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Research Article

GENETIC AND ENVIRONMENTAL IMPACT ON FLUID INTELLIGENCE OF TWINS

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Abstract: The genetic contribution was accounted for 50-60% variance in fluid intelligence of twins. Twin study has supported the concept of genetic and home environmental impact on fluid intelligence of twins. Twins (N = 200) from two districts namely: Bhiwani (N=90) and Hisar (N=110) of Haryana State were assessed at the age of 6-to-8 years using Wechsler Intelligence Scale for Children- Revised (WISC-R) (Wechsler 1974). Heritability estimate was used to analyze the genes contribute to shape the fluid intelligence of twins. The heritability estimates for fluid intelligence in Bhiwani and Hisar district were ranging from 60-70 per cent and remaining 30-40% variance in fluid intelligence of twins of Bhiwani and Hisar was due to environmental factors. Comparison of mean values at district level showed that the twins of Bhiwani district were significantly better in fluid intelligence as compared to Hisar district twins. The correlation coefficient among monozygotic and dizygotic twins for fluid intelligence of twins namely: arithmetic, picture arrangement and object assembly was ranging from r=0.43 (Dizygotic twins) to r=0.78 (Mnozygotic twins) in both Bhiwani and Hisar districts The result also revealed that the monozygotic twins were more correlated in fluid intelligence as compared to dizygotic twins. The fluid intelligence was more influenced by genetic factors as compared to environmental factors.

Keywords: *Environment, Fluid intelligence, Heritability estimate, Twins*

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Introduction

Fluid intelligence may be defined as innate and free from prior experience ability. The fluid intelligence includes general abilities such as solve problems, think abstractly, reasons etc. The substantial genetic influence was assessed for both fluid intelligence and cognitive abilities of twins [1]. The vast majority of heritable traits, such as, height, cognitive functions and Intelligence Quotient are highly heritable and very complex [2]. The twin study design was usually used to estimate the contribution of genetic and environmental basis to the variations between the variables. The monozygotic or identical twins share 100% genetic material whereas dizygotic twins share 50% genetic material. This twin study design allows for discriminate between variations in variables due to genetic factor and environmental factors [3].

Heritability is a mathematical statistic that usually captures how much of the variation of a trait that is attributed to genetic differences. It does not responsible to either capture how many genes are involved or how much of the trait relies exclusively on the genome [4]. The heritability estimates from identical and fraternal twins are used to estimate the extent to which early genetic influences on cognition were amplified over time [5]. The heritability estimates of cognition of twins increases from childhood to young adulthood [6].

Twins studies showed that identical twins have identical IQs since their genetic constitution is same, or it could be because they have the same experiences. The variations in IQ might be due to environmental circumstances. The dizygotic twins share 50% genetic material they are just like ordinary brothers and sisters [7]. The genetic effects on patterns of brain change over time and the magnitude of relative genetic versus environmental influences may increase over the course of development [8]. Both genetic and environmental factors contribute to the development of general cognitive ability 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 [9].

Wallace, *et al*., [10] Reported that the importance of genetic versus environmental influences may increase over the course of development.

Oommen (2014) [11] revealed that intelligence quotient was determined by a number of factors which included both genetic as well as non-genetic factors. Even though genetic factors played the major role in determining IQ, various other modifiable environmental influences could influence the IQ of an individual. Nature and nurture worked together in determining human intelligence. Moreover, the genetic played a significant role on the IQ of the individual and environmental circumstances also affect the IQ.

Materials and Methods

Study Design: The current twin study was formulated with the aim to find out genetic and environmental impact on fluid intelligence. The study was carried out in two districts namely: Bhiwani (N = 90) and Hisar (N = 110) of Haryana state. To assess the fluid intelligence of twins, total 100 pairs of twins were selected from two districts with the age group 6-to-8 years. Data collection: Data was collected through use of following methods: assessment, interview, observation and questionnaire methods were used to take out the information from twins.

Tool: The fluid intelligence of twins was examined by WISC-R [12]. The fluid intelligence included arithmetic, picture arrangement and object assembly.

Statistical Analysis: The statistical analysis performed in software SPSS (Statistical Package for the Social Sciences). Mean, Standard Deviation, z-test, correlation coefficient and heritable estimate were used to meet the objectives of the study. Heritability estimates (h^2) were calculated by the following formula given by [13], $h^2 = 2(RMz - RDz)$ 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 fluid intelligence of twins.

