



Exploring the understanding of basic genetic facts and disease related concepts among people based on gender, age and residential area

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Abstract

Background: Nowadays many cases of gene linked diseases are coming to light; however, not many people are aware of concepts of genes and gene-linked diseases. Majority of the people get exposed to information about genes and genetics only through movies or stories published in media. The present study investigates how aware is the general population about concepts of genes and genetics.

Method: In this descriptive survey involving 230 participants, selected using incidental sampling technique of different demographic background from nine states of India were assessed for the knowledge and understanding of basic concepts of genetics and gene related diseases using an instrument (questionnaire) by Ortega-Paredes et al. (2019) using online forms.

Results: Higher number of males were found to have a better understanding of genetic facts as compared to female respondents. Both male and female respondents had almost similar percent of correct responses on genetic diseases indicating similar level of understanding on it. Respondents of 16-19 years of age group were found to be most aware regarding genetics facts followed by 51-60 and 41-50years age group respondents. Young adults were found to have the most awareness regarding genetic diseases related concepts followed by respondents in the range of 41-50 and 10-15 years. Participants, from young to old, have a good understanding of genetic diseases except for some complex concepts. Partakers from semi-urban areas were followed by those from urban and rural areas in terms of percentage of most correct answers on disease-related concepts.

Conclusions: Overall the results of this study show that among the group of respondents, most are aware of genes, genetics and genetic diseases. However, when analysed based on different categories, it is observed that more percent of male respondents, students between the ages 16 to 19 years and respondents from semi-urban areas are conscious of genetic facts and disease related concepts than their counterparts. Overall, it can be concluded that females and adults should also be made to understand these concepts to allow them to have enough knowledge to take an informed decision when dealing with genetic diseases. Despite urban areas having supposedly better education, participants from semi –urban areas had a better understanding of genetics. Partakers from the rural regions had the least understanding which leads us to conclude that education, especially on topics related to genetics, should be improved to give everyone a fair chance in taking important decisions.

Keywords: Understanding of genetics facts, Genetic disease related concepts, Gene concepts.

Introduction

Genetic disorders are nowadays commonly seen among children worldwide. Knowledge regarding basic genetic concepts and various gene linked diseases have now become important for the common population too. This awareness will help people to have more knowledge about recent developments in the field of gene linked diseases, their diagnosis (at pre-natal level) and available cures and therapies for existing diseases. Moreover, it will also help them take an informed decision in case of any health crisis at pre-natal stage. As the family history of a genetic disease increases, the chances of having an affected child also increase. People are apprehensive about the reliability and potential harm caused by genetic testing. **Altaany et al. (2019)** highlighted the significance of making the younger generation more aware about genetic testing. To get better outcomes in the Jordanian community, fact related issues like cost prediction, safety, and the legitimacy of genetic testing have to be worked upon. **Lanie et.al (2004)** observed a lack of awareness of basic genetic facts, which could have major consequences for broader public education initiatives in genetic literacy, genetic counselling, and public health. Despite the fact that human and medical genetics are relatively new fields of study, their importance is evident from the wide range of researches being conducted in this area because of the surfacing of many cases of gene linked diseases. However, investigations show that many adults are not well versed and confident about various genetics facts and concepts. In the United States, education is not comprehensive enough in teaching basic genetic science applications that may impact Americans from now into the future. Similarly, **Ortega-Paredes et. al. (2019)** suggested that there is scope of improvement in the national education curriculum of Ecuador on genetic concepts. **Reilly (2000)** asserts that genetic terms and genetic concepts enter the consciousness of ordinary people in numerous ways; however, being exposed to a topic does not mean its understanding. **Oliveri et. al. (2016)** observed that the interest in genetic information and undergoing genetic testing was affected by the person's disposition, health consciousness, confidence and enthusiasm to avoid and work for healthiness. **Hega et.al. (2013)** concluded that despite the relatively high educational status and genetic knowledge of the study population, an imbalance of knowledge between scientific and medical concepts related to genetics as well as between the medical applications and societal

consequences of testing was found in general public in Durham, North Carolina.

There are not many researches that have been conducted in India to know the knowledge and understanding of genetics facts and disease related concepts of Indians. The investigator was interested to learn about what do Indians understand by inheritance and discern how well people understood when they are told about heredity, genes, their location, what they do and how can some irregularities in them affect a person's well-being. Given that genetics will soon become an important part of everyone's health care, solving these simple questions can help to assess the public's understanding of basic genetic concepts and diseases.

