

EVIDENCE BRIEF: NURSE-FAMILY PARTNERSHIP PROGRAM AND THE NT CONTEXT

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EXECUTIVE SUMMARY

Background

The first three years of a child's life can influence their future life course, with exposure to early stressors such as poor nutrition, overcrowding, neglect and abuse adversely affecting development. Many Aboriginal children in the Northern Territory (NT) grow up in disadvantaged communities and their early experiences can set them on a path towards poor health, education and social outcomes. This persisting cycle of disadvantage in the NT supports a priority focus on early childhood policy.

The Aboriginal Medical Service Alliance of the Northern Territory (AMSANT- the peak body for Aboriginal community controlled primary health care services in the NT) asserts that improving early childhood outcomes is critical to reducing the disparities in health, education and social outcomes for Aboriginal people. AMSANT has advocated for the expansion across the NT of evidence based early childhood development programs.

The Nurse-family Partnership Program (NFPP) is one such maternal and early childhood intervention, being a home visitation program that began in the United States (US) in 1977. It was designed to improve pregnancy outcomes, child health and development, and mothers' economic self-sufficiency, and also addressed risk factors for child maltreatment. The program involves frequent home visits to first time, low-income mothers by a trained nurse from the first trimester of pregnancy through to the child's second birthday. Importantly, the NFPP has been studied in randomised controlled trials (RCTs) in three ethnically and geographically diverse populations in the US.

In 2009 the Commonwealth government funded three Aboriginal community controlled health services to implement an adapted pilot of the NFPP, one of which was in the NT. From 2013, national partnership funding agreements between the Australian and Northern Territory governments present an opportunity to expand this program to reach more Aboriginal families across the Northern Territory. This literature review was undertaken to inform decision making related to the expansion of the NFPP in the NT.

Aims

This project aimed to critically review the results of the three trials of the NFPP, evaluate their relevance to the Aboriginal population in the NT, and compare these findings against alternatives.

Methods

A systematic literature search was carried out to identify all published articles about the NFPP trials. These articles were critically reviewed. Results were grouped under the three primary objectives of the NFPP (maternal and birth outcomes, child health, safety and development outcomes and maternal economic self-sufficiency), and an additional grouping for adolescent outcomes. The analysis focussed on objective, clinical end-points, and results that were consistent across two or more study populations, and those of high relevance to the NT context, were highlighted. A separate literature review identified alternative early childhood interventions to compare outcomes and scope against the NFPP studies.

Results

A literature search yielded 24 articles on NFPP trials in three US study populations in Elmira, Memphis and Denver. The Elmira study followed cohorts to the child's 19th year, the Memphis study until 12 years of age and the Denver study to four years. Two articles were also found on an adapted NFPP trial from the Netherlands.

Critical appraisal of the methodology of the NFPP studies highlighted the strengths of the RCT experimental design, but also identified some important weaknesses. These include unclear participant flow and attrition, and a tendency to report intermediate markers, without explanation of the clinical or 'real life' implications.

Nearly all other high quality long-term RCT tested programs identified by the literature search for comparable interventions targeted children over the age of three. Large-scale population wide interventions were generally ineffective and little evidence exists for interventions targeting Aboriginal families. Alternative interventions were commonly smaller in scope, for example targeting birth outcomes or infant development, but not both. Overall, the performance of the NFPP against alternative programs was generally favourable as described below.

Analysis of results from the NFPP trials

Key results (those that were consistent across two of more of the study populations, and those with more relevance to the NT context) are summarised in table 1.

Table 1: Summary of key NFPP trial results

Maternal and birth outcomes	
Positive findings	Equivocal findings
<ul style="list-style-type: none"> - Reduced maternal smoking - Increased pregnancy intervals - Increased use of services - Partner stability 	<ul style="list-style-type: none"> - No consistent effects on maternal health - No consistent effects on birth outcomes - No consistent effect on domestic violence
Child health, safety and developmental outcomes	
Positive findings	Equivocal findings
<ul style="list-style-type: none"> - Fewer injuries and ingestions and hospitalisations among children - Families less likely to be involved with child abuse or neglect cases - Home environment more conducive for children's development - Better developmental outcomes for children of most disadvantaged mothers 	<ul style="list-style-type: none"> - Little impact on parenting and development for children whose mothers were least disadvantaged - No consistent improvements in child behaviour
Economic self-sufficiency outcomes	
Positive findings	Equivocal findings
<ul style="list-style-type: none"> - Less use of welfare services - Increased employment in short-term after birth of child 	<ul style="list-style-type: none"> - No effect on maternal education outcomes - No long term effects on maternal employment
Adolescent outcomes	
Positive findings	Equivocal findings
<ul style="list-style-type: none"> - Less substance use - Reduced criminality before age 15 	<ul style="list-style-type: none"> - No effects on education for overall cohort - Not sustained effects on criminality for boys

Maternal and birth outcomes

Of the key maternal and birth outcomes (table 1), reduced smoking is particularly relevant to an NT setting where smoking rates among Aboriginal mothers remain high despite concerted local and national campaigns.

Poor maternal nutrition, low birth weight and perinatal complications are important issues in the NT so the lack of positive effects of the NFPP on these outcomes in the US trials is disappointing. There was no reduction in domestic violence in the three US trials, but a Dutch trial of the NFPP adapted to have a greater focus on domestic violence did produce positive effects. An NT program could potentially be changed to have a greater emphasis on domestic violence, but this would need to target the different drivers and issues implicated in high domestic violence rates among NT Aboriginal families.

Child health, safety and development outcomes

A key outcome of the NFPP trials was the reduced rates of childhood injuries and maltreatment. These are very important issues in the NT Aboriginal community setting, where rates are disproportionately high.

The NFPP trials demonstrate the program's success in helping mothers to create a better environment for children's development and resulted in measurable improvements in the maternal child relationship. Several other home visiting and parenting programs have produced positive effects in these outcomes, though often effects have been short lived or inconsistent.

Educational improvements amongst participants in the NFPP trials were concentrated among higher risk children only. This compares unfavourably with the Carolina Abecedarian Program, an enhanced pre-school early childhood program, which has produced better educational, such as long standing improvements in IQ.

Economic self-sufficiency outcomes

The NFPP studies demonstrated higher employment rates among nurse-visited mothers initially, and less use of welfare, but had no positive long-term education or employment outcomes for mothers. Evaluations of alternative home-visiting programs have demonstrated they have not been effective in assisting mothers to enter employment. In contrast, studies of the Carolina Abecedarian Program demonstrated the achievement of long lasting impacts in both education and employment for mothers whose children attended the Abecedarian preschool.

Adolescent outcomes

Among the Elmira cohort, there was initially a reduced rate of criminality at 15 years, but at the 19-year follow-up, the effect remained significant for female adolescents only. Nurse-visited children participating in NFPP trials also reported less substance use as adolescents. These are two pertinent issues for the NT where offending and substance use rates are very high among Aboriginal adolescents. As a comparison, the Carolina Abecedarian program also reported a delayed onset of smoking and marijuana use, but has no reported effects on criminality.

Conclusion

Early childhood presents a crucial opportunity to address disparities in health, education and social outcomes experienced by many Aboriginal families in the NT, and decisions to fund particular interventions need to be based on evidence of their likely effectiveness and relevance in this setting.

The NFPP is among the most robustly studied early childhood interventions. The strongest positive NFPP outcomes were found in areas of reduced maternal smoking, longer birth intervals, reduction in childhood injuries and hospitalisations, reductions in child maltreatment cases and reduced substance use among adolescents. These are each important priorities for Aboriginal communities in the NT. The pilot program already operating in the NT further suggests that the NFPP can be adapted and effectively delivered by an Aboriginal controlled organisation.

In reviewing the NFPP trials, there were also critical areas where results were disappointing including pregnancy outcomes, domestic violence and educational outcomes for the child. Despite these weaknesses, the breadth and reliability of the NFPP trials' positive outcomes remain unmatched by any one individual early childhood program.

The findings of this review support the decision to expand the NFPP in the NT but also suggest that other approaches such as those of the Carolina Abecedarian Program can be drawn upon for targeting other key areas, such as child education.

The current NT based pilot of the NFPP should be evaluated as a priority, as local evidence will be invaluable in guiding future decisions about interventions that will best support development of Aboriginal children in the NT.

INTRODUCTION

The first years of a child's life have lasting effects across their lifespan. Many Aboriginal children in the Northern Territory (NT) grow up in disadvantaged communities where exposure to early stressors adversely affects their development and can set them on a path towards the poorer health, education and social outcomes that are widespread among the adult population. This persisting cycle of disadvantage in the NT supports a priority focus on early childhood policy.

The Aboriginal Medical Service Alliance of the Northern Territory (AMSANT- the peak body for Aboriginal community controlled primary health care services in the NT) acknowledges that improving early childhood outcomes is critical to reducing the disparities in health, education and important social outcomes for Aboriginal people. AMSANT has resolved to advocate for the expansion of early childhood development programs that have the strongest evidence of effectiveness.