Result

Fluid intelligence dimensions of twins in two districts

As presented in [Table-1] there were highly significant differences in mean values for arithmetic (Z=2.90**) and object assembly (Z=2.89**) fluid intelligence dimensions of twins of Bhiwani and Hisar districts. The significant (0.05%) differences were found between twins of Bhiwani and Hisar districts on dimensions of fluid intelligence picture arrangement (Z=2.03*). Twins at Bhiwani district performed better for all the same mentioned dimensions as compared to their counter parts from Hisar district.

Table-1 *Fluid intelligence dimensions of twins in two districts (N=200)*

Fluid Intelligence	Bhiwani (n=90) Mean±SD	Hisar (n=110) Mean±SD	Z Value
Arithmetic	2.10±0.75	1.80±0.70	2.90**
Picture Arrangement	2.64±1.34	2.25±1.37	2.03*
Object Assembly	3.97±2.04	3.19±1.84	2.89**

Heritability estimates for fluid intelligence of twins over districts

The [Table-2] portrait regarding the heritability estimates for fluid intelligence of twins in both districts namely: Bhiwani and Hisar. The heritability estimates for fluid intelligence namely: Arithmetic (58%), Picture arrangement (57%) and Object assembly (60%) in Bhiwani district. The data clearly indicated that the remaining 42 percent variance in arithmetic fluid intelligence were due to environmental factors. Further the data portrait that 43 percent and 40 percent variance in picture arrangement and object assembly respectively were due to environmental circumstances. In Hisar district, the heritability estimates for arithmetic, picture arrangement and object assembly were 54 percent, 52 percent and 56 percent respectively. The clearly indicated that remaining 46 percent variance in arithmetic was due to environmental factors and 48 percent and 44 percent in picture arrangement, and object assembly respectively contributed to environmental situations. The heritability estimates clearly revealed that more genetic influence on object assembly followed by arithmetic and picture arrangement fluid intelligence in Bhiwani district. In Hisar district, the heritability estimates accounted for object assembly was highest (56%) followed by arithmetic that was 54%, and heritability was lowest for picture arrangement (52%). The genetic influence was more on object assembly followed by arithmetic and picture arrangement fluid intelligence in Hisar district.

Table-2 *Heritability estimates for fluid intelligence of twins over districts*

Fluid intelligence	Heritability (%)	
	Bhiwani	Hisar
Arithmetic	58	54
Picture Arrangement	57	52
Object Assembly	60	56

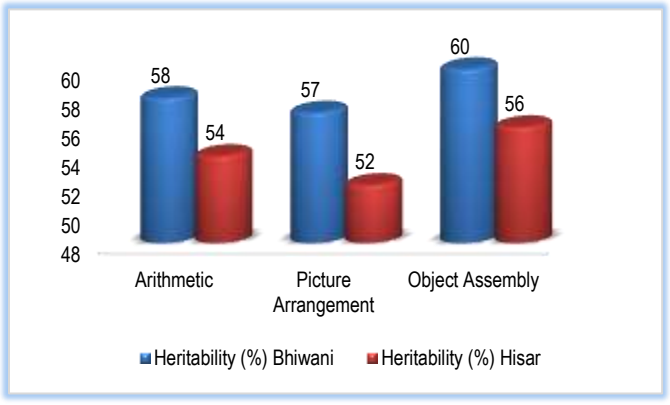

Fig-1 Heritability estimates for fluid intelligence in both districts

Correlation coefficient among monozygotic twins and dizygotic twins for fluid intelligence in both districts

The [Table-3] provided the information regarding the correlation coefficient among monozygotic and dizygotic twins for fluid intelligence in Bhiwani and Hisar district. The data in [Table-3] portrait that the correlation coefficient among monozygotic twins for fluid intelligence namely: Arithmetic, Picture arrangement and Object assembly was r=0.75, r=0.71 and r=0.78 respectively in Bhiwani district. Among dizygotic twins, the correlation coefficient for arithmetic (r=0.47), picture arrangement (r=0.43) and object assembly (r=0.48) in Bhiwani district. Further the correlation coefficient among monozygotic twins was for fluid intelligence namely: arithmetic (r=0.73), picture arrangement (r=0.72) and object assembly (r=0.75) in Hisar district. Among dizygotic twins, the correlation coefficient was for arithmetic (r=0.46), picture arrangement (r=0.45) and object assembly (r=0.47) in Hisar district. The data clearly indicated that monozygotic twins were more correlated with each other in all fluid intelligence as compared to dizygotic twins in both Bhiwani and Hisar district.

