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Research report

Building for the future: influence of housing on intelligence quotients of children in an urban slum

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Introduction: Interventions on behalf of the marginalized in society can assume many formats. In an urban slum the Government of Delhi built one-room houses for some of the residents in what is termed a 'plot area'. Not all residents could be accommodated in the project and the remainder continued to live next door in shanty houses of the slum. Nineteen years later, young children who had migrated with their parents, have grown up and have children of their own. We looked at the development of the children living in the two types of accommodation.

Methods: A total of 373 children were studied. All children (n = 200) between the ages of 3.5 and 5.5 years in a cluster of five residential blocks in the plot area were studied. As a control, children in two large clusters of shanty houses (n = 173) were also studied. For development assessment the Central Institute of Education (CIE) Test was performed. This is an Indian adaptation of the Standford–Binet Test. Multiple regression analysis was utilized to determine the factors that influenced IQ most.

Results: The mean IQ of the children in the plot area was 92.5 (s.d. 13.38) and in the shanty houses 89.5 (s.d. 12.9) (p = 0.05). Analysis showed that the most significant factors affecting IQ were malnutrition in the first 6 months of life and attendance of the child at pre-school. For nutrition in the first 6 months, there was no difference between the groups. For attendance at pre-school, 110 of 200 in the plot area and 47 of 173 in the shanty houses were attending pre-school (p < 0.01).

Conclusion: We find that children living in the permanent houses had a significantly better IQ than those in shanty houses. A review of the literature did not reveal a comparable study.

Key words: housing, intelligence quotient, urban slums, development, children, India

Introduction

Since the advent of the first successful IQ test devised by Alfred Binet and Theodore Simon in 1905, researchers from time to time have tried to study various factors affecting what is believed to be the measure of a person's mental abilities. Although the contribution of genetic factors is not doubted, studies show that it is highly malleable and is influenced by environmental factors like nutrition and nurture (Cardon et al. 1992). In the case of poverty stricken slum dwelling children, environmental factors seem to override genetic factors and their IQ scores tend to decline with age as these children are brought up afflicted by a multitude of adverse factors such as poor housing, inadequate nutrition, parental illiteracy and infection (Klineberg 1963). Hurt et al. (1998) noted that 79% of children living in ghettos had IQ scores below 90. Poor housing is the *sine qua none* of slums. Can the provision of better housing for slum dwellers improve the prospects of IQ attainment by children? The present study was designed with the objective of looking into the impact of this factor on the IQ of young children.

Study design

The St Stephen's Hospital Community Health Department of Pediatrics has been working in the urban slum of Nand Nagari, Delhi for the last 20 years. Delhi, like the capital cities of many developing countries, attracts migrant workers from surrounding villages. They come to live in urban slum clusters around construction sites. Periodically the government relocates the slum dwellers to areas in the outskirts of the city. Nand Nagari is a relocation settlement started 20 years ago. Most of the residents in this area had come to Delhi 25 years ago. The government provided the people relocated here with 250 sq. ft plots of land, on which they built their houses (an area called the 'plot area'). When the land and resources

earmarked for the project ran out, the remaining population was left to live in shanty houses next door to the plot area. Whether a family lived in a shanty house or plot area is believed to be a matter of chance. The community health project has detailed information on all families living in the area. All the people, whether living in the plot area or the shanty house area, came from the same cluster of villages surrounding Delhi and arrived in Delhi around the same time. Twenty years later, young children who migrated with their parents have now grown up and have children of their own. We looked at the development of children living in the two types of accommodation.

Material and methods

The study was conducted between July 1998 and October 1999. In total 373 children between the ages of 3.5 and 5.5 years were studied. Out of these, 200 children living in five residential blocks in the plot area constituted the subjects, while 173 children in two large clusters of shanty houses served as controls. The health workers were asked to select the blocks where the job profiles of the breadwinner were similar. All parents with children in the eligible age group living in the selected areas were invited to participate in the study. More than 90% responded to the invitation and were included for IQ analysis. We did a check to ascertain that all children who participated were descendents of the people who were originally allotted to the area. There were none who had migrated to the area subsequently. The child's particulars including age, sex, religion, birth order, number of siblings, duration of breast feeding, age at onset of supplementary feeding, pre-school education, family structure (nuclear or joint), family's income, family size, parent's education and medical history were recorded on a pre-structured proforma. The child's growth curve charted by the Community Health Nurse was used to assess the history of their nutritional status. Developmental assessment was done using the Indian adaptation of the Stanford–Binet test, the Central Institute of Education (CIE) test (Thorndike et al. 1986). This instrument has been previously tested and standardized in northern India and has been used by several authors since 1957.