The Nurse-Family Partnership Program (NFPP) is acknowledged internationally as one of the most rigorously evaluated early childhood interventions (Robinson et al., 2011). Studies of this program in the United States (US) have reported a wide-range of effects across different populations. While some results seem consistent, other outcomes were less clear. The NFPP was chosen by the Commonwealth government to be piloted by an Aboriginal community controlled health service in Alice Springs in the Northern Territory. From 2013, national partnership funding agreements between the Australian and Northern Territory governments have presented an opportunity to expand this program to reach more Aboriginal families across the Northern Territory, but it is uncertain how effective this program will be.

There have been no formal quantitative evaluations of the Alice Springs pilot to date. The decision to expand this program needs to be informed by a critical review of the evidence and relevance of the Nurse-family Partnership program to the NT Aboriginal context. This can provide decision makers with a clearer picture of both the expected benefits and challenges of implementing this program in the NT.

This project aimed to critically review the results of the three US trials of the NFPP, to evaluate their relevance to the Aboriginal population in the Northern Territory and to compare these effects against alternative interventions.

The report presents the background information around early childhood development and the NT Aboriginal context. Methods of the literature search and analysis are described. This is followed by a review of the results of the published NFPP studies. The review focuses on results that were consistent across different study populations and those with more relevance for Aboriginal families. The implications of these findings to the NT and comparison to alternative interventions are discussed.

BACKGROUND

Poverty, disadvantage and childhood development

Positive influences in early childhood not only foster healthy cognitive and behavioural development, they also act as a protective mechanism against later chronic disease and mental health conditions. Conversely, adverse events and experiences can have lifelong consequences for both physical and mental well being (University, 2010, NSCDC, 2010).

Early childhood is a key link between socioeconomic disadvantage and poor health, mental and social outcomes (WHO, 2008). Children growing up in communities of low socioeconomic status are more likely to experience stress (e.g. family violence, neglect and abuse), adverse environmental exposures (e.g. crowded houses, cigarette smoke), have less access to health and social services, and poorer parenting supports (Evans, 2004). Adverse in-utero and early childhood exposures have been linked to a diverse array of adult outcomes such as respiratory disease, ischaemic heart disease, depression, alcohol abuse, risk for intimate partner violence, sexually transmitted diseases, smoking, suicide attempts, and unintended pregnancies (CDC, 2013).

Aboriginal families in the Northern Territory

There are several key issues in the Northern Territory (NT) that present considerable challenges to implementing health promotion and interventions targeting childrearing.

Aboriginal families in the NT tend to be younger (ABS, 2011c) and are more geographically isolated compared to Australian families overall. Nearly half of the NT's Aboriginal children live in either remote or very remote regions, compared to just 3% nationally (ABS, 2012a). This geographical context creates significant challenges in providing and sustaining services targeting this population.

Many Aboriginal people in the Northern Territory live in communities of extreme socioeconomic disadvantage. A high proportion of Aboriginal children grow up among the detrimental influences of high rates of maternal smoking (Johnston et al., 2011), overcrowding (ABS, 2011a, ABS, 2011b), parental unemployment (ABS, 2011a), family violence (Mitchell, 2011), alcohol related health and social problems (Skov et al., 2010), and high rates of incarceration (ABS, 2013). Rates of child abuse and neglect are the highest in the nation (Bamblett et al., 2010) and the gap between the NT and national rates continues to widen (24.4 cases per 1000 children and 7.4 cases per 1000 children respectively) (AIHW, 2013).

The consequences of these negative influences show their effect early. Aboriginal children in the NT have much poorer health outcomes than non-Aboriginal children, with high rates of infections (Bar-Zeev et al., 2012), hospitalisations for assault, burns and scalds (AIHW, 2011), anaemia and malnutrition (Stamatoiu, 2011). Aboriginal children in the NT also consistently obtain the lowest scores in national measures of development and education attainment (Silburn et al., 2010).

The underlying social determinants of health of Aboriginal communities today cannot be separated from a history of dispossession, racism, social exclusion (Carson et al., 2007) and a legal framework that supported the removal of children from families (Wilson et al., 2010). These factors compound with contemporary issues to create a very challenging setting for implementing mainstream interventions directed at Aboriginal families.

Policy context of early childhood development in the NT

Aboriginal children living in remote and regional centres in the NT have significantly lower participation rates in quality child care and early childhood education than other Territory children even though they stand to benefit the most (Havnen, 2012). The NT Coordinator General of Remote Services' 2012 report concluded that "unless there is substantial change in the planning and implementation of early childhood development programs, long term goals in Aboriginal education, employment, health and well-being will be irrevocably undermined" (Havnen, 2012).

An audit of services targeting children under 15 years of age in the NT identified over 1,000 programs (Hourigan, 2012). Overall, there is no systematic approach to selecting programs that are supported by an evidence base. The majority of current interventions have not been formally evaluated and their success or impact remains unknown (Havnen, 2012).

Early childhood development interventions

Evidence shows that early and appropriate interventions that address risk factors and support children's cognitive and social-emotional development can positively affect the health, well-being, and competence of children in the long-term (WHO, 2013). However, there is a significant lack of high quality trials evaluating these effective programs (Mikton and Butchart, 2009) and a particular dearth of evidence from Aboriginal populations (Milldon and Polimeni, 2012, Munro, 2012).

Within the literature there are some 'stand out' early childhood interventions cited as having significant long-term results from well-designed mostly randomised control trial studies. These include the Nurse-Family Partnership Program, Triple P, The Incredible years, High/scope Perry preschool, and the Carolina Abecedarian program (Robinson et al., 2011, Macmillan et al., 2009, Milldon and Polimeni, 2012, Tully, 2009, Moore and McDonald, 2013).

The Nurse-family Partnership Program

Professor David Old's nurse home visitation program, known since as the Nurse-Family Partnership Program (NFPP), is widely acknowledged as one of the most researched and successful home-visiting programs (Milldon and Polimeni, 2012, Mikton and Butchart, 2009, AHRQ, 2013). The NFPP began in Elmira, New York in 1977, as a home-visitation program designed to improve pregnancy outcomes, child health and development, and families' economic self-sufficiency. It was initially implemented and tested as a randomised control trial in a large sample of mostly white, low-income, first-time mothers (Donelan-McCall et al., 2009). A further two studies were conducted in an urban-based mostly African-American population in Memphis, and among a low income, ethnically diverse population in Denver. In 2013, the program had 23,935 families enrolled across 42 states in the US, with branches in the United Kingdom, the Netherlands and Australia (NFP-Solutions, 2013).

The program involves frequent home visits to first time, low income mothers by a trained nurse from the first trimester of gestation through to the child's 2nd birthday (NFPP, 2013). The program was designed explicitly to address risk factors for child maltreatment, though this was downplayed to reduce potential for stigmatisation of participating families (Olds et al., 1994). Nurses work to improve women's health related behaviours, qualities of infant care giving, and personal development by encouraging mothers to set small achievable goals and to use problem solving methods to gain control over the difficulties they encounter (Olds et al., 1994). Nurses involve

other family members and friends and link families in with other social and health services (Olds et al., 1994).

Nurses were utilised rather than volunteers or other untrained staff because of their professional skill set and high ethical standing in the public's view (Olds et al., 2002). Other important elements of the program include visiting the client in their home, enrolment of mothers early in their pregnancy, adherence to core educational sessions that can be individualised to each family, and professional supervision of nurses (NFPP, 2013). There is a strong push for program fidelity and all sites must undergo performance measurement and coordination by a central support agency (NFPP, 2013).

The program has a comprehensive theoretical basis, around which the structure and content of the program has been developed. The primary theory is human ecology theory, with self-efficacy and attachment theory playing critical roles in the success of the program (Olds et al., 1997a).

The Australian Nurse-family Partnership Program

The NFPP has been piloted in three Aboriginal community controlled health services since 2009. The program is under license as the Australian Nurse-family Partnership Program (ANFPP) funded by the Office for Aboriginal and Torres Strait Islander Health (OATSIH) (Young, 2012). The sites were Central Australia Aboriginal Congress (Alice Springs NT), Wuchopperen Health Service (Cairns, QLD), and Wellington Aboriginal Corporation Health Service (Wellington, NSW).

Key adaptations for working with Aboriginal families were developed between the ANFPP Support Service team and health services (ANFPP, 2013). These included the addition of Aboriginal Family Partnership Workers (FPW) as there were concerns that the absence of an Aboriginal team member would both inhibit some mothers from agreeing to a home visitation program and also contravene the organisations' positions on employment of Aboriginal workers. This role included interpreting, promoting the program in the community, developing locally appropriate resources, and facilitating entry of the nurse home visitor into families' homes. The program was also open to multiparous women and not all visits were at the home as there were times when this was not possible or appropriate (Young, 2012).