Table-3 Correlation coefficient among monozygotic twins and dizygotic twins for fluid intelligence in both districts

Fluid Intelligence	Correlation Coefficient (r)			
	Bhiwani		Hisar	
	Monozygotic	Dizygotic	Monozygotic	Dizygotic
Arithmetic	0.75	0.47	0.73	0.46
Picture Arrangement	0.71	0.43	0.72	0.45
Object Assembly	0.78	0.48	0.75	0.47

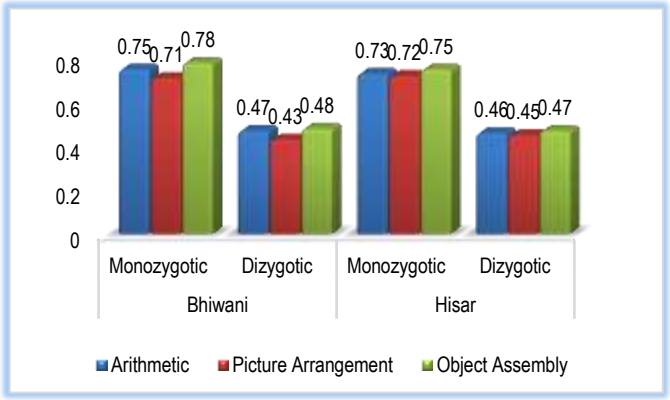

Fig-2 Correlation coefficient among monozygotic twins and dizygotic twins for fluid intelligence in both districts

Discussion

The heritability estimates for fluid intelligence of twins stated that the estimate of heritability was ranging from 50-60 percent for fluid intelligence of twins. The similar study reported that the fluid ability was highly heritable and concluded that heritability of fluid ability was up to 76% of twins [14]. Another twin study stated that the arithmetic performance was largely heritable in early years of life [15]. The genetic variation in fluid intelligence in individuals was approximately 50% which was assessed by conducting the genome-wide association study [16]. Thompson, *et al*., (2001) [17] reported that several particular brain structures were strongly heritable with heritability 80% or more and correlated significantly with IQ.

Marieke, *et al*., (2008) [18] studied several quantitative genetic models to find out the heritability of intelligence by using data from twins and found that additive genetic effects account for 67% of the variation in intelligence. The results suggested that an additional 9% of observed IQ scores variation was due to gene-environment interaction and cultural transmission effects. McGuffin (2008) [19] concluded that the heritability and unique environmental abilities increased with time, whereas common environment abilities decreased in monozygotic and dizygotic twins. Balouti and Nazari (2012) [20] observed that there were significant differences in arithmetic, picture completion, picture arrangement, block design and object assembly. The result of correlation coefficient of monozygotic twins and dizygotic twins indicted that that the monozygotic twins were more correlated with each other than the dizygotic twins. The similar findings stated by conducted research on monozygotic and dizygotic twins that monozygotic or identical twins were more similar than dizygotic or fraternal twins [21].

Conclusion

In conclusion, fluid intelligence of twins was more influenced by genetic factors as compared to environmental factors in both Bhiwani and Hisar districts of Haryana State.

As monozygotic twins share 100% of their genes whereas dizygotic twins share 50% genetic material, the correlation coefficient among monozygotic and dizygotic twins result revealed that monozygotic twins are more correlated than dizygotic twins for their fluid intelligence of twins.

Application of research: The statistical power of genetic study enhances by reducing the amount of variations of genetic or environment through the use of twins in the study. Twin studies analyse the overall role of genes in development of traits. The comparison between monozygotic twins and dizygotic twins evaluate the degree of genetic and environmental influence on a specific trait.

Research Category: Human Genetics, Environmental factors

Abbreviations:
h^2 - Heritability Estimate, SES- Socioeconomic Status
RMz- Correlation Coefficient for Monozygotic Twin Pairs
RDz- Correlation Coefficient for Dizygotic Twins Pairs
SPSS- Statistical Package for the Social Sciences
SD- Standard Deviation
WISC-R- Wechsler Intelligence Scale for Children-Revised

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University: Chaudhary Charan Singh Haryana Agricultural University, Hisar, 125004, Haryana, India
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Author Contributions: All authors equally contributed

Author statement: All authors read, reviewed, agreed and approved the final manuscript. Note-All authors agreed that- Written informed consent was obtained from all participants prior to publish / enrolment

Study area / Sample Collection: Bhiwani and Hisar

Cultivar / Variety name: Nil

Conflict of Interest: None declared

Ethical approval: This article does not contain any studies with human participants or animals performed by any of the authors.
Ethical Committee Approval Number: Nil

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