Effect of environmental factors on intelligence quotient of children

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ABSTRACT

Introduction: A child’s intelligence quotient (IQ) is determined by both genetic and environmental factors that start from the prenatal period itself. There is a lack of data on the factors which influence IQ in Indian children; therefore, we conducted a multicenter questionnaire-based study to determine the environmental factors which influence IQ in Indian children. Participants and Methods: In this cross-sectional observational study, we recruited 1065 schoolchildren between the age of 12 and 16 years from 2 government and 13 private schools in 5 towns, 6 cities, and 2 villages across India. All the children were administered a questionnaire consisting of various environmental factors such as parents’ education, occupation, income, and the physical activity of the students. IQ scores were assessed using Ravens Standard Progressive Matrices. An approximate IQ score was calculated using the score on the Ravens test. IQ scores were divided into three groups: below normal IQ (0–79), normal IQ (80–119), and high IQ (above 120). The data were analyzed using SPSS software. Results: In this study, it was observed that the environmental factors such as place of residence, physical activity, family income, parental education, and occupation of the father had an impact on the IQ of the children. Children living in cities (P = 0.001), children having physical activity more than 5 h/weeks (P = 0.001), children with parents having a postgraduate or graduate level of education (P = 0.001), children whose father having a professional job (P = 0.001), and those with a higher family income (P = 0.001) were more likely to have high IQ. Conclusions: In the present study, we found that various environmental factors such as place of residence, physical exercise, family income, parents’ occupation and education influence the IQ of a child to a great extent. Hence, a child must be provided with an optimal environment to be able to develop to his/her full genetic potential. Keywords: Children, intelligence, physical activity, socioeconomic status

Intelligence of a person involves the ability to reason, plan, solve problems, think abstractly, comprehend complex ideas, learn quickly, and learn from experience. It is not merely book learning, a narrow academic skill, or test-taking smarts. Rather, it reflects a broader and deeper capability for comprehending our surroundings — “catching on,” “making sense” of things, or “figuring out” what to do.[1-3]

Just like any other human trait, intelligence varies from person to person. Individuals differ in intelligence due to differences in both their environments and genetic heritage.[4] Most studies estimate that the heritability of intelligence quotient (IQ) is somewhere between 0.30 and 0.75.[5] This indicates that genetics plays a bigger role than environment in creating IQ differences among individuals. However, members of the same family also tend to differ substantially in intelligence (by an average of about 12 IQ points).[5]

Studies on the influence of gene–environment interaction on intelligence have shown that genetic and shared environmental components change in opposite directions as a function of socioeconomic status (SES), i.e., the heritability of IQ is very low for lower SES individuals and vice versa.

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The most probable explanation for this could be that children in poverty do not get to develop to their full genetic potential. The IQ difference between children adopted by upper-middle-class parents and those adopted by lower SES parents was observed to be approximately 12 points.\(^1\)

Apart from SES, a wide range of environmental factors influence intelligence adversely. Malnutrition during the early part of life (1–5 years) results not only in the delay in physical growth, motor development, and cognitive developmental disorders, but also a reduction in their IQ by 15 points.\(^6-9\) Deficiency of micronutrients, lack of breastfeeding, and presence of environmental toxins are associated with impaired neuropsychological development and classroom performance.\(^6-13\)

Another major influence on intelligence is the level of cognitive stimulation the child receives at home. In addition, the ratio of encouraging comments made to children versus reprimands seems to have an influence on IQ. Here, the quality of mother–child interactions is most relevant in determining the development of intelligence in infancy and early childhood.\(^14-18\)

Among the social factors affecting intelligence, the school the child goes to seems to have quite a major influence on IQ.\(^19\) Surprisingly, the quality of teaching in kindergarten and first-grade teaching also plays a role. Although the academic gains due to having more experienced teachers fade away in later grades, the noncognitive gains persist.