In 2013, national partnership funding agreements between the Australian and Northern Territory governments have presented an opportunity to expand this program to reach more Aboriginal families across the Northern Territory. However, with the pilot programs still too young to have produced observable outcomes, the decision to expand this program needs to be informed by reviewing what evidence is available regarding the NFPP and evaluate this against the NT Aboriginal context.

This project aimed to critically review the results of the three US randomised control trials (RCTs) of the Nurse-Family Partnership Program, to evaluate their relevance to the Aboriginal population in the Northern Territory and to compare these effects against alternative interventions.

METHODOLOGY

Literature search of the Nurse-family Partnership Program

A literature search for published studies of the NFPP RCTs was performed via MEDLINE and PubMed using combinations of “nurse home visiting”, with “D. Olds” and “Elmira” or “Memphis” or “Denver”, and “nurse-family partnership”. This yielded 24 separate articles on the RCTs, and two further studies of the NFPP in the Netherlands and one from the United Kingdom.

Additional information regarding the NFPP and Australian Nurse-family Partnership program (ANFPP) was gathered from online resources located on the official program website (www.nursefamilypartnership.org; www.anfpp.com.au) and the Office of Aboriginal and Torres Strait Islander Health (OATSIH) website (www.health.gov.au), including an initial evaluation of the ANFPP trial commissioned by the OATSIH.

Critical evaluation of the articles was guided by the CONSORT Statement, which is an evidence-based, minimum set of recommendations for reporting randomised trials (CONSORT, 2012).

Consistency of significant results across different studies is highlighted by comparing like outcomes reported across the study populations, using four outcome domains that correspond with the three primary objectives cited by the research team (maternal and birth outcomes, child health, safety and development outcomes and economic self-sufficiency of families), as well as an additional group for adolescent outcomes.

Results and effect sizes where reported are compared to comparable interventions found in the literature (search strategy listed below). Due to the large volume of results presented across the studies, analysis focuses on outcomes based on objective, clinically relevant endpoints rather than intermediate, or clinically ambiguous measures. Unless otherwise specified, only results that were statistically significant with p value <0.05 are included. The Elmira 15 year follow-up results were subject to a reanalysis in 2006 using a different analytical method, but not formally published. These alternative results are listed as footnotes.

Literature search of alternative early childhood interventions

A targeted literature search was undertaken to find relevant alternative early childhood programs to compare to the NFPP. The literature search utilised Cochrane and Medline databases, and the grey literature for alternative home visiting and centre-based programs for disadvantaged and Indigenous populations, which predominantly target the period from pregnancy to age three.

The Cochrane database lists were searched under relevant topic headings (child health; developmental, psychological and learning problems; pregnancy and childbirth; effective practice and health systems) and key word search for combinations of ‘home-visiting’ or ‘parenting programs’ and ‘child health’ or ‘maternal health’, ‘child development’ and ‘Indigenous’. This yielded 14 studies, with two having been withdrawn. The Medline search used these same key words together with ‘review’. Systematic reviews were included if they used a clear and reproducible strategy for finding and reviewing studies for inclusion and had a well described methodology for synthesizing the evidence. Abstracts were reviewed and rejected if they were not predominantly targeting the period from pregnancy to age three, or did not report on

any maternal health, birth, child health, safety and development, or economic outcomes for families.

A grey literature search targeting early childhood development in the Aboriginal or Australian context, included known and recommended relevant online sources including government repositories (the Closing the Gap Clearinghouse website, Federal and State health departments websites) and health and research bodies (the Menzies School of Health Centre for Child Development and Education, the Harvard Centre on the Developing Child, the World Health Organisation, The Murdoch Children's Research Institute and the Telethon Institute for Child Health Research). Publications were assessed against the criteria listed above.

Further pertinent individual references were identified via reference lists from these articles and reports, but were limited to studies with both treatment and control arms. Relevance was determined by characteristics of participants, objectives, and/or intervention design.

RESULTS

Literature search for the Nurse-Family Partnership Program trials

The literature search for the NFPP trials yielded a total of 24 published articles across three separate study populations in Elmira, Memphis, and Denver in the US, which included a total of 2,274 mothers. These were published between 1978 and 2010.

The populations, design and setting of three RCTs are described below (Table 2). Table 3 illustrates the follow-up articles and attrition rates where available. A critical review of the RCTs is presented before exploration of the key results of the studies (tables 4-7). The Denver trial also assessed a paraprofessional-visited sample of women, but this report only presents results from the nurse-visited cohort to maintain consistency.

Table 2: Features of the three RCT studies of the US based NFPP.

Study	Elmira	Memphis	Denver
Year started	1978	1987	1994
Study participants	400	1,139	735
Population	Low income Caucasian	Low income African Americans	Large proportion of Hispanics
Eligibility criteria of mother	Primigravida and any one of: -<19 years -Single parent -Low socioeconomic status	Primigravida and any 2 of: -Less than 12 years education -Unmarried -Unemployed	Primigravida and either qualified for Medicaid or had no private health insurance
Setting	Semi-rural	Urban	Urban
Treatment groups	1. No services provided during pregnancy. Sensory development review by a specialist at age 12 and 24 months (n=90) 2. Provided free transportation for antenatal and well-child care appointments. Development review as per group 1. (N= 94) 3. Provided with transport and screenings as per group 2 as well as nurse home visiting during pregnancy only (n=100) 4. Same services as group 3 with nurse home visits until child's 2 nd birthday (n=116) (groups 1 and 2 combined for analysis)	1. Provided free transportation for antenatal care (n=166) 2. Provided with free transportation for antenatal care and developmental screening and referral services at 6, 12 and 24 months (n=515) 3. Provided with transport and screening as per group 2, as well as nurse home visiting during pregnancy only (n=230) 4. Same services as group 3 with nurse home visits until child's 2 nd birthday (n=228) (Results for group 2 and 4 used in analysis)	1. Provided with free developmental screening and referral for children at age 6, 12, 15, 21, and 24 months of age (n=255) 2. Provided with screenings as per group 1 with additional paraprofessional home visits during pregnancy until child's 2 nd birthday (n=245) 3. Provided with screenings as per group 1 with additional nurse home visits during pregnancy until the child's 2 nd birthday (n=235)
Subset analysis group	"Poor, unmarried teens" - Low income - Unmarried - < 20 years of age	Low psychological resource: combined score of- - Mental health - Sense of mastery - Intelligence	Low psychological resource: combined score of - Mental health - Sense of mastery - Intelligence (40% of sample)
Special characteristics	High rates of child abuse and neglect in population	92% of mothers were African American 98% of mothers were unmarried	Included a paraprofessional and nurse stream Greater focus on infants' affective development and parent-infant communication of emotion

Critical review of the Nurse-family Partnership Program randomised control trials

RCTs are generally considered to give the best evidence of all epidemiological studies (Webb et al., 2009), which is a major strength of these studies. Evaluation against the CONSORT statement exposes some weaknesses, though it should be noted that most of the articles were published prior to the development of this tool in 2010.

Table 3: Number of follow-up published articles and attrition rates reported for the three NFPP cohorts

Study	Elmira	Memphis	Denver
Published follow-ups	Birth, 2yr, 4yr, 6yr, 15yr, 19yr	2yr, 5yr, 6yr, 9yr, 12yr	2yr, 4yr
Pre-inclusion attrition	400 enrolled of 500 eligible women invited to participate. (80%)	1139 enrolled of 1290 eligible women invited to participate. (88%)	735 enrolled of 1178 eligible women invited to participate (62%)
Characteristics of those who accepted/declined	94% of the non-white women enrolled as opposed to 80% of white women (p=0.02)	-89% of African-American women enrolled compared to 74% non-African American (p<0.001). -Average age of participants was 18, compared to 19 for non-participants (p=0.001). -89% of non-high school graduates enrolled compared to 84% graduates. (p=0.01).	Hispanics and smokers were more likely to enroll. (p values not reported).
Attrition to 24-month follow-up.	26 women of 400 dropped out of program before completion (12 control, 14 nurse-visited). Authors report rates of attrition “varied between 15 and 21%”. Distributed equally among trial arms.	13 post randomization drops, 39 miscarriages, 10 stillbirths, 12 infant deaths (35/515 in treatment group 2 (6.8%), 15/228 in treatment group 4 (6.5%)). 91% families were available for follow-up	28 research refusals, 26 foetal demises, 4 infants deaths and 4 adoptions. 630 of 735 participants (86%) completed 24-month interviews.
Attrition to most recent study	352 of 400 children available at 19-year-old follow-up (78% of randomized, 88% alive, not adopted or mentally disabled). No indication of attrition bias (data not shown)	578 of 743 (from treatment groups 2 and 4) children available at 12-year-old follow-up (78%).	As above.

The randomisation process, inclusion and exclusion criteria, baseline characteristics, and pre-inclusion attrition rates are well documented in the three studies. The intervention services received by the mothers are clearly stated, but general services that would have been available to the control group are not described in detail. For those unfamiliar with US Federal and State maternity and early childhood services, it is difficult to know what would have been available to the control families.