Materials and Methods

Methodology:

An online survey was conducted using a questionnaire, in which 230 respondents of varied demographic characteristics viz., gender, age and residential area from various states of India participated. A brief survey instrument for measuring genetic knowledge of adolescents and adults prepared by Fitzgerald-Butt et.al. (2016) was used in the present study. It consisted of 18 items (10 items measuring Genetic facts related knowledge and 8 items assessing knowledge about disease-related concepts). The responses are in form of true/ false.

Objectives:

1. To study the overall knowledge of common people about genetic facts and disease related concepts.
2. To study the knowledge of common people about genetic facts and disease related concepts based on gender.
3. To study the knowledge of common people about genetic facts and disease related concepts based on age.
4. To study the knowledge of common people about genetic facts and disease related concepts based on residential area.

Analysis and Interpretation:

Sample Distribution:

The sample distribution based on variables and sub variables/ sub categories for present study is given in Table 1.

Table 1: Sample distribution

Sl.No.	Variables	Categories	Frequency	Percent
1	Gender	Male	65	28.3
		Female	165	71.7
2	Age (levels)	10-15 years	8	3.5
		16-19 years	90	39.1
		20-30 years	83	36.1
		31-40 years	25	10.9
		41-50 years	21	9.1
		51-60 years	3	1.3
3	Residential Area	Rural	18	7.8
		Urban	192	83.5
		Semi-urban	20	8.7

Description:

The sample for the present study consisted of participants from both the genders, a range of age group from 10 to 60 years, and belonging to different residential areas.

Table 1 shows sample distribution based on variables and sub variables/ categories, same has been represented graphically in the Figure 1. From Table 1 and Figure 1 it can be concluded that;

Majority of the participants are females (71.7%) as compared to males (28.3%). Respondents in the age group 16-19 years were found in highest number (39.1%), followed by the respondents in the age group 20-30 years (36.1%); whereas other age groups were found to have very low number of respondents i.e., 31-40 years (10.9%), 41-50 years (9.1%), 10-15 years (3.5%); and 51-60 years (1.3 %) having the lowest.

Majority of the respondents were found to belong to urban area (83.5%), whereas from semi-urban and rural area respondents were less, (8.7 %) and (7.8) respectively.