Not only these social factors, but also physical exercise has a role to play in intelligence. While on children, it plays a role in creating and consolidating memory, in elderly, it has a role to play in maintaining intelligence for executive functions such as planning and scheduling of mental procedures.\(^20-22\)

There is a lack of data on the factors which influence IQ in Indian children; therefore, we conducted a multicenter questionnaire-based study to determine the environmental factors which influence IQ in Indian children.

### Participating and Methods

**Participants and recruitment process**

In this cross-sectional observational study, we recruited 1065 schoolchildren between the age of 12 and 16 years from 2 government and 13 private schools in 5 towns, 6 cities, and 2 villages across India. Children <12 years and >16 years of age, children with learning disabilities, and those who were not willing to participate were excluded from the study.

The schools for inclusion in this study were selected as per convenience. Permission from the school authorities was obtained for administering the questionnaire of the students and they were explained in detail about the procedure and the implications of the study. The classrooms were chosen randomly, and from classes, students were selected according to the inclusion and exclusion criteria mentioned above. Demographic characteristics of each participant such as age and gender were recorded.

**Interviewer**

This study was conducted by medical students.

**Questionnaire for the study**

A questionnaire consisting of various environmental factors such as parents’ education, occupation, income, and physical activity of the student [Appendix A] was used. The questionnaire was made in English and translated into Hindi without any loss of meaning of the questionnaire during translation. The participants were administered the questionnaire as per their choice. All participants were explained about the questionnaire and they filled up the questionnaire themselves.

**Assessment of intelligence quotient**

For the assessment of IQ scores, Ravens Standard Progressive Matrices were used. It is a multiple choice type of a questionnaire consisting of sixty questions. There is no language barrier in this test as it uses only figures. Hence, no translation was required.

**Administration of the questionnaire**

The eligible participants were made to fill up the environmental factors’ questionnaire first. Thereafter, they were asked to solve the Ravens test, and the time in which they completed that test was also noted.

**Calculation of the intelligence quotient**

An approximate IQ score was calculated using the score on the Ravens test. IQ scores were divided into three groups: below normal IQ (0–79), normal IQ (80–119), and high IQ (above 120).

**Statistical analysis**

The data were analyzed using SPSS software analyzed using IBM SPSS package for Microsoft Windows Version 22.0 (Armonk, NY:IBM Corp.). Qualitative data were analyzed using Chi-square test, and \(P < 0.05\) was considered statistically significant.

### RESULTS

**Demographic details of students**

In this study, the IQ and environmental factors of 1065 students were assessed by a questionnaire. The
mean age of the 1065 students was 14.1 ± 1.3 years and 596 (56.1%) students were males. The demographic details of the students have been summarized in Table 1.

**Demographic details of the families**
The demographic details of the families of these 1065 students have been summarized in Table 2. Of the 1065 students, 754 (70.8%) came from nuclear families while the rest came from joint families [Table 2].

**Association between intelligence quotient of children and their place of residence**
The association of IQ with their place of residence of children is shown in Table 3. Most children with high IQ were residing either in cities (55.8%) or towns (42.3%) than those living in villages (1.8%) ($P = 0.001$).

**Association of intelligence quotient with physical exercise**
Out of the 163 people in the high IQ group, more than 50% engaged in some form of physical exercise for more than 5 h a week. Children engaged in physical exercise for more than 5 h a week had more often normal IQ in comparison to those performing physical exercise of <5 h (69.1% vs. 30.9%; $P = 0.001$) [Table 3].

**Association of intelligence quotient with income of the family**
Almost half (50.7%) of the children with low IQ came from families with income <Rs. 50,000/month. On the other hand, 65.6% of children with high IQ came from families with more than Rs. 50,000/month ($P = 0.001$) [Table 3].

**Association of intelligence quotient with father’s education**
Of 162 students with high IQ, 137 (84.6%) students had fathers who were either postgraduates or graduates while none of them had fathers who were not educated at all. The number of fathers having postgraduate or a graduate degree was significantly higher in children with high IQ group than in those with low IQ group (84.6% vs. 46.6%; $P = 0.001$) [Table 3].