All studies used an intention to treat approach to analysis. In most instances assessors and data analysts were blinded to the participants’ status, however the authors comment that there may have been times that a participant divulged which treatment group they were in during interviews or assessments. The frequency of this occurrence is not reported.

There are no study flow diagrams, and attrition rates are not consistently reported across the different follow-ups (see table 3). For example in the 24 month Elmira study, the authors state that attrition rates varied between 15 and 21%, but give no further details. Throughout the studies, different outcomes are reported on different numbers of mothers and children. It is not clear if this exclusion from analysis was due to conscious objection (e.g. active refusal) or was unintentional (e.g. missed appointment).

Teasing out the key results and finding consistency across the studies’ effects is problematic. Differing outcomes were often used between studies (e.g. reported number of cigarettes smoked vs. measuring a chemical marker of smoking in a blood test). Often intermediate outcomes were reported without a clear description of the relationship to the final outcome (e.g. use of behavioural rating scales as a proxy for the rates of child maltreatment). Such surrogate outcomes with ambiguous implications were

intentionally not emphasised in the review. The authors also did not explicitly identify outcomes as being primary or secondary.

Subgroup analysis was undertaken in the Memphis and Denver studies as the early Elmira results uncovered the most disadvantaged mothers benefited the most from the intervention. Results that were limited to these sub groups cannot be extrapolated to the overall population, but do provide a general sense of the circumstances in which the program was most effective.

Notably in an interview transcript available on the official NFPP website, Professor Olds explained that a reanalysis of the 15 year follow-up of the Elmira cohort resulted in many outcomes previously reported as statistically significant becoming either trends or not statistically significant (NFP, 2006). A formal publication of these results and rescinding of previous papers could not be found, so it is unknown if these new data are the definitive results, or further analysis is in progress. These results are indicated as footnotes.

Lastly, the same research team that developed the intervention conducted all the evaluations. This opens a window of bias towards finding positive outcomes.

Analysis of results from the Nurse-Family Partnership Program randomised control trials

Results of the studies are summarised under four outcome domains: maternal and birth outcomes; child health, safety and development outcomes; economic self-sufficiency of families; and adolescent outcomes. Key results -those reliably reported across more than one study population and those more relevant for the NT context- are highlighted. Additional pertinent positive and negative results are included in the tables.

Maternal and birth outcomes

A key goal of the NFPP was to positively affect pregnancy outcomes and maternal health behaviours. The key findings across the three studies are presented in table 4. The studies did not demonstrate consistent improvements in maternal health nor pregnancy outcomes. Only the Elmira trial showed positive effects on birth outcomes. This was restricted to nurse-visited girls aged younger than 16 who had heavier babies than their control counterparts, but this did not impact the frequency of low birth weight babies (less than 2500 grams) in this group(Olds et al., 1986).

Smoking is a significant yet preventable cause of poor pregnancy outcomes (RCH, 2009). Two of the three NFPP studies were able to demonstrate significant improvements in maternal smoking rates. The Memphis study did not show any effects on smoking, though initial rates were comparatively low at 9% (Kitzman et al., 1997).

The authors viewed better-spaced pregnancies as a means to reduce the risk of poor child outcomes, as well as being less economically straining on families. All three studies achieved wider pregnancy intervals among the nurse-visited mothers (Kitzman et al., 1997, Olds et al., 2002, Olds et al., 1986). Participation in the NFPP made women more aware of services available in the community in the Elmira and Memphis studies.

Table 4: Key results for maternal health, pregnancy and birth outcomes of the three RCT cohorts

Outcome	Elmira	Memphis	Denver
Smoking rates in pregnancy	Reduction by average of 4 cigarettes smoked per day (95% CI 3.16 to 5.18, p=0.0001)	No effect	Reduction in cotinine levels (MD -246.68ng/mL, 95% CI -466.19 to -27.16, p=0.03)
Maternal physical health	-Higher rates of adequate diet (73.86% vs. 71.75%, 95% CI of difference ±4.38, p=0.04) -Less kidney infections (0.00 v 0.03 p=0.04).	Less pregnancy induced hypertension (OR 0.6, 95% CI 0.5 to 0.9, p=0.009)	Not reported
Knowledge/use of services	-Higher number of services known (5.47 vs. 4.91; p≤ 0.01, 95% CI -0.56± 0.45) -More likely to use nutritional vouchers (2.18 vs. 1.56; 95% CI of difference ± 0.55, p≤0.05). -More likely to attend childbirth sessions (70% vs. 54%; 95% CI of difference ± 0.13, p≤0.01)	More likely to use community services (29% vs. 20%, OR 1.8, 95% CI 1.2 to 2.7, p=0.01)	No effect
Birth outcomes	-Better birth weights for very young mothers (MD 395g (95% CI ± 343, p=0.02). -Less premature delivery for smoking mothers (2% versus 10%, 95% CI ± 7.05, p=0.04)	No effect	Not reported
Spacing of subsequent pregnancies	Fewer pregnancies at 15 years (1.5 vs. 2.2; MD 0.7, 95% CI 0.1 to 1.3, p=0.03). Greater interval between pregnancies (64.8 vs. 37.3 months; MD -27.5, 95% CI -44.1 to -10.9, p=0.001)*	Less likely to be pregnant by child's second birthday (36% vs. 47%; OR 0.6 CI 0.4-0.9, p<0.01).	Less pregnancies within 2 years of birth of first child (29% vs. 41%, p=0.02)
Domestic violence	No effect	No effect	Half as likely to report domestic violence at four year follow-up (6.9% vs. 13.6%; OR 1.05 p=0.05; no CI), No effect
Stability of partner relationships	Two times more likely to be married at 15 year follow-up* (p value not given)	-More likely to be cohabiting with child's father or a different partner at the five year follow-up (p value not given) -Longer relationships with current partners at the six year follow-up (p value not given)	No effect
Long term maternal outcomes	Fewer days impaired from alcohol and other drugs* ¹ Less arrests*(log incidence difference 1.46, 95% CI 0.38 to 2.54; p<.01) and convictions*(log incidence difference 1.46, 95% CI 0.38 to 2.54; p<.01)		

*Women of low socioeconomic status only.
1. The 44% reduction in behavioural problems in mothers due to use of substances was no longer statistically significant in a 2006 reanalysis (NFP, 2006). CI Confidence Interval MD= mean difference. OR Odds Ratio

Domestic violence is a known contributor to early childhood stress. In Denver, follow-up to the children's fourth year revealed that nurse-visited mothers were almost half as likely to have reported domestic violence in the six months prior to the interview (Olds et al., 2004b). However, the effect was not statistically significant over the whole 24-month period. This effect was not replicated in either of the Elmira or Memphis cohorts (Eckenrode et al., 2000, Olds et al., 2004a).

Nurse visitation achieved some longer-term effects on mothers. In the 15-year follow-up of the Elmira cohort, nurse-visited mothers of low socioeconomic status reported 60% fewer convictions and less impairment from alcohol and other drug use and compared to their counterparts (Olds et al., 1997b), however an unpublished reanalysis of the data by the study team revealed the impact on impairment from alcohol and other drug use

was no longer statistically significant. As stated earlier, there has been no formal correction or challenge to the original results.

Box 1: Summary of key maternal and birth outcomes

Positive findings	Equivocal findings
<ul style="list-style-type: none"> - Reduced maternal smoking - Increased pregnancy intervals - Increased use of services - Partner stability 	<ul style="list-style-type: none"> - No consistent effects on maternal health - No consistent effects on birth outcomes - No consistent effect on domestic violence

Child health, safety and development outcomes

The second key objective of the NFPP was to improve child health, wellbeing and development. The three studies reported on a large number of outcomes concerning the maternal-child relationship, child development and behaviour, child safety and child abuse and neglect. Only the more definitive end-point or clinically significant outcomes are presented in the text with additional intermediate and surrogate outcomes listed in table 5.

Table 5: Key results for child health, safety, and development of the three study populations.

