ARC Journal of Pediatrics
Volume 10 Issue 3, 2025, PP 7-12
ISSN No. (Online) 2455-5711
DOI: https://doi.org/10.20431/2455-5711.1003002
www.arcjournals.org

Early Intervention Programs for Developmental Delays in Children

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Abstract

Childrens' early experiences shape the architecture of their brains. Research shows that there are critical periods of brain development and children who face adversity too early might permanently disrupt the developing neuronal pathways of their brain. Children with developmental delays have to face additional adversity because of their disability. Early intervention strategies are a successful way to reverse or mitigate the effects of toxic stress. The earlier they are implemented, the more successful they are. Early intervention programmes have positive short term impacts for the cognitive, behavioural and performance scores, but also have a tendency to fade out later in childhood. More importantly, they have long term impacts to society by preventing mental, emotional and behavioural disorders, decreasing criminality and increasing lifelong earnings for the individual. Early intervention programmes are cost effective with returns from $1.26 to $17.91 per dollar spent.

Keywords: *Acute malnutrition, 24-hour dietary recall, dietary diversity, feeding practices, under-five children.*

1. INTRODUCTION

Children's' emotional development is a dynamic, ever changing process. As children grow, the emotions they experience shape the architecture of their brains.[1] This is the resource they utilise which will help define meaningful relationships, endorse resilience over adversity and provide them with the ability to cope with the stress of everyday life. Children who grow up in environments with poorer stimulation are more likely to be at risk for developmental delay. [2]

Overwhelming stress, signified "toxic" encountered during early critical periods of brain development can seriously hamper normal development probably due to the release of the stress hormone cortisol disrupting the budding of neuronal pathways. For example extreme lack of stimulus as in severe neglect has been shown to decrease brain power.[3] As a result, there is considerable variation in the ability of self regulation and impulse control and failure to attain such executive function might be more disruptive for future school work. Early adversity can thus be correlated to poor academic achievement, unhealthy lifestyle choices as well as health problems as diverse as autoimmune disease, cardiovascular disease and depression. Build up of resilience through early intervention in children especially prone to experience early adversity can be used to reduce the detrimental effect of toxic stress, and reverse these trends.[4]

According the Commonwealth of Australia Department of Health and ageing "Early intervention is the process of providing specialist intervention and support services for a person who needs them, either early in the life course, and/or early in the development of an issue or problem. The term (...)can be used to refer to interventions for infants and young children who are known to have additional needs because of a developmental delay, learning difficulties, a disability, sensory impairment (e.g. vision or hearing), or a specific risk or disadvantage. We will call this Early Childhood Intervention, because it specifically occurs in the early years of life".[5] It is incorporated in the American Public Law (Part C IDEA).[6]

The concept of early childhood intervention however is a new one. Shonkoff and Menzies reiterate Caldwell's categorisation on changing attitudes towards children with developmental delays. Beginning from the first half of the 20th century where developmentally delayed children were excluded from the everyday life in order to alleviate stigma, on to 1950-60s where they were identified but segregated to the era from 1970s onwards. During the third period there has been

a trend to identify and provide intervention strategies early. This trend has also been helped by landmark legislation and educational reforms in the United States.[7]

Defining disability is the first step in acknowledging the extent of the problem. According to the World Health Organisation's The International Classification of Functioning, Disability and Health: Children and Youth Version (ICF-CY) disability is neither purely biological nor social but instead the interaction between health conditions and environmental and personal factors.[8] Disability according to the same source can be either at the level of body function, sensory or motor, or restriction in participation. Taking into account this broader definition of disability up to 1 billion people or 15% of the World's population live with disability 110-190,000,000 of those have significant limitations in everyday life.[9] The Individuals with disabilities education act is a framework of laws that was voted in the United States in 1975 amended in 2004 and in 2009 served 2.6% of the total US population but true prevalence could be as high as 13%.[10,11] Developmental delay is defined as a significant differentiation of a child achieving the normal milestones and can be measured through standardised tests. In developing countries, from the 559 million children, 150 million have developmental delay.[12] Children with developmental delays can have the additional burden of poverty, low socio economic status and minority status. Early interventions are programmes designed to help children with or at risk of developmental delay. Since these children form a much heterogeneous population, the intervention strategies are quite diverse as well. Intervention strategies can start from before birth or at the age of 4 years, they can be home or centre based, or a combination of both.