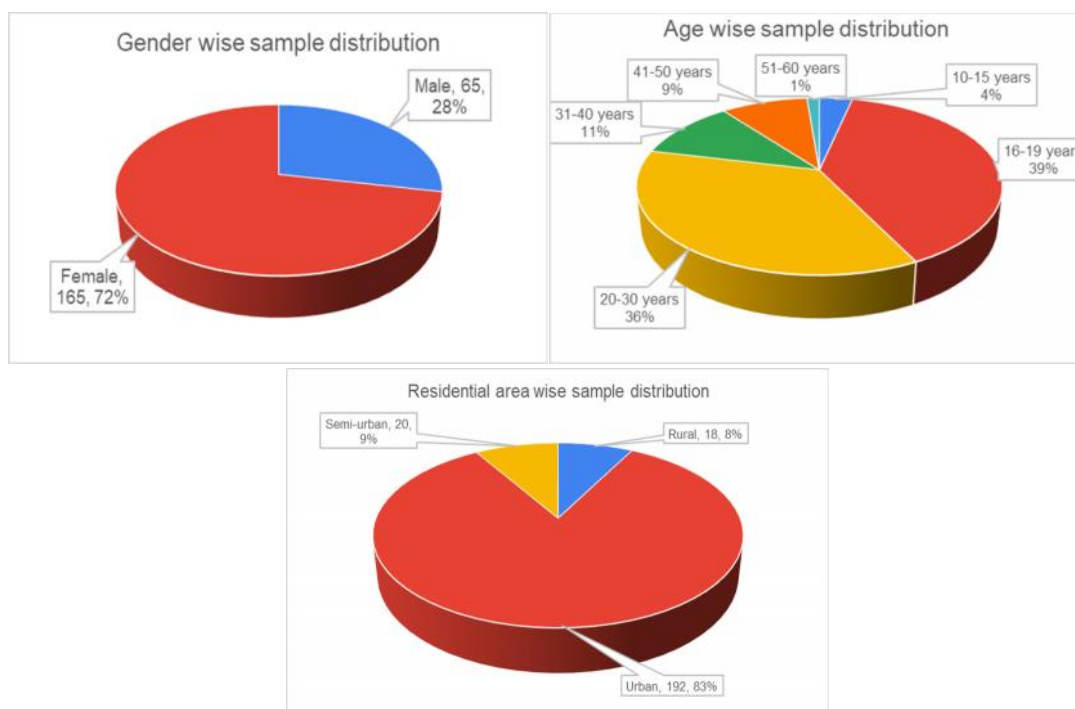


Fig. 1 Category wise sample distribution

Objective-1 To study the overall knowledge of common people about genetic facts and disease related concepts.

Table 2: Correct and incorrect responses on Knowledge about genetic facts and disease related concepts

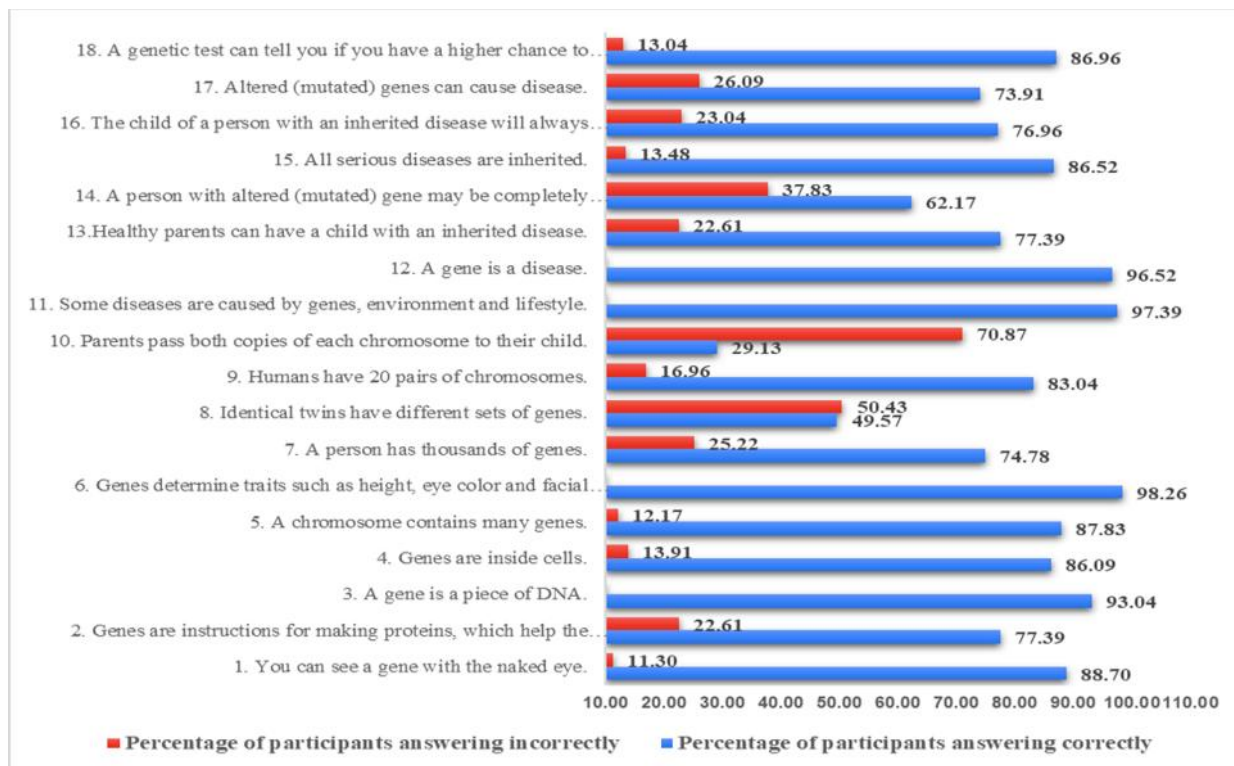
Sl. No.	Statements	N (%) of participants answering correctly	N (%) of participants answering incorrectly
Genetics Facts			
1	You can see a gene with the naked eye.	204 (88.7)/ F	26 (11.3)/T
2	Genes are instructions for making proteins, which help the body grow and work properly.	178 (77.4)/ T	52 (22.6)/ F
3	A gene is a piece of DNA.	214 (93.0)/T	16 (7.0)/ F
4	Genes are inside cells.	198 (86.1)/T	32 (13.9)/ F
5	A chromosome contains many genes.	202 (87.8)/ T	28 (12.2)/ F
6	Genes determine traits such as height, eye colour and facial appearance.	226 (98.3)/ T	4 (1.7)/ F
7	A person has thousands of genes.	172 (74.8)/ T	58 (25.2)/ F
8	Identical twins have different sets of genes.	114 (49.6)/ F	116 (50.4)/ T
9	Humans have 20 pairs of chromosomes.	191 (83.0)/F	39 (17.0)/ T
10	Parents pass both copies of each chromosome to their child.	67 (29.1)/ F	163 (70.9)/ T
Disease-related concepts			
11	Some diseases are caused by genes, environment and lifestyle.	224 (97.4)/ T	6 (2.6)/ F
12	A gene is a disease.	222 (96.5)/F	8 (3.5)/ T
13	Healthy parents can have a child with an inherited disease.	178 (77.4)/ T	52 (22.6)/ F
14	A person with altered (mutated) gene may be completely healthy.	143 (62.2)/ T	87 (37.8)/ F
15	All serious diseases are inherited.	199 (86.5)/F	31 (13.5)/T
16	The child of a person with an inherited disease will always have the same disease.	177 (77.0)/ F	53 (23.0)/T
17	Altered (mutated) genes can cause disease.	170 (73.9)/ T	60 (26.1)/ F
18	A genetic test can tell you if you have a higher chance to develop a specific disease.	200 (87)/ T	30 (13)/F

