The Pharma Innovation Journal 2022; SP-11(6): 2207-2211

www.ThePharmaJournal.com

The Pharma Innovation

ISSN (E): 2277-7695
ISSN (P): 2349-8242
NAAS Rating: 5.23
TPI 2022; SP-11(6): 2207-2211

www.thepharmajournal.com
Received: 15-03-2022
Accepted: 18-04-2022

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Genetic and environmental contribution on intellectual abilities during early childhood: A twin study

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Abstract
Individual differences in intellectual abilities are highly heritable in the early childhood. Twin investigation has supported the concept of intellectual abilities by showing the genetic and environmental contributions on intelligence of twins. The contribution of genetic architecture was ranging from 50-67% in the variations of intellectual abilities of twins in early years of life. The sample size for present study comprised of 150 pairs of twins with the age group 3-6 years from two districts, namely: Bhiwani (N = 174) and Hisar (N = 126) of Haryana State. The contribution of genetic and environmental factors was examined in twin study design. The intellectual abilities of twins were measured using the Stanford Binet Intelligence Scale (Terman and Merrill, 1960) [10]. Language stimulation and physical environment aspects of home environment was measured by using the Home Observation for Measurement of the Environment (HOME) (Caldwell and Bradley, 1984). Heritability estimate was used to examine the genes contributed to shape the intellectual abilities of twins in early years of life. The result of heritability estimates revealed that the heritability estimates of intellectual abilities was from 50 percent to 67 percent from the age group 3-6 years. The findings clearly elucidated that the intellectual abilities were more influenced by genetic architecture than the environmental factors during early childhood period. The monozygotic twins were more correlated in their intellectual abilities than the dizygotic twins. The home environmental aspects were also significantly associated with intellectual abilities of twins in early years.

Keywords: Genetic, heritability estimate, environment, monozygotic twins, dizygotic twins

Introduction
Behavioural genetics studies have sharpened focused on genetics of intelligence and considered that intelligence is a highly stable and heritable trait. Twin study design estimates the relative contribution of heritability in shaping the intelligence of twins. Intelligence differs from individual to individual similar to any other human traits. Intelligence is important scientifically and socially. Intelligence is one of the best predictors of key outcomes such as education and occupational status. People with higher intelligence tend to have better mental and physical health and fewer illnesses throughout the life course, and longer lives (Deary, 2013) [21]. It is one of the essential elements of life outcomes such as education, occupation, mental and physical health and illness, and mortality. Intelligence is one of the most heritable behavioural traits (Plomin and Deary, 2015) [3].

Heritability is a statistics that describes the amount of variance in a trait that can be attributed to genetic differences in a given population (Malanchini *et al*. 2020) [8]. It is not a constant value and varies for a trait depending on when in the developmental process like neonate, child and adult (Greenspan, 2022) [7]. Both genetic heritage and environmental circumstances responsible for varies in intelligence of twins start from the prenatal period (Davies *et al*. 2011) [24]. The genetic studies have shown that intellectual abilities are heritable, highly polygenic, and that shared genetic factors account for part of their observed co-variation (Deary *et al*. 2019) [19]. The genetic influences are an important component of variation for almost all human traits. Penke *et al*. (2007) [25] stated that the specific intellectual abilities are determined by circumscribed sets of function-specific genes but that general intelligence is likely be affected by nearly any gene, anywhere on the genome.

Most behavioural genetic studies, including comparing monozygotic and dizygotic twins, are often used to evaluate the extent to which variations in human abilities like intelligence are the result of contribution of genetic material and environmental factors. Identical (monozygotic) twins' pairs showed closer similarities than non-identical (dizygotic) twin pairs at later ages and that indicates a genetic contribution to variation in a trait because the only real difference between the two types of twins is that identical twin pairs are twice as similar genetically.

Intelligence performance is determined by both genetic potential and environmental factors. Although about 50 per cent of variation in intelligence among individuals is contributed to genetic factors (Deary *et al*. 2009) [19]. The genetic and environmental influences on intelligence are not static, rather they change and shift during development (Zheng *et al*. 2019) [11]. Both nature and nurture contributed to the development of intelligence throughout the first 16 years of life, whereas considerable genetic influences at each age and modest shared environmental influences were observed within and across ages (Petrill *et al*. 2013) [9].