**Association of intelligence quotient with mother’s education**
Similarly, mothers of 118 (72.4%) children with high IQ were postgraduate or graduate and only two (1.2%) students with high IQ had mothers who had no formal education. On the other hand, in the low IQ group, only 89 (37.7%) students had mothers who were graduates/postgraduates ($P = 0.001$) [Table 3].

**Association of intelligence quotient with father’s occupation**
Among children with high IQ, 120 (73.6%) of them had fathers working as professionals or semi-professionals. While out of the 238 students in the low IQ group, only 95 (39.9%) had their fathers working as professionals or semi-professionals ($P = 0.001$) [Table 3].

**Discussion**
In this study including 1065 schoolgoing children, we observed that the environmental factors such as place of residence, physical activity, family income, education of the mother and father, and occupation of the father had an impact on the IQ of the children. Children living in cities, children having physical activity more than 5 h/week, children with parents having a postgraduate or graduate level of education, and children whose father working as a professional were more likely to have high IQ.
Similar to most other traits, intelligence is also inheritable; the heritability of intelligence varies from 0.30 to 0.75. While there is a potential for high intelligence, it is not necessary that everyone will reach the upper limit of their genetic potential. A variety of the components of the social environment the child is exposed to right from his/her conception, determine the ultimate intelligence of a person.

As we observed in this study that most children with high IQ were residing either in cities (55.8%) or towns (42.3%) than those living in villages (1.8%) \( (P = 0.001) \), the place of residence is an important factor as it governs the opportunities available to reach the full genetic potential. A child brought up in a village setting may not get the same facilities and the same level of intellectual stimulation as compared to his/her counterparts brought up in a town or city. Similarly, physical exercise also plays an important role in acquiring high IQ as observed in the present study. There is a secretion of certain hormones in association with exercise which enhances memory. Aerobic exercise has also been associated with maintenance of executive functions.\(^{[20-22]}\)

In a study from India, the scholastic performance, IQ and scores of mental balance, attention and concentration, verbal memory, and recognition were found to be lower in iron-deficient girls, both anemic and nonanemic, as compared to the noniron-deficient girls.\(^{[7]}\)

We, in the present study, observed that the education of both mother and the father had a positive effect on IQ of the children. The beneficial effects of parental educational level are not limited to academic achievement through the school years but have long-term implications in the form of indirect effects (adolescent aspirations and educational achievement) also.\(^{[10]}\)

Family income is also one of the major determinants of a child’s intelligence.\(^{[11]}\) A higher family income implies good schooling for the child and also every possible level of cognitive stimulation can be made available to the child. In such cases, the child gets better chances to reach his/her full genetic potential in terms of intelligence. The same is true for parents’ occupation and educational qualification which are mostly related. High educational qualification ensures a dignified occupation and therefore high family incomes. All these point toward more chances of children with IQ on the higher side. Another way in which occupation is important is in determining the amount of time parents spend with their children. The more family time together, more is the cognitive stimulation of children.

Thus, all these environmental factors as brought out in our study are interrelated and together play a role in determining a child’s intelligence.

While the present study has certain merits including inclusion of a large number of children from many parts of the country, there are certain limitations too. We did not give the Ravens test to parents or grandparents and therefore our study did not establish the heritability of intelligence. The number of villages, towns, and cities covered was not