Outcome	Elmira	Memphis	Denver
Child safety and injuries	35% fewer emergency department visits to age 5 (log incidence mean comparison 0.52, 95% CI 0.21 to 0.81, p=0.006)	Less health care encounters for injuries and ingestions by 24 months (LID 0.256, 95% CI 0.00 to 0.50, p=0.05)	Data not available.
	40% fewer injuries and ingestions at 48 months recorded in physicians' records (LID 0.50, 95% CI - .04 to 0.96, p=0.03)	79% less days hospitalised at 24 months (LID 1.64, 95% CI 0.78 to 2.50, p<0.001)	
Child abuse and neglect	Less reports to Child Protective Services at 15 years (adjusted incidence 0.44 vs. 0.73, LID 0.59, no CI reported; p=0.04)	Less maternal beliefs around child rearing associated with child abuse and neglect) (98.7 vs. 100.5, MD 1.9; 95% CI 0.6 to 3.1, p.003)	Less likely to exhibit emotional vulnerability in response to fear stimuli at 6 months (16% vs. 25%; OR 0.57, 95% CI 0.32 to 1.00, p=0.05)
	Mothers less likely to be perpetrator of abuse or neglect at 15 years (adjusted incidence 0.32 vs. 0.65; LID 0.81, no CI reported; p=0.01)		Less likely to exhibit "low vitality" to joy and anger stimuli at 6 months* (24% vs. 40%, difference 0.46 95%, CI 0.22 to 0.98, p=0.04 and 13 vs. 32%, difference 0.33, 95% CI 0.14 to 0.79 p=0.01 respectively).
Mother-child interaction and HOME score to 24 months	Not reported.	Home environment more conducive to early learning (32.3 vs. 30.9, MD: 1.3; 95% CI 0.4 to 2.2, p=0.003)	More responsive maternal-child interaction at 6 months (scores 100.31 vs. 98.99; 95% CI 0.03 to 2.60, p=0.05).
		Higher sense of mastery in mothers (score 101.6 vs. 99.4, MD 2.2, 95% CI 0.7 to 3.8, p=0.005)	No difference in overall home environment at 12 months.
		More communicative and responsive infants (17.9 vs. 17.2; P=0.03, CI not reported)*	

Table 5 continued

Mother-child interaction and HOME scores to 48 months	More frequent punishment of children (Avoidance of punishment LID 0.37, 95% CI 0.09 to 0.65, $p \leq 0.01$). Mothers more involved with children at 34 months (data not shown, $p \leq 0.05$). Low income teen mothers showed greater stimulation of infants' language skills (LID - 0.68 95% CI -0.012 to -0.14; $p \leq 0.01$) and provision of stimulating materials (LID - 1.26 95% CI -2.36 to -0.16; $p \leq 0.05$)	No 48 month measures	Home environment more conducive to early learning* (HOME total score 24.61 vs. 23.35, ES 0.37, $p = 0.03$) (Individual HOME components not reported)
Development and cognitive skills of children to 24 months	Not reported	No effect on child's mental development score at 24 months	Fewer language delays (mean 6% vs. 12% MD 0.48, 95% CI 0.23 to 1.01, $p=0.05$) Superior average language (101.52 vs. 96.85; MD 4.67 95% CI 0.85 to 8.49, $p=0.02$) and mental development* (Mental development Index 90.18 vs. 86.20; MD 3.98 95% CI -0.07 to 8.02, $p=0.05$)
Development and cognitive skills of children after 24 months	No difference in intellectual functioning at 48 months.	Higher scores for intellectual functioning (ES 0.18, $p=0.03$), receptive language, (ES 0.17, $p=0.04$) and arithmetic achievement* (ES 0.25, $p=0.04$) at age 6.	Better language scores (ES 0.31, $p=0.04$)*, superior executive functioning (ES 0.47 $p=0.004$)* at age 48 months.
Child behavioural problems	Less behavioural problems reported by physicians at 48 months (Log incidence mean difference 0.87, 95% CI 0.25 to 1.47, $p=0.006$)	No effect on behavioural problems at 24 months Mothers reported fewer behavioural problems at age 6 (1.8% vs. 5.4%, OR 0.32 $p=0.04$)	No effect on mothers' reporting of behaviour problems at 24 months Better "behavioural adaptation" at 48 months (ES 0.38, $p=0.04$) No effect on emotional regulation or externalizing behaviour (rule breaking and aggressive behaviour) at 48 months.
*Children of mothers with 'low psychological resources' only. CI= Confidence interval. ES= Effect size. HOME= Home Observation for Measurement of the Environment LID= Log Incidence Difference MD= Mean difference.			

Child health and safety

The studies demonstrated a marked effect on risk of childhood injuries. Nurse-visited children in the Elmira had significantly fewer emergency presentations and fewer cases of injuries or ingestions recorded by their family physician (Olds et al., 1994). Similarly, the Memphis trial reported a 28% relative reduction in all types of health care encounters and a 79% reduction in number of days children were hospitalised for injuries and ingestions by the age of two (Kitzman et al., 1997). The Denver trial researchers did not have access to medical or hospital records.

Child maltreatment

The 15-year follow-up of the Elmira cohort revealed that Child Protective Services reports were significantly lower for nurse-visited children and the nurse-visited mothers were also less likely to be identified as a perpetrator of abuse or neglect (Eckenrode et al., 2000).

In the Memphis and Denver studies, the authors opted not to use child maltreatment notifications as an outcome because rates within the populations were too low to reach significance (Olds et al., 2002, Donelan-McCall et al., 2009). Instead these studies used proxy measures (see table 5) however, no indication is given of their potential relationship to maltreatment rates.

Maternal-child relationship and caregiving

The infant-toddler version of the Home Observation for Measurement of the Environment (HOME) is a widely used assessment on various aspects of the home environment and parenting practices that influence child development (Kendrick et al., 2000). In Elmira, nurse-visited mothers were more involved with their children. Both the Memphis and Denver studies demonstrated that nurse visiting helped mothers create a home environment that was conducive to early childhood development (at 24 months for Memphis, and at 6 months and 48 months assessments for Denver) (Kitzman et al., 1997, Olds et al., 2004b).

Child behaviour, language and cognitive development

A myriad of behavioural observations, language and cognitive tests, and educational outcomes were reported throughout the studies. This review focussed only on objective outcomes derived from medical records or school-based assessment. Follow-up at 48 months in the Elmira cohort found 45% fewer behavioural and parental coping problems for nurse-visited children as recorded by physicians (Olds et al., 1994). There was no effect on behavioural problems reported by teachers for the Memphis cohort (Olds et al., 2004a) and no comparable objective measures from the Denver cohort (Olds et al., 2004b). The Elmira cohort did not demonstrate any positive effects on child intellect or educational outcomes (Olds et al., 1994). Both the Memphis and Denver studies demonstrated some improvements in intellectual development and language, concentrated among the low psychological resources subset, and measures were of unclear significance (Olds et al., 2002, Olds et al., 2004b).

Box 2: Summary of key child health, safety and development outcomes.

Positive findings	Equivocal findings
<ul style="list-style-type: none"> - Fewer injuries and ingestions and hospitalisations among children - Families less likely to be involved with child abuse or neglect cases - Home environment more conducive for children’s development - Better developmental outcomes for children of most disadvantaged mothers 	<ul style="list-style-type: none"> - Little impact on parenting and development for children whose mothers were least disadvantaged - No consistent reported improvements in child behaviour

Economic self-sufficiency outcomes

The third objective of the NFPP was to improve families’ economic self-sufficiency. The keys means to achieve this was through improving maternal education and employment. Lessening the use of welfare adds a strong cost saving dimension to the program. The key findings are described in table 6.

Table 6: Key results for markers of economic self-sufficiency in the three study populations.

Outcome	Elmira	Memphis	Denver
Use of welfare	Less use of welfare and food stamps at 15 years for unmarried women of low socioeconomic status (welfare use 60.4 vs. 90.3 months, difference 29.9 95% CI 9.0 to 50.7; p=0.005, and food stamps 46.7vs. 83.5 months, difference 36.8 95% CI 14.6 to 59)	Less use of welfare (mean - 1.75 months, ES 0.22; no CI, p 0.01) Less use of food stamps (MD 1.83 months, Effect size 0.24; no CI, p0.004)	No effect
Maternal employment	7 months more employment among unmarried women of low socioeconomic status at 2-year follow-up (95% CI 0.25 to 13.89, p value not reported)	Mothers not attending school more likely to be employed at 36 weeks gestation (8% vs. 2%, p=0.01) but no long term differences	Average 1.14 months more employment at 2-year follow-up (95% CI 0.15 to 2.13, p=0.02)
Maternal education	No long term differences No difference at 46 months postpartum	No effect	No effect

CI= Confidence interval. ES= Effect size. MD= Mean difference.

Welfare use was reduced among nurse-visited mothers in two of the study populations. By the 15-year follow-up of the Elmira cohort, the unmarried nurse-visited mothers of low socioeconomic status had received welfare and food stamps 30% and 44% less often respectively compared to control groups (Olds et al., 1997b). The Memphis cohort reported smaller reductions in welfare use, but by the 12 year follow-up, the authors estimated the average saving was greater than the per child cost of the program (Olds et al., 2010). The Denver cohort did not show any significant effects on welfare dependency (Olds et al., 2004b). The study authors suggested this was due to better economic conditions at the time as well as welfare reforms. This result demonstrates suggests that the economic influences of the NFPP are dependent on external conditions and welfare systems.