Early childhood period is crucial period for brain development in order to provide distinctive relationships between neural system development and intellectual functioning. Early brain development over the preschool years support more efficient information processing abilities (Tsujimoto, 2008) [22]. Schumann *et al*. 2007 [23] revealed that gray matter volume was significantly positively correlated with general intelligence and verbal intelligence. The early and lasting experiential effects are likely to operate differentially by gene expression. The stability of genetic influences are lower on intellectual abilities in early childhood as variation in environmental experiences over time serves to activate different sets of genes, but increasing stability of genetic influences over development as later experiences become less effective in activating or deactivating genetic variation. Most of the researches emphasized that intellectual ability is also shaped by environmental and social factors and stated that the early life interventions effectively addressed the intellectual performance during early childhood. Early life intervention promote favourable family environment for young children, reach their full intellectual potential (Engle *et al*. 2011) [18].

Material and Methods

Study Design: The objective of twin investigation was to examine the contribution of genetic and environmental factors on intellectual abilities of twins during 3-6 years. The study was carried out in two districts namely: Bhiwani (N = 174) and Hisar (N = 126) of Haryana state. The purpose of selection of state Haryana was availability of maximum numbers of twins in the required age group of 3-6 years. To examine the intellectual abilities of twins, total 150 pairs of twins were selected from two districts with the age group 3-to-6 years.

Data collection: Data was collected by using assessment, interview, observation and questionnaire method from the twins and their parents as well.

Tool: The intellectual abilities of twins were measured by Stanford Binet Intelligence Scale (Terman and Merrill, 1960) [10] and Home Observation for Measurement of the Environment (HOME) (Caldwell and Bradley, 1984) [4].

Statistical Analysis: The statistical analysis performed in software SPSS (Statistical Package for the Social Sciences). Correlation coefficient, Chi-square test and heritable estimate were used to meet the objectives of the twin study. Heritability estimates (h^2) were calculated by the following formula given by Falconer (1960) [6], h^2= 2(RMz- RDz) Where, h^2 is the heritability estimate, RMz is the correlation coefficient for monozygotic twin pairs and RDz is the correlation coefficient for dizygotic twins. Correlation coefficient was used to find the correlation between the intellectual abilities of twins.

Results of study

The results obtained from the present twin investigation have been summarized under following heads:

Heritability estimates for intellectual abilities of twins during 3-6 years

The data presented in Table 1 revealed that the heritability estimates for intellectual abilities was 67.00 percent in Bhiwani district. The interpretation of data clearly indicated that remaining 33.00 per cent variations in intellectual abilities of twins was attributed to environmental circumstances in Bhiwani district. Further, the data in this table showed that the heritability estimates for intellectual abilities was 50 percent and remaining 50.00 percent variations in intellectual abilities of twins due to environmental factors in Hisar district. On conclusion, it was observed the contribution of genetic in intellectual abilities of twins was more as compared to environmental factors.

Table 1: Heritability estimates for intellectual abilities of twins during 3-6 years

District	Intellectual abilities
	Heritability estimate (%)
Bhiwani	67.00
Hisar	50.00

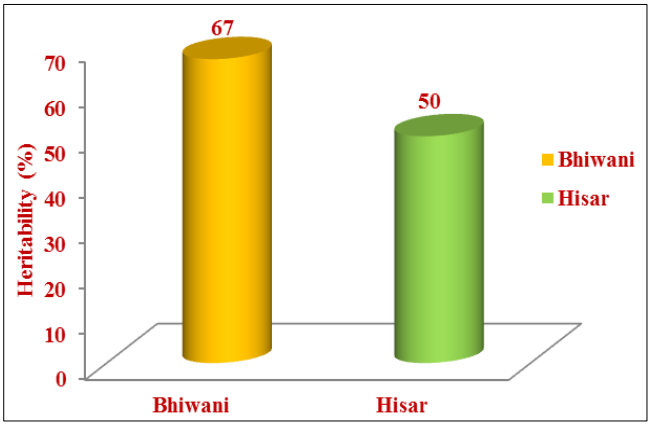

Fig 1: Heritability estimates for intellectual abilities of twins during 3-6 years

Correlation co-efficient among monozygotic and dizygotic twins for intellectual abilities in both districts