### Table 3: Association of intelligence quotient with environmental factors \( (n=1065) \)

| Variable                    | Subvariable               | IQ         | Total  | P   |
|-----------------------------|---------------------------|------------|--------|-----|
| Place of residence \( (n=1065) \) | Village                  | 51 (21.4)  | 72 (10.8) | 3 (1.8) | 126 (11.8) | 0.001 |
|                             | Town                     | 142 (58.8) | 286 (43.1) | 69 (42.3) | 495 (46.5) |
|                             | City                     | 47 (19.7)  | 306 (46.1) | 91 (55.8) | 444 (41.7) |
| Physical exercise \( (n=1065) \) | <5 h/week                | 62 (26.1)  | 205 (30.9) | 77 (47.2) | 344 (32.3) | 0.001 |
|                             | >5 h/week                | 176 (73.9) | 459 (69.1) | 86 (52.8) | 721 (67.7) |
| Family income \( (n=1053) \) | <10,000/month            | 89 (37.9)  | 66 (10.1)  | 5 (3.1)  | 160 (15.2) | 0.001 |
|                             | 10,000-50,000/month      | 77 (32.8)  | 222 (33.9) | 51 (31.3) | 350 (32.4) |
|                             | 50,000-100,000/month     | 27 (11.5)  | 132 (20.2) | 38 (23.3) | 197 (18.7) |
|                             | >100,000/month           | 42 (17.9)  | 235 (35.9) | 69 (42.3) | 346 (32.0) |
| Father’s education \( (n=1063) \) | Postgraduate/graduate    | 111 (46.6) | 506 (76.3) | 137 (84.6) | 754 (70.9) | 0.001 |
|                             | Diploma/10th or 12th pass| 84 (35.3)  | 131 (19.8) | 24 (14.8) | 239 (22.5) |
|                             | Middle or primary school education | 36 (15.1) | 22 (3.3) | 1 (0.6) | 59 (5.6) |
|                             | No formal education      | 7 (2.9)    | 4 (0.6)    | 0        | 11 (1.0)  |
| Mother’s education \( (n=1060) \) | Postgraduate/graduate    | 89 (37.7)  | 423 (64.0) | 118 (72.4) | 630 (59.4) | 0.001 |
|                             | Diploma/10th or 12th pass| 65 (27.5)  | 161 (24.4) | 37 (22.7) | 263 (24.8) |
|                             | Middle or primary school education | 53 (22.5) | 65 (9.8) | 6 (3.7) | 124 (11.7) |
|                             | No formal education      | 29 (12.3)  | 12 (1.8)   | 2 (1.2)  | 43 (4.1)  |
| Father’s occupation \( (n=1065) \) | Professional/semi-professional | 95 (39.9) | 447 (67.3) | 120 (73.6) | 662 (62.2) | 0.001 |
|                             | Others                   | 143 (60.1) | 217 (32.7) | 43 (26.4) | 403 (37.8) |

IQ – Intelligence quotient
proportionate. Therefore, the data obtained in our study are not representative of the country.

CONCLUSIONS

We, in the study including 1065 schoolgoing students, found that various environmental factors such as place of residence, physical exercise, family income, and parents’ occupation and education influence the IQ of a child to a great extent. Hence, a child must be provided with an optimal environment to be able to develop to his/her full genetic potential.

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Conflicts of interest

There are no conflicts of interest.

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Environmental factors’ questionnaire

1. Name: _____________________
2. Age: _______
3. Sex: M/F
4. Place of residence (name of city/town/village):
5. Parents’ education:
   - Father
     - □ Honours
     - □ Post Graduate/Graduate
     - □ Diploma courses
     - □ High school education (12th or 10th Pass)
     - □ Middle school education (7th Pass)
     - □ Primary school education (5th Pass)
     - □ Received no formal education.
   - Mother
     - □ Honours
     - □ Post Graduate/Graduate
     - □ Diploma courses
     - □ High school education (12th or 10th Pass)
     - □ Middle school education (7th Pass)
     - □ Primary school education (5th Pass)
     - □ Received no formal education.
6. Family Income: (/month)
   - □ <10,000
   - □ 10,000 – 30,000
   - □ 30,000 – 50,000
   - □ 50,000 – 1,00,000
   - □ >1,00,000
7. Parents’ occupation:
   - Father: _______________  Mother: _______________
8. Physical exercise
   1. Frequency
      - □ >3 times a week
      - □ 1-3 times a week
      - □ Once a week
      - □ < once a week
   2. Duration per session:
      - □ >1 hour
      - □ 30 min – 1 hour
      - □ <30 min
   3. What kind of exercise?: (please specify) _______________