Student's t-test and analysis of variance were used to test the differences in the mean IQ levels among the different groups formed by each of the study variables. The associated study variable with the type of residential area (shanty/plot area) was assessed using the χ^2-test. Multiple linear regression analysis was used to identify the independent variables that had significant association with the children's IQ. All statistical analysis was carried out using BMDP (Bio-Medical Data Program) software from the University of Berkeley, California. When comparing the influence of different factors like malnutrition, cases with incomplete data available were excluded.

Results

Three hundred and seventy-three children were studied, of which 200 lived in the plot area and 173 lived in shanty houses. Three children in the plot area and five children in shanty houses did not complete the IQ test and so were excluded. Thus a total of 365 children had IQ testing done. Table 1 shows the IQ of the children in the two areas. The mean IQ of children living in the plot area (92.5 ± 13.4, n = 197) was significantly higher than those living in shanty houses (89.4 ± 13, n = 168; ±95% CI, $p < 0.05$).

Table 2 shows the composite group of 365 children according to factors that are known to influence IQ. Children who were malnourished in the first 6 months of life had significantly lower IQ ($p < 0.01$) than those of normal nutrition (IQ 83.8 ± 11.5 vs. 93.9 ± 13.2). Children of illiterate mothers had significantly lower IQ (mean ± s.d., 89.9 ± 13.0) than children of literate mothers (mean IQ ± s.d. = 93.8 ± 13.1; $p = 0.01$). Children attending pre-school had significantly better IQ (mean ± s.d. = 92.3 ± 11.8) than those who had not attended pre-school (mean IQ ± s.d. = 87.8 ± 13.3; $p < 0.01$). Other factors examined, including education of father, sex of the child, religion and family type (joint or nuclear), did not show significant association with IQ. Multiple regression analysis showed that the most significant factors affecting IQ were malnutrition in the first 6 months of life and the attendance of the child in pre-school.

Table 3 shows a comparison by area of the factors significantly affecting IQ. Maternal literacy was not significantly different in the two residential areas; 45 mothers (73%) in the shanty house area were literate compared with 61 (69%) in the plot area ($p = 0.3$). The number of children with malnutrition in the first 6 months of life was also comparable in the two areas; 51 children (31.1%) in the shanty house area had suffered malnutrition in the first 6 months of life compared with 49 (25.1%) in the plot area ($p = 0.2$). However, the number of children attending pre-school in the two areas was significantly different ($p < 0.01$); 110 children (53.1%) in the plot-area attended pre-school compared with 47 children (28.1%) in the shanty house area. We could find no difference in IQ in the two types of housing after controlling for attendance at pre-school (Table 3).

Discussion

An issue of grave concern has been that children living in poverty may be deprived of their optimal physical and mental potential. Nand Nagari, an urban slum area where we carried out our study, provided a unique arena of an unintentional experiment in social engineering. Twenty years ago migrant workers living in different parts of Delhi were relocated to Nand Nagari by government fiat. All were supposed to be

Table 1. IQ of children living in the two areas

Variable	Shanty house (n = 168)	Plot area (n = 197)	p-value	Difference (CI)
Mean IQ (±s.d.)	89.4 (13.0)	92.5 (13.9)	<0.05 (0.4–5.8)	3.1

CI = confidence interval.

Table 2. Univariate analysis of factors affecting IQ

Variable		n[a]	Mean IQ (±s.d.)	p-value	Difference (95% CI)
1 Nutrition in first 6 months of life	Normal	250	93.9 (13.2)		
	Malnourished	100	83.8 (11.5)	<0.01	10.0 (7.1–12.9)
2 Education of mother	Literate	106	93.8 (13.1)		
	Illiterate	259	89.9 (13.0)	<0.01	3.9 (0.9–6.9)
3 Schooling	No	207	87.8 (13.3)		
	Yes	157	92.3 (11.8)	<0.01	7.5 (4.9–10.2)
4 Education of father	Literate	211	90.8 (13.6)		
	Illiterate	154	91.2 (12.8)	n.s.	–0.4 (–3.1–2.4)
5 Sex	Male	196	92.2 (13.6)	n.s.	2.3 (–0.4–5.1)
	Female	169	89.8 (12.8)		
6 Religion	Hindu	174	90.7 (13.2)		
	Muslim	191	91.4 (13.3)	n.s.	0.7 (–2.0–3.5)
7 Duration of breast feeding (months)	>24	102	92.0 (12.7)		
	19–24	150	91.2 (12.6)		0.8[b] (–2.4–4.0)
	13–18	50	92.1 (13.7)		–0.1[b] (–4.5–4.3)
	7–12	31	87.0 (14.5)	n.s.	5.0[b] (–0.3–10.3)
	0–6	31	89.5 (16.0)		2.5[b] (–2.9–8.0)
8 Onset of supplementary feeding (months)	<6	194	92.2 (13.8)		
	7–12	143	90.3 (12.0)		1.9[c] (–0.9–4.8)
	>12	24	88.1 (14.4)	n.s.	4.1[c] (–1.8–10.0)
9 Family structure	Nuclear	310	91.0 (13.2)	n.s.	0.8 (–3.0–4.6)
	Joint	55	91.8 (13.6)		