The data in Table 2 revealed regarding the correlation coefficient of monozygotic and dizygotic twins for intellectual abilities of twins from 3 to 6 years. The data clearly indicated that the correlation coefficient(r) of monozygotic twins for intellectual abilities in age group 3-6 years was 0.88 in Bhiwani district and 0.87 in Hisar district. Further the data in this table portrait regarding the dizygotic twins, the correlation coefficient(r) was 0.55 and 0.62 in Bhiwani and Hisar years respectively for intellectual abilities of twins during 3-6 years. The result provided robust evidence that the monozygotic twins were more correlated with each other than the dizygotic twins. The monozygotic twins in Bhiwani district were more correlated with each other in intellectual abilities than Hisar district.

Table 2: Correlation co-efficient among monozygotic and dizygotic twins for intellectual abilities in both districts

District	Correlation co-efficient (r) for intellectual abilities	
	Monozygotic twins	Dizygotic twins
Bhiwani	0.88	0.55
Hisar	0.87	0.62

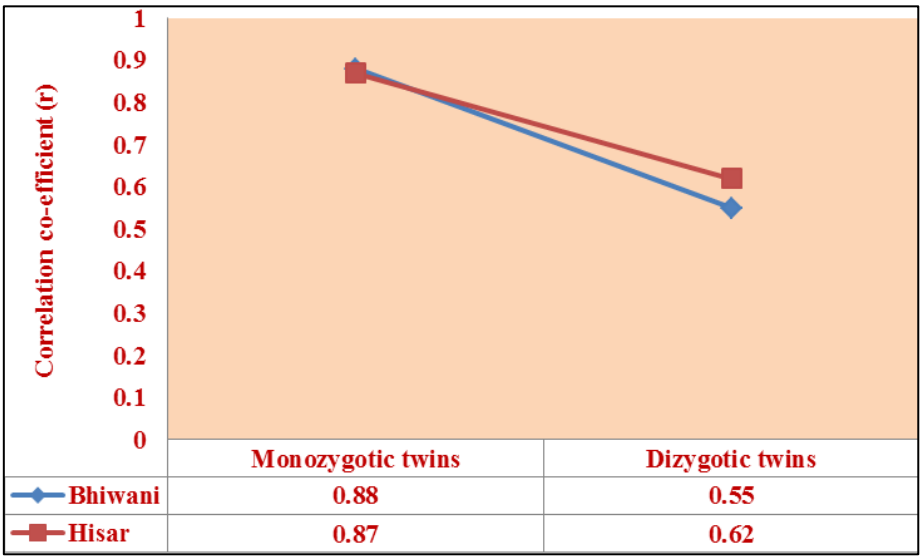

Fig 2: Correlation co-efficient among monozygotic and dizygotic twins for intellectual abilities in both districts

Association of intelligence of twins with home environment in Bhiwani district

The data in Table 3 indicated that intellectual abilities of twins were associated with dimensions of home environment, namely, language stimulation ($\chi2$=11.61*) and physical environment ($\chi2$=6.89*), at Bhiwani district.

Table 3: Association of intellectual abilities of twins with home environment in Bhiwani district

Home environment	Intellectual abilities				
	Low	Moderate	High	Total	$\chi2$
Language stimulation					
Below average	24(13.79)	15(8.62)	5(2.87)	44(25.29)	11.61*
Above average	36(20.69)	57(32.76)	37(21.26)	130(74.71)	
Total	60(34.48)	72(41.38)	42(24.14)	174(100.00)	
Physical environment					
Below average	21(12.07)	20(11.49)	5(2.87)	46(26.44)	6.89*
Above average	39(22.41)	52(29.89)	37(21.26)	128(73.56)	
Total	60(34.48)	72(41.38)	42(24.14)	174(100.00)	

Association of intellectual abilities of twins with home environment in Hisar district

The data in Table 4 revealed that intellectual abilities of twins was not associated with dimensions of home environment, namely, language stimulation ($\chi2$=1.50) and physical environment ($\chi2$=1.50) at Hisar district.

