appendix 7 Income bands and tax paid

Data from HRMC<sup>35</sup>

Range of total income (lower limit)	Tax group number	% income paid in tax	Estimated % income paid in tax
£0	0		
£6,475	1	1.3	1.5
£7,500	2	4.3	3.9
£10,000	3	7.7	6.9
£15,000	4	11.3	10.3
£20,000	5	13.7	14.1
£30,000	6	15.4	18.2
£50,000	7	22.3	22.6
£100,000	8	29.8	27.2
£150,000	9	33.1	32.1
£200,000	10	37.8	37.2
£500,000	11	41.4	42.5
£1,000,000	12	44.4	47.9

“Estimated % income paid in tax” are the baseline average values used for each income band in the model, calculated using the formula shown in the graph below. Also shown are the original data and fitted curve.



## Appendix 8 National Insurance rates and thresholds

The table below is an extract of a larger table from HRMC.<sup>36</sup> It shows the thresholds and rates paid by employees and employers. The values used (2011/12) are highlighted. A simplified model was used. It was assumed all wage earners are employees, and pay the primary class 1 rate (12%) between the primary threshold (£139) and upper earnings limit (£817). Higher earning employees pay 2% on weekly earnings above £817. Contributions by those on low wages (between the lower earnings limit and the primary threshold) have been ignored. It is assumed employers pay 13.8% on employee earnings above the primary threshold (in fact they pay on earnings above the secondary threshold, which is £3 in 2011/12).

<b>National Insurance Contributions</b>			
National Insurance contributions - rates and allowances			
<b>£ per week</b>	<b>2009-10</b>	<b>2010-11</b>	<b>2011-12</b>
<b>Lower earnings limit, primary Class 1</b>	£95	£97	£102
<b>Upper earnings limit, primary Class 1</b>	£844	£844	£817
<b>Upper accrual point</b>	£770	£770	£770
<b>Primary threshold</b>	£110	£110	£139
<b>Secondary threshold</b>	£110	£110	£136
<b>Employees' primary Class 1 rate between primary threshold and upper earnings limit</b>	11%	11%	12%
<b>Employees' primary Class 1 rate above upper earnings limit</b>	1%	1%	2%
<b>Employers' secondary Class 1 rate above secondary threshold</b>	12.80%	12.80%	13.80%