CI = confidence interval; n.s. = not significant.
[a] A small number of children did not have their nutritional status, etc. recorded and so were not included for analysis of that factor. The number 'n' relates to those who were included.
[b] As compared with >24 months.
[c] As compared with <6 months.

given plots of land, but the land earmarked for the project ran out. The remaining families lived in shanty houses adjoining the plot area. Those in the plot area lived in permanent houses of brick and cement. The Community Health Department of St Stephen's Hospital, working in this area for 19 years, is not aware of any extraneous factors that influenced allotment to the plot area. It would seem a random allotment of families to plot area or shanty house area, made 20 years ago. In our study, the mean IQ of children living in the plot area was significantly higher (92.5) compared with the shanty house area (89.4) ($p < 0.05$). A comparable study could not be found on review of the literature. The study

Table 3. Distribution of factors significantly affecting IQ in the two areas

Variable		Shanty house (n = 168)	Plot area (n = 197)	p-value
Maternal literacy				
Proportion	Literate mother	27.0%	31.0%	n.s.
	Illiterate mother	73.0%	69.0%	
Malnutrition in first 6 months of life				
Proportion	Malnourished	31.1%	25.1%	n.s.
	Not malnourished	68.9%	74.9%	
Attendance at pre-school				
Proportion	Attended	28.1%	53.0%	<0.01
	Not attended	71.9%	47.0%	
Mean IQ	Attended	93.2	96.7	n.s.
	Not attended	87.9	87.7	n.s.

n.s. = not significant.

showed malnutrition in the first 6 months of life, maternal literacy and attendance at pre-school education were factors influencing the IQ of children.

Intellectual deficits secondary to malnutrition has previously been demonstrated by Mendez and Adair (1999), Perales et al. (1996), Galler et al. (1987), Sathy et al. (1991) and Upadhyay et al. (1989). Parental literacy has been speculated to be associated with child's IQ through heredity and environmental factors. Bacharach and Baumeiser (1998) have found maternal IQ to be associated significantly with child's health and child's IQ. However, Hurt et al. (1998) found no significant impact of parental IQ on child's IQ. Our study found maternal IQ to be significantly associated with child's IQ, but no significant association of father's IQ with the child's IQ. Project Head Start, initiated by the American government in 1965, has previously demonstrated the effect of attending pre-school education. This programme provided 1 or 2 years of pre-school education to children from low-income families, before they entered formal school. Children who attended the programme scored higher in IQ and achievement than controls during the first 2–3 years of elementary school (Schweinhart and Weikart 1986; Lee et al. 1988, 1990). Similar conclusions were drawn from the Carolina Abecedarian Project (Cambell and Ramey 1991). Our study also showed that children who attended pre-school had higher IQs than children who did not.

The fact that a literature review did not reveal a comparable study, with the IQ of children being compared in two types of housing accommodation, made us curious to find out whether it was housing *per se* that was influencing child's IQ or was it through some other factors present in a better housing area which had this influence. We compared schooling, maternal literacy and malnutrition in the first 6 months of life, the factors we had found to be significantly influencing IQ, in both types of accommodation. We found that maternal literacy and malnutrition in the first 6 months (when most babies are breast fed) were comparable in the two areas. Attendance at pre-school education was significantly different. More than twice as many children were going to pre-school from the plot area than from the shanty house area (47 vs. 110; $p < 0.01$).

It was interesting that although a significant difference was seen in the IQ of children between the two housing areas, it did not emerge as a significantly associated variable in multivariate analysis. This implies that housing *per se* is not associated directly but that other factors associated with housing have an important role to play. One of these could be the parental attitude that makes parents send a child to pre-school, as we saw in our study. About one-quarter (28%) of children were attending pre-school in the shanty house area compared with more than half (53%) in the plot area. The difference is statistically significant. Our study shows that among the factors that make for better IQ pre-school attendance was the factor that was most significantly different in the two types of housing. This shows that people living in better houses were more likely to send their children to pre-school. This finding is interesting as it is consistent with an attitudinal change brought about by moving up the scale from living in a slum to a house of one's own. Living in a slum is demoralizing and degrading. Such parents are likely to have less self-esteem, be less ambitious and have lower expectations of their children. The change in attitude would likely result in providing better opportunities, widened choices and optimal attainment of physical and mental potential of the child. This change in aspirations would perhaps be even more beneficial than the three-point improvement in IQ noticed in our study.