They can be variable in the intensity as well as costs.[13-15] A substantial proportion of neonates will have significant health problems requiring public health resources. Preterm babies, LGA, or SGA neonates, NICU graduates, children who fall behind in achieving normal developmental milestones, survivors of neonatal congenital and perinatal infections, as well as children born into harsh social conditions such as a family with history of drug abuse or a history of mental health problems require a more rigorous follow up. [16] Still even in countries where Early Intervention Services have been implemented there is a marked disparity on participation with poor children more likely to defer receiving these services.[17]

The convention of the rights of the child mandates that "all children are entitled to full realization of their rights". Excluding children with developmental delays are not only unjust, but in direct violation of the rights of the child. The British 1970 Cohort Study showed that children with lower test scores but from a high socio-economic background improved during school. On the contrary children with good initial scores but from a lower background did worse. [18] Similarly studies have shown a disparity between children of different social classes which start to manifest at the age of 18-24 months. The gap is deeper between 5 year old children with developmental delay.[19] Children in the developing world are worse off as they also have to endure a nutrient poor diet, exposure to environmental toxins and infectious diseases.

2. SHORT TERM IMPACT

The full impact of the implementation of early developmental strategies is not readily perceived, as it might not become evident for some time. A report by the NSW Department of community services showed some reduction in subsequent low birth weight children, which was not consistent. There were small short term benefits in cognitive scores for participants of programs of parental education. Interestingly the same report did show behavioural changes in former participants who were adolescents with decreased instances of running away, arrest, convictions and decreased use of alcohol in nurse visiting home program. There were benefits for parents as well, with mothers from the Nurse Home Visiting Program having less number of pregnancies and being less likely to use physical punishment. The Nurse Home Listing program started earlier than parents as teachers programs.

The impact of Early Childhood Programs has been well documented. A Brookings Institution report in the United States summarized the impacts of five early childhood education programs. All of them showed improvement in cognitive skills and school outcomes, despite the emergence of a fade out phenomenon 1-2 years after school. The effects were more pronounced for children who were admitted to the programme at an earlier age and for Black African and Hispanic children. Programs which combined home visiting with centre based intervention were the most effective. [14] Implementation of good quality early interventions has been associated with short term but significant improvements in cognitive and social skills measured as 0.5-0.75 standard deviations. The

benefits again were more pronounced when the intervention had specific goals and individual oriented. [15] Families of newly diagnosed visually impaired children have reported satisfaction from implementation of Community Liaison Services in a tertiary hospital in comparison to controls. [16] Interventions implemented after early identifications of speech delay have resulted in improvements in multiple aspects of language acquisition. An improvement in social skills was also present but less consistently. [17] The National Early Intervention Study (NEILS) was conducted by the US Department of Education, Office of Special Education Programs. The most import reason for entering early intervention was speech delay (41%), followed by perinatal problems (19%), motor (17%) and global developmental delay (12%). The outcomes were positive at 36 months with 76% parents reporting that intervention had a lot of impact for the child, 20% reporting some impact and 4% no impact. Children's overall health at 36 months was not dissimilar to the entry although there were considerable variations in both ways. Maternal education was the best prediction factor for improved health. Speech functioning was higher at 36% months than at entry level. Importantly parents also reported children's' health as good or very good at 70% and looked optimistic for the future. By the time the children entered kindergarten, 32% were not in special education. The ones who needed special education required speech and language therapy (80%), occupational therapy (60%) and physical therapy (40%). Teachers' perception was that former Early Intervention participants were lagging behind in the use of hands, communication, with 50% having normal communication skills. 52% of former Early Intervention participants had appropriate thinking and reasoning skills, in contrast to 75% of normal children. Similarly to the result of satisfaction at 36 months, parents at kindergarten entry perceived their children's' health as excellent or very good (71%) and 22% as good. Parents were even more optimistic for their child, most expecting him to enter higher education and earn a college degree. [19]Accordingly, parents whose children received Part C Services reported positive experiences and felt empowered to discuss with health professionals and felt that services were appropriate. The effect was less in lower education of the mother and poorer families. [20]