## Appendix 9 The incidence and costs of crime

Data derived from Brand and Price<sup>40</sup> and Dubourg<sup>41</sup>

			Societal (excluding victim impact)			Societal (excluding victim impact)		
			Total Public sector	Total societal	Total societal	Total Public sector	Total societal	Total societal
<b>Crimes against commercial and public sector</b>								
			Cost (1999)			Cost 2010		
<b>Type of crime</b>	<b>Recorded no. incidents (1000's) (1999/2000)</b>	<b>Estimated no. incidents (1000's) (1999/2000)</b>	<b>£ Millions</b>	<b>£ Billions</b>	<b>£ Billions</b>	<b>£ Millions</b>	<b>£ Billions</b>	<b>£ Billions</b>
Burglary not in a dwelling	464	960	470	2.6	2.6	583.04	3.23	3.23
Theft from a shop	292	29,000	620	3.1	3.1	769.12	3.85	3.85
Theft of commercial vehicle	0	40	2	0.3	0.3	2.48	0.37	0.37
Theft from commercial vehicle	0	60	2	0	0.0	2.48	0.00	0.00
Robbery/theft by employees/others)	29	1,740	103	0.36	0.4	127.77	0.45	0.50
Criminal damage against commercial/public sector	473	3,000	180	2.6	2.6	223.29	3.23	3.23
Fraud and forgery	335	9,200	600	13.8	13.8	744.31	17.12	17.12
<b>Sub-total</b>	<b>1593</b>	<b>44,000</b>	<b>1977</b>	<b>22.76</b>	<b>22.76</b>	<b>2452.51</b>	<b>28.23</b>	<b>28.28</b>
<b>Offences against individuals and households 2003/04</b>								
			Cost 2003			Cost 2010		
<b>Type of crime</b>	<b>Recorded no. incidents (1000's) (2003/2004)</b>	<b>Estimated no. incidents (1000's) (2003/2004)</b>	<b>£ Millions</b>	<b>£ Millions</b>	<b>£ Millions</b>	<b>£ Millions</b>	<b>£ Millions</b>	<b>£ Millions</b>
Homicide	1	1	0.15	0.00	1.46	0.17	0.00	1.73
Serious wounding	42	76	1.19	0.09	1.63	1.41	0.11	1.93
Other wounding	670	1,199	2.80	1.40	9.66	3.31	1.66	11.44
Sexual offences	52	269	1.14	0.31	8.46	1.35	0.37	10.01
Common assault	242	1,851	0.71	8.21	2.67	0.84	9.73	3.16
Robbery	91	335	1.04	0.09	2.44	1.23	0.11	2.89
Burglary in a dwelling	402	880	1.01	1.00	2.88	1.20	1.18	3.41
Other theft	1043	3,157	0.95	1.37	2.00	1.13	1.62	2.37
Theft of vehicle	198	230	0.05	0.05	0.95	0.05	0.06	1.13
Theft from vehicle	450	1,249	0.06	3.92	1.07	0.08	4.64	1.27
Attempted vehicle theft	152	332	0.02	0.18	0.17	0.03	0.21	0.20
Criminal damage	603	2,589	0.33	0.65	2.24	0.39	0.77	2.65
<b>Sub-total</b>	<b>3946</b>	<b>12,168</b>	<b>9.46</b>	<b>17.27</b>	<b>35.62</b>	<b>11.20</b>	<b>20.45</b>	<b>42.18</b>
<b>Total</b>	<b>5539</b>	<b>56,168</b>				<b>£ Millions</b>	<b>£ Billions</b>	<b>£ Billions</b>
						2463.70	28.25	28.33
<b>Cost/reported crime (£)</b>						<b>£</b>	<b>£</b>	<b>£</b>
<b>Cost/crime (£)</b>						<b>£445</b>	<b>£5,101</b>	<b>£5,114</b>
						<b>£44</b>	<b>£503</b>	<b>£504</b>



## Appendix 10 Summary of economic model parameters and assumptions

Data type	Data Item	Value	Source	Reference number
Ratio wages relative to wages age 55-64	16-24	0.531	ONS	29
	25-34	1.063	ONS	29
	35-44	1.156	ONS	29
	45-54	1.125	ONS	29
	55-59/64	1.000	ONS	29
Ratio wages relative to those with A-levels	Degree or equivalent	1.625	ONS	29
	GCE A level or equivalent	1.000	ONS	29
	GCSE grades A*-C or equivalent	0.750	ONS	29
	Other (including GCSE below grade C)	0.813	ONS	29
	No qualifications	0.625	ONS	29
Tax	factor determining overall % tax	1.483	Derived from HRMC data	30
	factor determining ratio between income groups	1.399	Derived from HRMC data	30
NI	lower threshold	7228	HRMC	31
	upper primary rate threshold	42484	HRMC	31
	primary rate	0.12	HRMC	31
	upper rate	0.02	HRMC	31
	Difference between employer rate and employee	0.018	HRMC	31
Economic activity relative to males age 38	Males age 16-34	1.011	ONS	26
	Males age 35-49	1.000	ONS	26
	Males age 50-64	0.798	ONS	26
	Females age 16-34	0.805	ONS	26
	Females age 35-49	0.845	ONS	26
	Females age 50-64	0.600	ONS	26
Years in education age 16-24	Degree or equivalent	6	Author assumption	
	GCE A level or equivalent	2	Author assumption	
	GCSE grades A*-C or equivalent	0	Author assumption	
	Other (including GCSE below grade C)	0	Author assumption	
	No qualifications	0	Author assumption	
Benefits	Benefits per annum	1319	ONS	32
Unemployment	Degree or equivalent	0.042	Department for Children..	27,28
	GCE A level or equivalent	0.062	Department for Children..	27,29
	GCSE grades A*-C or equivalent	0.086	Department for Children..	27,30
	Other (including GCSE below grade C)	0.105	Department for Children..	27,31
	No qualifications	0.142	Department for Children..	27,32
Crime	Crimes per criminal (M)	4.35	Home Office	34
	Female/male crime per criminal ratio	0.302	Home Office	34
	Crimeshare 16-24	0.583	Home Office	34
	Crimeshare 25-34	0.259	Home Office	34
	Crimeshare 35-44	0.111	Home Office	34
	Crimeshare 45-54	0.047	Home Office	34
	Cost/crime to public sector	445	Home Office	35,36
QALYs	Relative reduction in mortality rate for individual with	0.643	Derived from references	46 - 48
	Utility degree (NVQ 4&5)	0.94	Kind et al.	45
	Utility A level (NVQ 3)	0.91	Kind et al.	45
	Utility GCSE (NVQ 2)	0.87	Kind et al.	45
	Utility other qual (NVQ 1)	0.84	Kind et al.	45
	Utility no quals (NVQ 0)	0.78	Kind et al.	45
Education	Annual cost 16-18	4800	Hansard	38,39
	Annual cost university	6000	HEFCE, UCU	40,41
	% university cost public sector	25	Author assumption	
	Duration 16-18 ed	2	Author assumption	
	Duration degree	3	Author assumption	
Prob. adult criminal conviction, poor child conduct	males	0.350	Derived from Murray et al.	33
	females	0.080	Derived from Murray et al.	33
RR adult criminal conviction, poor child conduct	male RR	1.585	Derived from Murray et al.	33
	female RR	2.289	Derived from Murray et al.	33
Mortality rates by age		various	ONS	50