This was the first study of its kind and we are aware of the possible limitations within it. Children living in poor housing also have poorer sanitation and hygiene, and may have higher incidence of hookworm infestation and consequently more anaemia. Anaemia is known to affect the cognitive functions of young children (Youdim et al. 1989). This could be a contributing factor to the IQ difference seen in the two areas. It is also possible that although nutritional status was similar in both the areas, there could have been differences in micronutrient, vitamin and mineral deficiency in the diet of the children living in the two areas, which could influence IQ (Schoenthaler et al. 2000). We have not evaluated dietary content or blood levels of vitamins and minerals.

Thousands and millions are spent in policy planning and implementation to raise the status of the poor. Our results would suggest a novel concept in policy to address poverty for future generations. Aid, in this case simple houses, can assist in lifting the poor out of the cycle of poverty, slum dwelling, low self esteem, lowered IQ of children and poverty perpetuated into the next generation. Such aid may perhaps be small, but is a powerful empowerment tool and could be a significant step in ameliorating poverty.

References

Bacharach VR, Baumeister AA. 1988. Effect of maternal intelligence, marital status, income, home environment on cognitive development of low birth rate infants. *Journal of Pediatric Psychology* **23**: 197–205.

Campbell FA, Ramey CT. 1991. The Carolina Abecedarian Project. In: Early experience and children's competencies: new findings from four, longitudinal studies. Chair: M Burchinal. Symposium presented at the biennial meeting of the society for Research in Child Development, Seattle, WA.

Cardon LR, Fulker DW, De Fries JC, Plomin R. 1992. Continuity and change in general cognitive ability from 1 to 7 years of age. *Developmental Psychology* **28**: 64–73.

Galler JR, Ramsey FC, Forde V, Salt P, Archer E. 1987. Long-term effects of early kwashiorkor compared with marasmus. *Journal of Pediatric Gastroenterology and Nutrition* **6**: 847–54.

Hurt H, Malmud E, Braitman LE, Batencourt LM, Brodsky NL, Giannetta JM. 1998. Inner-city Achievers: who are they? *Archives of Pediatrics and Adolescent Medicine* **152**: 993–7.

Klineberg O. 1963. Negro-white differences in intelligence test performance: a new look at an old problem. *American Psychologist* **18**: 198–203.

Lee VE, Brooks-Gunn J, Schnur E. 1988. Does Head Start work: a 1-year follow-up comparison of disadvantaged children attending Head Start, no preschool and other preschool programs. *Developmental Psychology* **24**: 210–22.

Lee VE, Brooks-Gunn J, Schnur E, Liaw F. 1990. Are Head Start effects sustained? A longitudinal follow-up comparison of disadvantaged children attending Head Start, no preschool and other preschool programs. *Child Development* **61**: 95–501.

Mareck J, Shapiro IM, Burke A, Katz SH, Hediger ML. 1983.

Low-level lead exposure in childhood influences neuro-psychological performance. *Archives of Environmental Health* **38**: 355–9.

Mendez MA, Adair LS. 1999. Severity and timing of stunting in first two years of life affect performance on cognitive tests in late childhood. *Journal of Nutrition* **129**: 1555–62.

Perales CG, Heresi E, Pizarro F, Colombo M. 1996. Cognitive functions of school children with normal IQ and histories of severe and early malnutrition. *Archivos Latinoamericanos de Nutricion* **46**: 282–6.

Sathy N, Elizabeth KE, Nair MK, Bai NS. 1991. Growth faltering and developmental delay in children with PEM. *Indian Pediatrics* **28**: 255–8.

Schwienhart LJ, Weikart DP. 1986. What do we know so far? A review of Head Start Synthesis Project. *Young Children* **41**: 49–55.

Schoenthaler SJ, Bier ID, Young K, Nicole D, Jansenns S. 2000. The effect of vitamin-mineral supplementation on the intelligence of American school children: a randomized, double blind placebo controlled trial. *Journal of Alternative and Complimentary Medicine* **6**: 19–29.

Thorndike RL, Hagen EP, Sattler JM. 1986. *The Stanford–Binet Intelligence scale: Fourth Edition, Guide for administering and scoring*. Chicago: Riverside Publishing.

Upadhyay SK, Agarwal DK, Agarwal KN. 1989. Influence of malnutrition on intellectual development. *Indian Journal of Medical Research* **90**: 430–41.

Youdim MBH, Ben-Schachar D, Yehuda S. 1989. Putative biological mechanisms of effect of iron deficiency of brain biochemistry and behavior. *American Journal of Clinical Nutrition* **50**: 607–17.

Biographies

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