Generally, there were no large impacts on improving maternal education or employment. Early improvements in employment were noted among all three trials, but these effects were not maintained over time(Olds et al., 2004a, Olds et al., 1997b, Olds et al., 2002, Olds et al., 1988). There were no effects on maternal education outcomes in the Memphis and Denver cohorts (Olds et al., 2004b)(Olds et al., 2004a). An initial positive impact on Elmira nurse-visited mothers did not last to the 46 months follow-up(Olds et al., 1988).

Box 3 Summary of key economic self-sufficiency outcomes

Positive findings	Equivocal findings
<ul style="list-style-type: none"> - Less use of welfare services - Increased employment in short-term after birth of child 	<ul style="list-style-type: none"> - No effect on maternal education outcomes - No long term effects on maternal employment

Adolescent outcomes

As the Elmira and Memphis cohort children were followed into adolescence, a further range of outcomes was collected, including school and employment outcomes, criminality, substance use and other risky behaviors.

Table 7: Key adolescent results of 15 and 19-year follow-up of the Elmira and 12 year follow-up of the Memphis cohorts

Outcomes	Elmira	Memphis
Education	No effect	Higher scores in reading and mathematics throughout 6 years of education (Peabody Individual Achievement Tests 88.78 vs. 85.70, p=0.009)*
Alcohol and other drug use	Less reported days of alcohol consumption (1.09 vs. 2.49; p=0.03, no CI) ¹	Less reported smoking of cigarettes, alcohol and marijuana at age 12 (1.7 vs. 5.1 OR=0.31, 95% CI 0.09 to 1.07, p=0.02)
Criminality	Less arrests (LI 0.2 vs. 0.45; p=0.03, no CI), and fewer convictions and violations of probation (0.09 vs. 0.47; p<0.001, no CI) ² at 15 years. Less arrests (10% vs. 30 %; RR 0.33; 95% CI, 0.13-0.82) and convictions (4% vs. 20%; RR 0.20; CI 0.05-0.85) for girls only at 19 years.	No effect
Risk taking behavior	Fewer instances of running away (LI 0.24 vs. 0.60; p=0.003, no CI) ³ and fewer sexual partners (0.92 vs. 2.48; p=0.003, no CI) ⁴ at 15 years. Among girls of unmarried, low socioeconomic mothers fewer pregnancies (11% vs. 30%; RR 0.35; 95% CI 0.12-1.02) and less Medicaid use (18% vs. 45%; RR 0.40, 95% CI 0.18-0.87)	Not reported
CI= Confidence interval. LI=Log Incidence *Effect significant in children of mothers with low psychological resources only ¹ The 56% reduction in the number of days that children reported drinking alcohol was no longer statistically significant in a 2006 reanalysis (NFP, 2006) ² The 81% reduction in youth convictions was found to be only a trend in a 2006 reanalysis (NFP, 2006) ³ The 60% reduction in number of times children reported running away from home was no longer statistically significant in a 2006 reanalysis (NFP, 2006) ⁴ The 63% reduction in number of sexual partners was found to be only a trend in a 2006 reanalysis (NFP, 2006)		

At 15 years of age, adolescents from the Elmira cohort of unmarried, low socioeconomic mothers reported fewer instances of running away, fewer arrests, fewer convictions and violations of probation, fewer life time sex partners and less days of alcohol consumption in previous 6 months (Olds et al., 1998). However, in an unpublished reanalysis these results did not retain their significance statistically (NFP, 2006). There was no change in self-reported antisocial acts or major delinquent acts (Olds et al., 1998).

By 19 years of age, analysis of treatment effects by gender found girls were less likely to be arrested and convicted, but there was no longer a significant difference for boys (Eckenrode et al., 2010). At 19 years, there were no overall effects on high school graduation, economic productivity, number of sexual partners, use of birth control, teen pregnancy, or use of welfare. Girls born to unmarried, low socioeconomic mothers had fewer children and less Medicaid use than control counterparts (Eckenrode et al., 2000).

At 12 years of age, the Memphis trial found nurse-visited adolescents reported fewer days of having used cigarettes, alcohol or marijuana. Additionally those born to mothers with low psychological resources scored higher on reading and mathematical testing throughout schooling grades 1 to 6 (Kitzman et al., 2010).

Box 4: Summary of key adolescent outcomes

Positive findings	Equivocal findings
<ul style="list-style-type: none"> - Less substance use - Reduced criminality before age 15 	<ul style="list-style-type: none"> - No effects on education for overall cohort - Not sustained effects on criminality for boys

Results of literature search for alternative early childhood programs

Early childhood development programs with high level of evidence

Among the literature there are some 'stand out' early childhood interventions cited as having significant long-term results from well-designed mostly randomised control trial studies. Alongside the Nurse-Family Partnership Program are Triple P, The Incredible Years, High/scope Perry preschool, the Carolina Abecedarian program and the Chicago Child-Parent Centres (see box 5). (Robinson et al., 2011, Macmillan et al., 2009, Milldon and Polimeni, 2012, Tully, 2009, Moore and McDonald, 2013).

Box 5: Early childhood interventions frequently demonstrating strong evidence of positive effects (Robinson et al., 2011)

- **Triple P:** multilevel, multi-age intervention to improve parenting and reduce conduct disorder; includes group and individual components; mode of delivery, duration and intensity vary at different levels
- **The Incredible Years*:** multi-component parenting program, targeting parenting training, children's social skills and (indirectly) parent-child and teacher-student interaction; trialled with range of social and emotional and clinically diagnosed conduct disorders.
- **High/Scope Perry Preschool*:** enriched intensive half-day, full-week preschool curriculum with home visits, attendance one to two years.
- **Carolina Abecedarian Program:** full-day day care for children aged six months to five years with enhanced learning activities and regular support for parents.
- **Chicago Child-Parent Centres*:** half-day, full year centre-based education with parent involvement.
- **Nurse-Family Partnership:** parent home visiting support provided by nurses to low income, first-time mothers; duration antenatal to two years.

*Targets children age three and over

Large-scale early childhood programs

The US and United Kingdom (UK) provide examples of early childhood development programs implemented on a large scale as part of key national policy. Examples include Early Head Start and Healthy Families America from the US, and Sure Start from the UK. Even though these programs were based on successful pilots, evaluations have found inconsistent or equivocal effects once they were scaled up (Robinson et al., 2011). The UK's Sure Start was initially rolled out to 5000 families across 150 disadvantaged communities targeting families the ages of 0 to 3 years (Melhuish et al., 2008). Evaluations have demonstrated some positive effects in up to 5 of 14 outcomes, but also revealed several outcomes that were worse for families receiving the services (NESS, 2012). Additionally, the evaluations were limited by their quasi-experimental observational study design and time lag in collecting data. Healthy Families America and Healthy Families Alaska were derived from the Hawaii Healthy Start Program (Duggan et al., 2005). This home visiting program focused on the prevention of child abuse and neglect and the promotion of child health and development in families identified as 'at risk', but evaluations have not been convincing (Duggan et al., 2005). Early head start is a mix of home and centre-based early education, parenting and nutrition education, health services and mental health services for mothers and children, and family support services (Love et al., 2005). The underwhelming evidence from these population level programs illustrate the difficulties with maintaining effectiveness of the original design components when up-scaling such complex interventions (Duggan et al., 2005).

Early childhood development interventions targeting Aboriginal families

The literature search targeting early childhood interventions for Aboriginal families revealed a lack of quality studies. A Closing the Gap Clearinghouse brief found few published studies of home visiting or parenting programs developed specifically for Aboriginal families in Australia (Milldon and Polimeni, 2012). The authors could only

identify two mainstream home visiting programs that included a proportion of Aboriginal mothers (ranging from 6% to 30%)(Armstrong et al., 1999, Quinlivan et al., 2003) (Table 8); one non-peer reviewed review article (Herceg, 2005); and the qualitative findings of one pilot study(Sivak et al., 2008). The two home visiting programs did not report outcomes for Aboriginal families separately, which limits their utility in this setting.

A review of early childhood interventions specifically developed for Indigenous communities included programs in Australia, Canada, New Zealand and the United States (countries with parallel histories of colonisation) identified five Indigenous specific early intervention programs (Munro, 2012). Only two met their criteria for quality: a New South Wales Health Department maternal child health intervention (NSWHealth, 2005) and a US home visiting model for reservation based American Indian mothers (Walkup et al., 2009) (see table 8). However the New South Wales intervention used historical controls only, and has not been peer-reviewed. While the US study did not follow-up after 12 months and relied on many subjective measures (e.g. parental report).