### Abbreviations

ONS

HRMC

Department for Children..

HEFCE

UCU

Office for National Statistics

Her Majesty's Revenue and Customs

Department for Children, Schools and Families

Higher Education Funding Council for England

University and College Union

## **Summary assumptions economic parameters**

### Intervention costs

The intervention effectiveness data were from a variety of interventions, for only one of which were costs available. As other intervention effect data was sourced principally from Sure Start interventions the intervention costs are based on the mean annual cost of provision of the Sure Start programme across the country, and assumed duration according to scenario. The Sure Start outcomes were derived from large samples of Sure Start programmes, reducing the risk that the outcome data were from atypical programmes.

### Probability of being economically active

The probability of being economically active for different age groups relative to age 38 was not specific to educational level, but the age of commencement of economic activity was adjusted for those with higher educational qualifications (age 18 NVQ level 3 (A level or equivalent level), age 22 NVQ level 4/5 (degree/higher degree or equivalent)). The probability of being unemployed if economically active was adjusted for educational level, but not age.

### Education Costs

The following assumptions are made:

- NVQ level 2 qualifications are attained within compulsory education so their costs can be ignored.

- The public sector funds NVQ level 3 (A-level equivalent) education at an annual cost of £4,800 for 2 years.
- Higher education costs £6,000 per year for 3 years. Individuals bear 75% of the costs, and the public sector 25%.

### Returns to education

It was assumed that the returns to education in terms of wages accrue to individuals from the age at which they are most commonly achieved (NVQ3 age 18, NVQ 4-5 age 22). QALYs are calculated from the age of 21. Some people acquire qualifications later in life, and returns to education may be different for these people compared to those achieving them younger, and they also have fewer years in which to realize them. However achievement of qualifications at any age may be a marker of characteristics which lead to increased wages and health related quality of life prior to the qualification being achieved.

### National Insurance

A simplified model of National Insurance contributions for both employees and employers was implemented. Rates for employees that will come into force in 2011 were used. It was assumed all contributors are employees (as opposed to self-employed workers), payments made by employees between the lower earnings limit and the threshold for primary class 1 contributions were ignored, as was the small discrepancy (£3) in the threshold for primary class 1 contributions for employees and employers that has been introduced from 2011.

## Benefits

Estimation assumes all non-pension benefits accrue to the non-retired members of the household. Note the model predicts whether an individual will be resident in a household in receipt of benefits at age 38, and for costing purposes it is assumed that such a person will be resident in such a household all their adult life (age 16-64).

## Crime

In attributing costs to adult criminal convictions it is assumed that the type of offence for which adults are convicted, as well as the ratio of recorded to unrecorded crimes are independent of child conduct disorder.

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