3. LONG TERM IMPACT

Furthermore, there have been improved behavioural and emotional aspects which lead to long term reductions in criminality. [14] Economic hardships in families, substance abuse and mental health problems in parents, mothers with postnatal depression, family at risk for violence are all risk factors for having a child with developmental delay. [18]

The NEILS report did show that early intervention recipients lag behind social skills achieved by their peers. [19] Early interventions could spot early behavioural characteristics which might be a sign of conduct disorder thus preventing future mental illness or mitigating its severity. [5]

Early interventions have also been associated with the prevention of mental, emotional and behavioural disorder in young people. Conduct disorders are a known causative agent of substance abuse and adolescent delinquency. [21]

Early intervention is important for later academic achievement and decrease in grade retention. There was a difference in high school graduation, increased employment, welfare dependence and involvement with the law among early intervention recipients although of course it would be unethical to conduct a randomised control trial withholding intervention form children who would deem to benefit from it. [15] Model early childhood programs are comprehensive centre based programs in the United States. Longitudinal data suggest long lasting impacts in reduction of special education attendance, decreased likelihood of repeating a grade, higher IQ scores by 4.5 at age 21, reduced criminal activity and teen pregnancy. Similarly Nurse Home Visiting Programs showed fewer arrest in former participants and better outcomes at school. The long term effects were not known for less intense Programs such as Pre K, Head Start, and Early Head Start .[14]

3.1. Impact on Low and Middle Income Countries

Developments in the war against infectious diseases such as tuberculosis, HIV and malaria, as well as the fight against malnutrition have had a marked reduction in mortality. Children survivors however have a higher prevalence of developmental delays requiring special needs .[22] Improved nutrition alone is not sufficient for optimal brain development in the lack of caretaker emotional responsiveness. [23] Often however the emotional needs of children with developmental delays can be overlooked as developmental delay is associated with guilt and fear and such children can be hidden. [9] Children with

developmental delay face institutionalization and are more prone to violence, abuse and neglect. These can lead to further disability and behaviour problems. [9]Deficiencies in psychosocial stimulation lead to decreased developmental potential, poorer school outcomes, poor employment opportunities and lifelong dependency.[23] Developmental surveillance tolls are easy to implement and be incorporated in developmental screening tests akin to screening for height/weight by health professionals .Once identified, it is appropriate to provide even in resource poor settings increased awareness for psychosocial stimulation.[22] Children fare better when they receive psychosocial stimulation combined with nutritional supplementation than nutritional supplementation alone. Programmes that support home visiting or mother to mother visiting have also had positive impacts on mother by promoting natural coping strategies in the face of adversity and stress.[23,24] Stimulation can be combined with feeding practices as one to one counselling, interactive health messaging or forming mother baby groups.[23] Such interventions have a positive impact on the quality of life and improve cognitive, motor and behavioural development. Additional support to families can therefore be provided by facilitating the emancipation of children with developmental delays.[22]

4. COST EFFECTIVENESS

It can be difficult to measure the real impact of cost effectiveness of early intervention strategies as the benefits can be variable. Measuring for example the long term benefits that society reaps in reducing juvenile delinquency and teenage pregnancies is not easy. It might be more feasible to calculate cost effectiveness from short term benefits.