Table 4: Association of intellectual abilities of twins with home environment in Hisar district

Home environment	Intellectual abilities				
	Low	Moderate	High	Total	$\chi2$
Language stimulation					
Below average	8(6.35)	5(3.97)	5(3.97)	18(14.29)	1.50
Above average	43(34.13)	45(35.71)	20(15.87)	108(85.71)	
Total	51(40.48)	50(39.68)	25(19.84)	126(100.00)	
Physical environment					
Below average	12(9.52)	7(5.56)	5(3.97)	24(19.05)	1.50
Above average	39(30.95)	43(34.13)	20(15.87)	102(80.95)	
Total	51(40.48)	50(39.68)	25(19.84)	126(100.00)	

Discussion

The results on heritability estimates indicated that more genetic influence on intellectual abilities of twins as compared to environmental factors in both Bhiwani and Hisar district. The present study was supported by another twin study of Davies *et al.* (2018) [13] calculated heritability estimates for intellectual abilities of twins and found that the impact of genetics was significant on intellectual abilities of twins. Savage *et al.* (2018) [15] conducted twin study and emphasized that complex polygenicity, means influenced by many genes of intellectual abilities by identifying hundreds of relevant genes. Moreover, intellectual abilities of twins were more

influence by genetic factors than environmental factors. Plomin *et al*. (2013) [14] twin study had consistently shown that genetic influence on individual differences in intelligence is substantial.

The dimensions of home environment, namely, language stimulation, physical environment were associated with intellectual abilities of twins in Bhiwani district. The results of present study concordant with Bouchard (2013) [12] supported that the more home environmental influences on intelligence of twins than the genetic influence in early years of life. The researcher also suggested that the home environment of children is relevant for their intellectual outcomes. The variance in intelligence is the cognitively stimulating experiences that the individual is provided with and seeks for him/herself and the experiences are primarily imposed on the individual in early years of life. Sundet *et al*. (2005) [16] emphasized on the fact that intelligence was influenced by shared environmental factors which are important component of variation intelligence. Chiang *et al*. (2011) [8] observed that the heritability estimates for intellectual measures was greater in individuals from a higher socio-economic back ground. The Gene-Environment correlation is present when genetic effects result in phenotypic differences that in turn affect environmental exposures within individuals and, in some extended twin-family designs, within families (Dolan *et al*. 2014) [17].

The correlation co-efficient among monozygotic twins was more as compared to dizygotic twins for intellectual abilities. The results were supported by similar results that about 70% of the variance in intellectual abilities found in their particular sample of identical twins was found to be associated with genetic variation. The results of present study line with Sahu and Prasuna (2016) [1] supported that the twin study design depended on studying twins raised in the same family environments, which provides control not only for genetic background but also for shared environment in early life. The excess similarity is seen between the identical twins when a researcher compares the similarity between sets of identical twins to the similarity between sets of fraternal twins for a trait or condition, then most probably the reason behind this similarity is due to genes rather than environment. Another study (Joseph, 2022) [2] stated that intellectual abilities are strongly affected by genetic material. Plomin and Deary (2015) [3] emphasized that intelligence is also one of the most stable behavioural traits, yielding a correlation of 0.63 in a study of twins.

Conclusion

The results of present twin study investigation revealed that the contribution of genetic was ranging from 50-67% on variations of intellectual abilities of twins and remaining variations in intellectual abilities of twins was attributed to environmental circumstances. The variations in intelligence of twins more attributed to genetic material than environmental experiences in early childhood. The monozygotic twins were more correlated for intelligence of twins than dizygotic twins. The home environmental factors were also responsible for shaping the intelligence of twins.

Acknowledgement

I express my deep sense of gratitude to my speculative prudent and dignified revered guide Dr. Bimla Dhanda, Professor cum Dean and other advisory committee members, I.C college of Home Science, Chaudhary Charan Singh Haryana Agricultural University, Hisar, for her valuable and gifted guidance, keen interest, unfailing source of inspiration, critical supervision and painstaking efforts during the entire course of study.