Table 8: Studies concerning Australian or Aboriginal early childhood interventions

Name	Author	Population and setting	Description
NSW Aboriginal Maternal and Infant Health Strategy, RCT.	NSW Health, 2005	689 Aboriginal mothers across 6 area health regions in rural/remote New South Wales involved during 2003-04; compared to clinical data from 1996-2000.	Aim: to improve the health of Aboriginal women during pregnancy and decrease perinatal morbidity and mortality. Model: seven community-based antenatal/postnatal programs. State wide training for midwives and Aboriginal Health Workers to deliver program. Results: less pregnant women under 20 years of age, earlier antenatal appointments, reduction in low birth weight babies, improved breast feeding rates, no change in smoking. *Used a historical comparison, so influence of external factors versus direct impact of intervention cannot be determined. Not published in peer-reviewed literature.
Post-natal home visits in teenage mothers, Western Australia.	(Quinlivan et al., 2003)	RCT of 139 teenagers attending their first antenatal appointment in Western Australia. 25% participants were Aboriginal	Aim: reduce adverse neonatal outcomes; improve maternal knowledge of contraception, vaccination schedule and breastfeeding. Model: 5 structured postnatal home visits by nurse-midwife. Follow-up at 6 months. Results: reduction in neonatal adverse outcomes and increase in contraception knowledge.
Miller Early Childhood Sustained Home visiting programme	Kemp, 2011	208 eligible at risk mothers living in a socioeconomically disadvantaged area in Sydney	Aim: To improve in quality of the home environment for child development (12-24months), parent-child interaction and child development at 18 months Model: A sustained and structured nurse home visiting antenatal and postnatal parenting education and support program-the Miller Early Childhood Sustained Home visiting programme (MECSH)- embedded within the established local comprehensive universal maternal, child and family health service system. Delivered by nurse between 26 weeks gestation and up to child's second birthday, plus group activities Follow-up: 24 months Results: Improved breastfeeding, mothers' emotional and verbal responsiveness. No impact child-maternal interaction, or child development. (Results not disaggregated by Aboriginal status)

Table 8 continued

Nurse home visiting to vulnerable families with newborns.	(Armstrong et al., 1999)	RCT of 181 women at risk enrolled after birth, through self-reported vulnerability questionnaire at a Brisbane women's hospital 6% intervention and 9% control mothers were Aboriginal.	Aim: To improve child health, postnatal depression, parent stress, Home environment, satisfaction with child health services. Model: A home visiting program that targeted families at great risk for poor child health and developmental outcomes. Nurse, social worker and paediatrician team deliver program over 6 months post-partum. Follow-up: 6, 12, 18 months Results: Initial improvement in post-natal depression scores, experience of parental role, better home environment, satisfaction with services, positive maternal-infant interaction. Not sustained at follow-up. (Results not disaggregated by Aboriginal status)
Family Spirit Program	Walkup et al. 2009	RCT of 167 reservation-based young American Indian mothers, Arizona, US. Age range 14-22.	Aim: improve mothers' childcare knowledge, skills and involvement. Model: 25 home visits from American Indian paraprofessionals with a focus on pre-natal and infant care parent education as well as family planning, substance abuse and problem solving. Follow-up: 12 months Results: Increased parenting knowledge, less parent report of infant impulsivity, peer aggression, and separation distress in the intervention group. No differences in parenting stress, maternal depression, substance abuse or maternal social support.
Early Start	Fergusson et al., 2005	443 mothers in New Zealand randomized identified as facing stress and difficulty 25% Maori	Aim: To provide families with sources of assistance, support, empowerment and advice to address issues relating to health, parenting and related matters during the preschool years. Model: A social learning model approach to home visiting. Elements include: assessing family needs, develop positive partnership, collaborative problem solving, provision of support and mentoring. Delivered by nurses or social workers for up to 36 months (mean of 24 months). Follow-up: 36 months Results: Improved use of child health services, reduced rates of hospital attendance for child injury/poisoning, increased parenting and non-punitive parenting, reduced rates of severe parent/child assaults, reduced early problem behaviours.

Comparison of the NFPP studies' key results to alternative programs

In this section, results of the NFPP studies across the four key domains are compared to alternative programs from the literature.

Maternal outcomes

Maternal smoking cessation was not commonly an outcome of published studies of early childhood or parenting programs. A Cochrane review of psychosocial interventions for supporting women to stop smoking in pregnancy found mixed results (Chamberlain et al., 2013). There is little published literature of specific smoking cessation interventions targeting Aboriginal women during pregnancy (Healthinfonet, 2013). The NSW Aboriginal Maternal Infant health program noted an *increase* in smoking rates among mothers, though not statistically significant (NSWHealth, 2005). The Dutch RCT of the NFPP also demonstrated a significant reduction in cigarettes smoked per day and cigarettes smoked near the baby among nurse-visited women (Mejdoubi et al., 2013a).

Few other early childhood studies report on maternal health and pregnancy outcomes (Shaw et al., 2006) and when they do, results are inconsistent (Bull et al., 2004). In Australia, the Sydney MESCH trial was unsuccessful in improving incidence of low birth weight (Kemp et al., 2011). The NSW Aboriginal Maternal and Infant Health Strategy did report a reduction in low birth weight rates, however this was compared to an historical control so changes may reflect external influences (NSWHealth, 2005).

Improvements in family planning have been achieved in other programs. An Australian based nurse-midwife visiting program increased effective contraceptive use, but did not report on follow-up pregnancy rate (Quinlivan et al., 2003). Two programs from the US successfully reduced the number of repeat unplanned pregnancies in African American teens (Shaw et al., 2006, Lopez et al., 2012). Both studies were generally limited to this objective and neither provided information on sequence generation, concealment, or blinding, which reduces the reliability of these results. In contrast, the Hawaii Healthy Start home visiting program found no effect on repeat birth occurring within two years (El-Kamary et al., 2004).

Despite its significance to childhood safety and development, domestic violence is not a frequently reported outcome among early childhood interventions. A Dutch implementation of the NFPP was adapted to include a stronger focus on domestic violence (Mejdoubi et al., 2013b). At 24 months follow-up, major physical assault was significantly lower in home visited mothers (OR .46; 95% CI 0.24 to 0.89). Over the course of the intervention, reports of major psychological aggression and minor physical assault reduced significantly more for the home-visited mothers. The Hawaii Healthy Start Program reported a limited impact on partner violence; only those who received over 75% of visits recorded repeated physical abuse fewer times than their counterparts (Duggan et al., 2004).

Child outcomes

A strong outcome of the NFPP studies was the reduced rates of childhood injuries and ingestions. The Early Start home visiting program from New Zealand demonstrated a relative risk reduction of 0.67 (95%CI 0.45 to 0.98) for hospital attendance for accident, injury or poisoning in the first three years of life among the intervention arm. This effect endured to the most recent follow-up at age nine (Fergusson et al., 2005). A Brisbane based postnatal home-based intervention initially reported a RR 0.44 (95% CI 0.19 to 1.01) of maternal reported injury (not medical records) at four months, but did not report on this outcome in the 18 month follow-up (Fraser et al., 2000). Most other initial differences of this study were not sustained, which casts doubt that this outcome endured.

The literature search revealed that many early childhood interventions that were specifically designed to prevent child maltreatment failed to show significant impacts. Notable examples include Hawaii Healthy Start, Healthy Families America and Healthy Families Alaska (Duggan et al., 2004, Donelan-McCall et al., 2009).

MacMillan et al.'s review (2009) on preventing child maltreatment highlighted the NZ Early Start and Triple P programs alongside the NFPP as programs with strong, high quality evidence of reducing child maltreatment (Macmillan et al., 2009). The Triple P program trial randomised families at a county level in the US. Comparison pre and post the 2-year intervention revealed decreased rates of substantiated cases of child maltreatment, injuries, and out of home placements (Prinz et al., 2009). However, the study has been criticised for its randomisation and statistical methods (Macmillan et al., 2009). The study also does not include the average age of the participating children, which makes it difficult to determine its applicability as an early childhood (from birth to age three) intervention. Early Start in NZ reduced parents' reporting of severe physical assault (4.4% vs. 11.7, $d=0.26$ 95% CI 0.07 to 0.48), but there was no difference in reported contact with child services for maltreatment claims (Fergusson et al., 2005). This incongruity could reflect surveillance bias: that abuse or neglect was more likely to be noticed because intervention families had more contact with health workers. After nine years, intervention parents' reporting of "harsh punishment" (shaking, hitting with object or fist, burning etc.) remained significantly less than controls (9.8% vs. 20.1%,

$d=0.29$ 95% CI 0.09 to 0.49) but there was no data regarding substantiated maltreatment cases (Fergusson et al., 2005).

A comparative review of the effectiveness of 33 home visiting programs in reducing child maltreatment used direct and indirect measures of child abuse and neglect to quantify how many cases of maltreatment each intervention prevented (Dalziel and Segal, 2013). Of programs targeting low to medium risk populations, the Elmira trial was nearly twice as effective as the nearest intervention. It was calculated to prevent the equivalent of 47 cases per 1000 children of maltreatment (Dalziel and Segal, 2013). However, the medium to very high risk population programs, the Denver and Memphis studies were outperformed by the Child and Youth Program Module from Baltimore with 83/1000 cases avoided; Quinlivan et al.'s WA based RCT with 123/1000; and the Community infant project from Colorado with 150/1000 cases avoided. In comparison, the Denver and Memphis NFPP studies achieved rates of 79/1000 and 16/1000 respectively (Dalziel and Segal, 2013).