The average total expenditure in early intervention programs was $15,740. Children stayed on average 17.2 months which would be $916/month/child. There was significant difference in expenditure according to children's' needs. Children with at risk conditions required $549, those with communication delay only $642, those with developmental delay but no diagnosed condition $948 and children with a developmental delay arising from a diagnosed condition $ 1103. However most children in all categories required less than average. A proportion of the cost went to social service supports. Still, these cost are far less than required for institutionalisation and exclusion had the interventions not been implemented in the first place.[19]

A report from the economic advisers of the president of the United States showed that the economic returns to society would be $8.6 for every $1 spent and half of these earnings would come from future income of children when they grow up. Early childhood education can increase the individuals earnings in adulthood by 1.3-3.5%. That would translate to $9,166-$30,851 per lifetime excluding the cost of the program. Participants in the Abecedarian project a Carolina early intervention program have increased lifetime earnings of $44,000 while their mothers had $79,000. Families of affluent children spend seven times more on educational activities than poor families. Differences in development can be evened out and the children have the potential to acquire new skills on top of their existing ones. In total, if all children who are entitled to early intervention enrolled and participated in a programme they could generate wealth of $4.8-16.1 billion per cohort raising the United States Gross Domestic Product by 0.16-0.44%.[25]

A RAND corporation report described that the features of effective programmes were better training of caregivers, decreased children-staff ratio and intensive programmes. They found returns of $1.8-17.07 per dollar spent which would be $1400-240,000 per child.[26]

Should Pre K, an intervention before kindergarten be implemented in California the cost benefit ratio would be an estimated $2.62 per dollar spent. More intense programmes like the Model Early Childhood Programmes are even more cost effective. The Abecedarian Project yields $3.23 per dollar, the Perry Preschool from $5.15-17.14 per dollar and the Chicago Child Parent Centres $7.14. For example the Perry School Programme is more intense and expensive-it cost $12,356 in 1992 value. The returns were calculated as reductions in crime, higher adult earnings and decreased expenditure in supporting education as $70,000/ child[15] From these $8,815 were accrued directly to the child as future earnings, but the majority went to the tax payers and potential crime victims from reduction in crime (49,000) and reduction in the need for special education (7,000). Positive outcome were also noted for programmes less intense.[15] Nurse Home Visiting Programmes are also cost effective-for $5.68 per dollar invested returns in high risk children and $1.26 in low risk. Another analyst group found returns of $2.88 in both cohorts combined.[14] Nurse Home Visiting yield benefits per child of $11,000 for the cost of

$5,000, Nurse Family Partnership $26,280 for the cost of 9,118 and Home Instruction for Preschool Youngsters $3,313 for $1,837 (24).

Early childhood interventions reduce or mitigate the emergence of mental emotional behaviour in young people. The costs of conduct disorders in 13-16 year old in North Carolina, USA were $894 per adolescent, a quarter of which was due to involvement with the criminal justice system. The cost of juvenile arrests was $14.4 billion in 2004 in the United States whereas the costs on juvenile delinquency including costs of medical care, property damage are at a burgeoning $95 million.[22]

In Australia, the different interventions were considered but a more formal cost benefit analysis was deemed to be necessary as there were various differences between the respective society (13). In low income countries where resources and equipment are limited, there is great variability in early intervention strategies. However, early intervention can be incorporated along with the provision of basic health care needs such as nutrition. [22]

5. Conclusion

Children with developmental delay face additional adversity and burdens to achieve their full developmental potential. Fortunately, attitudes are changing, from alleviating the stigma to encouragement to full participation in everyday life. This attitude is humane and just and derives from the implementation of the World Health Organisation Declaration of the Rights of The Child. Apart from being ethical, investing in early intervention for children with developmental delay can reap tremendous benefits to the individual as well as society. The individual benefits from increased earnings throughout his lifetime, but society benefits too from decreased institutionalisation, decreased costs of supplemental education, which might have otherwise be required. Furthermore, it yields reductions in criminality and prevention of mental and behavioural disorders. Early interventions can have a great variability which makes them appropriate even for resource poor settings. They could be incorporated along with basic services provision such as humanitarian aid. Early interventions are cost effective which makes a case of prioritising them while allocating resources and diverting funds.

Declarations

Data Availability statement

All data generated or analysed during this study are included in this published article

Competing interests

The authors declare that they have no competing interests

Funding

No funding was given

Authors contributions

AA analyzed and interpreted the data

Acknowledgements

Not applicable

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Citation: *Anagnostopoulou Andriana. Early Intervention Programs for Developmental Delays in Children. ARC Journal of Pediatrics. 2025; 10(3):7-12. DOI: https://doi.org/10.20431/2455-5711.1003002.*