Reference

1. Sahu M, Prasuna JG. Twin Studies: A Unique Epidemiological Tool. Indian J Community Med. 2016;41:177-82.
2. Joseph J. A Reevaluation of the 1990 “Minnesota Study of Twins Reared Apart” IQ Study Human Development. 2022;66:48-65.
3. Plomin R, Deary IJ. Genetics and intelligence differences: five special findings. Molecular psychiatry. 2015;20(1):98-108.
4. Caldwell B, Bradley R. Home observation for the measurement of environment (HOME) inventory-Revised Edition. University of Arkansas, Little Rock. 1984.
5. Deary Ian J, Harris SE, Hill WD. What genome-wide association studies reveal about the association between intelligence and physical health, illness, and mortality. Current Opinion in Psychology. 2019;27:6-12.
6. Falconer DS. The Ronald Press Co., New York, USA, 1960, 36.
7. Greenspan NS. Genes, heritability, ‘race’, and intelligence: misapprehensions and implications. Genes. 2022;13:346.
8. Malanchini M, Rimfeld K, Allegrini AG, Ritchie SJ, Plomin R. Cognitive ability and education: how behavioural genetic research has advanced our knowledge and understanding of their association. Neuroscience & Biobehavioral Reviews. 2020;111:229-245.
9. Petrill SA, Lipton PA, Hewitt JK, Plomin R, Cherny SS, Corley R. Genetic and environmental contributions to general cognitive ability through the first 16 years of life. Dev Psychology. 2013;25:445-451.
10. Terman LM, Merrill MA. Stanford-Binet Intelligence Scale: Manual for the Third Revision Form L-M. Boston: Houghton Mifflin. 1960.
11. Zheng A, Briley DA, Malanchini M, Tackett JL, Harden KP, Tucker-Drob EM. Genetic and Environmental Influences on Achievement Goal Orientations Shift with Age. European Journal of Personality. 2019;33(3):317-336.
12. Bouchard T. The Wilson Effect: The Increase in Heritability of IQ With Age. Twin Research and Human Genetics. 2013;16(5):923-930.
13. Davies G, Lam M, Harris SE, Trampush JW, Luciano M, Hill WD. Study of 300,486 individuals identifies 148 independent genetic loci influencing general cognitive function. Nature Communications. 2018;9(1):1-16.
14. Plomin R, Haworth CMA, Meaburn EL, Price T, Davis OS. Common DNA markers can account for more than half of the genetic influence on cognitive abilities. Psychol Sci. 2013;24:562-568.
15. Savage JE, Jansen PR, Stringer S, Watanabe K, Bryois J, De Leeuw CA. Genome-wide association meta-analysis in 269,867 individuals identifies new genetic and functional links to intelligence. Nature Genetics. 2018;50(7):912-919.
16. Sundet JM, Tambs K, Harris JR, Magnus P, Torjussen TM. Resolving the genetic and environmental sources of

the correlation between height and intelligence: A study of nearly 2600 Norwegian male twin pairs. Twin Research and Human Genetics. 2005;8:307-311.
17. Dolan CV, de Kort JM, van Beijsterveldt TC, Bartels M, Boomsma DI. GE covariance through phenotype to environment transmission: an assessment in longitudinal twin data and application to childhood anxiety. Behav. Genet. 2014;44:240-253.
18. Engle PL, Fernald LC, Alderman H. Global. Child Development Steering Group. Strategies for reducing inequalities and improving developmental outcomes for young children in low-income and middle-income countries. Lancet. 2011;378:1339-53.
19. Deary IJ, Johnson W, Houlihan LM. Genetic foundations of human intelligence. Human Genetics. 2009;126(1):215-232.
20. Chiang M, Barysheva M, Shattuck DW, Lee AD, Madsen SK, Avedissian C, *et al*. Genetics of brain fiber architecture and intellectual performance. The Journal of Neuroscience. 2009;29(7):2212-2224.
21. Deary IJ. Intelligence. Annual Review of Psychology. 2013;63:453-482.
22. Tsujimoto S. The Prefrontal Cortex: Functional Neural Development During Early Childhood. The Neuroscientist. 2008;14(4):345-358.
23. Schumann CM, Hamstra J, Goodlin-Jones BL, Kwon H, Reiss AL, Amaral DG. Hippocampal size positively correlates with verbal IQ in male children. Hippocampus. 2007;17(6):486-93.
24. Davies G, Tenesa A, Payton A. Genome-wide association studies establish that human intelligence is highly heritable and polygenic. Mol Psychiatry. 2011;16:996-1005.
25. Penke L, Denissen JJA, Miller GF. The evolutionary genetics of personality. European Journal of Personality, 2007;21(5):549-587.