The Community Infant Project from the US was an interdisciplinary early intervention that reduced confirmed episodes of child abuse among participating families compared to a control cohort (Huxley and Warner, 1993). Quinlivan et al.'s trial of a 6 month home-visiting intervention for teenage parents in Western Australia found fewer adverse outcomes among the intervention cohort (adjusted RR 0.22 95% CI 0.02 to 0.98) (Quinlivan et al., 2003). The wide confidence intervals, inclusion of all cause neonatal death together with non-accidental injury and foster care outcomes, and short follow-up makes these results less striking. The US based Child and Youth Program Module involved 10 visits from a low-skilled health worker who reported fewer suspected cases of abuse reported among intervention families, but did not report substantiated cases (Hardy and Streett, 1989).

The literature is mixed on the impact of home visiting programs on the HOME measures of childrearing environments with both positive (Kendrick et al., 2000), and equivocal findings (Kendrick et al., 2008) presented in systematic reviews. Other home visiting programs demonstrated patchy (Caldera et al., 2007, Kemp et al., 2011, Melhuish et al., 2008) or short-lived (Armstrong et al., 1999) effects to HOME scores. In comparison, the Denver and Memphis studies achieved better overall and individual HOME scores.

The NFPP studies showed limited impacts on objective educational outcomes. In contrast, the Carolina Abecedarian Program is an early childhood intervention that has produced strong, long lasting cognitive and educational outcomes. A longitudinal RCT reported that IQs of the intervention arm children ranged between 7.9 and 20.1 points higher than those of the control children between 6 and 54 months of age (Martin et al., 1990). This impact remained 10 years after intervention ended: children who received the preschool intervention significantly outscored controls in academic achievement and were less likely to be retained in grade or placed in special education (Ramey et al., 2000). There are some limitations to the Abecedarian results. Outcomes measures relied on questionnaires or self-report and it is not clear if the interviewers were blinded. Also, the authors did not follow an intention to treat analysis as 11% of families assigned to be in the intervention arm dropped out of the study as compared to only 3% of controls (Ramey et al., 2000). This may have created a bias within the intervention arm of families who were more committed to their child's education.

Economic self-sufficiency

Systematic reviews suggest that home-visiting programs in general do not assist mothers to enter employment (Sweet and Appelbaum, 2004, Bull et al., 2004). In contrast the Carolina Abecedarian Program achieved long lasting impacts in both

education and employment for mothers whose children attended the Abecedarian preschool(Ramey et al., 2000).

Adolescent outcomes

Educational outcomes were limited to the Memphis cohort and only for children of the most at risk mothers. In comparison, a Carolina Abecedarian Program RCT reported that by the age of 21, children who had attended the preschool program were nearly three times as likely to be attending a 4-year college course and young adults with preschool treatment were more likely to be engaged in skilled jobs (47% vs. 27%, $p < 0.05$)(Campbell et al., 2002).

There are no comparable early childhood intervention studies that reduce criminality in later adolescence. However, the unpublished statistical reanalysis of the Elmira 15-year follow-up puts the reliability of this outcome into question.

The reduced substance use achieved by the NFPP is also a very relevant outcome for NT Aboriginal communities. A separate follow-up study of Abecedarian participants also reported that the treatment group as adolescents had delayed onset of smoking by average 5.5 years and marijuana use by 3.7 years, though these were unadjusted figures (Muennig et al., 2011).

DISCUSSION

Review of the 24 articles reporting on NFPP trials across three different US populations revealed a wide spectrum of results of varying quality, strength and relevance to the NT context. Pertinent positive and equivocal outcomes were found in each domain of maternal and birth outcomes, child health, safety and development outcomes, economic self-sufficiency of families, and adolescent outcomes.

Performance of the NFPP against alternative programs was generally favourable, especially against large-scale population wide interventions and interventions targeting Aboriginal families. Alternative programs were commonly smaller in scope and followed for short periods (e.g. 12 months).

The key positive maternal outcomes were reduced maternal smoking, longer intervals between pregnancies, increased use of services and partner stability. Reduced smoking is particularly relevant in the NT where smoking rates amongst Aboriginal mothers remain high despite national and local efforts to reduce smoking. The NFPP outperformed alternative programs for its effects on maternal smoking.

Poor maternal nutrition, low birth weight and perinatal complications are important issues in the NT so the lack of consistent effects on maternal health or birth outcomes is a pertinent weakness of the program. However, there are no strong alternatives. While other programs have demonstrated longer spacing of pregnancies, these tended to lack the breadth of the NFPP. Domestic violence continues to be a major problem among Aboriginal communities in the NT. The results from the Dutch adapted NFPP suggest that changes could be made for an NT implementation to improve effectiveness against domestic violence, though these would need to reflect the particular issues implicated in domestic violence among these communities.

The positive effect of the NFPP on childhood injuries and ingestions is very relevant for the NT Aboriginal community setting, where rates of child injury and hospitalization are particularly high. Reducing hospitalisations in a remote population could also confer significant savings from medical evacuations and repatriation. There is the potential for additional impacts that may not have been demonstrated in the original studies, such as reduction in childhood anaemia and growth faltering.

Objective outcomes for child maltreatment were reported for the Elmira trial only, with Memphis and Denver relying on indirect measures to show effects. Child maltreatment was identified as a key objective of many early childhood interventions, but few have been able to make positive impacts. For the few effective studies, methodological issues impact on the reliability of their findings. The California evidence-based Clearinghouse for Child Welfare, a US based collaboration, which identifies and reviews evidence of practices relevant to child welfare, gave the NFPP the only top scientific rating for a home-visiting program regarding its evidence of preventing of child abuse and neglect (CEBC, 2013). In this context, the child maltreatment outcomes across the NFPP studies are significant.

The NFPP was successful in helping mothers create a childrearing environment more conducive for children's development as measured through the widely used HOME scores. These results are not unique to the NFPP, but they appear stronger than the alternative programs'.

Improving educational outcomes for Aboriginal people is fundamental to bringing about improvements in other social and health problems. The objective improvements to

children's academic development and employment of mothers of the Carolina Abecedarian program remain unmatched by any of the NFPP cohorts, limitations notwithstanding.

While the reduced rate of criminality for males in the Elmira cohort seen at 15 years had dissipated by 19 years it remained for females and still represents a delay in interaction with the criminal justice system. This is highly pertinent to the NT context where youth offending rates are very high amongst Aboriginal adolescents. However, the 2006 reanalysis of these results brings these outcomes into question and without any more information regarding the status of the original results, it is not possible to offer a definitive interpretation.

This review has some key limitations. A meta-analysis of the data from the trials was beyond the scope of this review, but would have served as an effective means to aggregate and present the NFPP results. Similarly, results and data were not statistically reanalysed to produce like outcomes (e.g. effect size), which limited direct comparisons between the trials and to the alternative interventions.

CONCLUSION

The Federal government has signalled its interest in funding early childhood programs for Aboriginal families. There is already substantial investment in early childhood programs in the NT but evidence based programs and perceptible benefits to children and families are lacking. There is an opportunity to implement effective programs for Aboriginal families in the NT targeting early childhood development. However, this task should be approached cautiously if we are to learn from the many examples of ineffective programs.

The NFPP is one of the most robustly evaluated early childhood interventions. There are also important weaknesses in their design including lack of independence of researchers, unclear participant flow and attrition in follow-ups, and a tendency to report intermediate markers, without explanation of the clinical or 'real life' implications.

The strongest outcomes were found in areas of reduced maternal smoking, longer birth intervals, improvements in parenting skills, reduction in childhood injuries and hospitalisations, reductions in child maltreatment cases and reduced substance use among adolescents. Maternal smoking, child maltreatment, child injuries are important priorities for Aboriginal people in the NT. The ability for the program to be adapted to be delivered within an Aboriginal community controlled health service further adds to the likely effectiveness it would have for Aboriginal families.

However, there were pertinent areas where the NFPP failed to demonstrate reliable improvements. These included maternal health and birth outcomes, domestic violence, and maternal employment and education. Its impact on adolescent criminality cannot be reliably deduced at this stage and will require longer follow-up of the different RCT cohorts. This could be another highly relevant outcome for the NT context.

In comparison to other programs in the literature the quality and strength of the results of the NFPP RCTs stand up favourably. The breadth and reliability of its positive outcomes remain unmatched by any one *individual* program.

The findings of this review support the decision to expand the NFPP in the NT but also suggest that other approaches such as those of the Carolina Abecedarian Program can be drawn upon for targeting other key areas such as child education.

However, the current pilot of the ANFPP in Alice Springs and other Aboriginal communities should be evaluated as a priority. Only with local data will we know how this unique context and its challenges will impact on the feasibility, delivery and outcomes of the program. This information should then inform decisions to expand the Nurse-Family Partnership Program to other Aboriginal communities in the NT. v

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