It is evident from the results of percentage analysis of the participant responses on the survey instrument consisting of 18 items graphically represented in Figure 2 that:

Most of the participants answered all the items correctly except for two. Item no. 10 stating '*Parents pass both copies of each chromosome to their child*'

has a significantly greater number of incorrect responses (70.9%). Additionally, item no. 8 stating '*Identical twins have different sets of genes*' received almost equal correct and incorrect responses, 114 (49.6%) and 116 (50.4%) respectively. This shows that the participants have fairly good understanding of genes and related diseases.

Figure 2 Correct and incorrect responses on Knowledge about genetic facts and disease related concepts



Objective-2 To study the knowledge of common people about genetic facts and disease related concepts based on gender.

Table 3: Percentage analysis of responses on genetic facts based on gender

Sl No		Gender			
		Male N	Male (%)	Female N	Female (%)
1. You can see a gene with the naked eye.	Incorrect	0	0.0	26	15.8
	Correct	65	100.0	139	84.2
2. Genes are instructions for making proteins, which help the body grow and work properly.	Incorrect	10	15.4	42	25.5
	Correct	55	84.6	123	74.5
3. Gene is a piece of DNA.	Incorrect	5	7.7	11	6.7
	Correct	60	92.3	154	93.3
4. Genes are inside cells.	Incorrect	6	9.2	26	15.8
	Correct	59	90.8	139	84.2
5. A chromosome contains many genes.	Incorrect	8	12.3	20	12.1
	Correct	57	87.7	145	87.9
6. Genes determine traits such as height, eye colour and facial appearance.	Incorrect	2	3.1	2	1.2
	Correct	63	96.9	163	98.8
7. A person has thousands of genes.	Incorrect	16	24.6	42	25.5
	Correct	49	75.4	123	74.5
8. Identical twins have different sets of genes.	Incorrect	26	40.0	90	54.5
	Correct	39	60.0	75	45.5
9. Humans have 20 pairs of chromosomes.	Incorrect	8	12.3	31	18.8
	Correct	57	87.7	134	81.2
10. Parents pass both copies of each chromosome to their child.	Incorrect	43	66.2	120	72.7
	Correct	22	33.8	45	27.3

A percentage analysis of responses on genetic facts based on the participant's gender reveals that more than half of the questions were answered correctly by a majority of the male respondents as compared to female ones. 100% of the male respondents were aware that a gene cannot be viewed by the naked eye.

Almost all male (96.92%) and female (98.8%) participants were aware of the fundamental role of genes in inheritance of traits. Overall, both genders have a good understanding of the basic principles of genes.

Figure 3 Graph representing percentage of responses on genetic facts based on gender

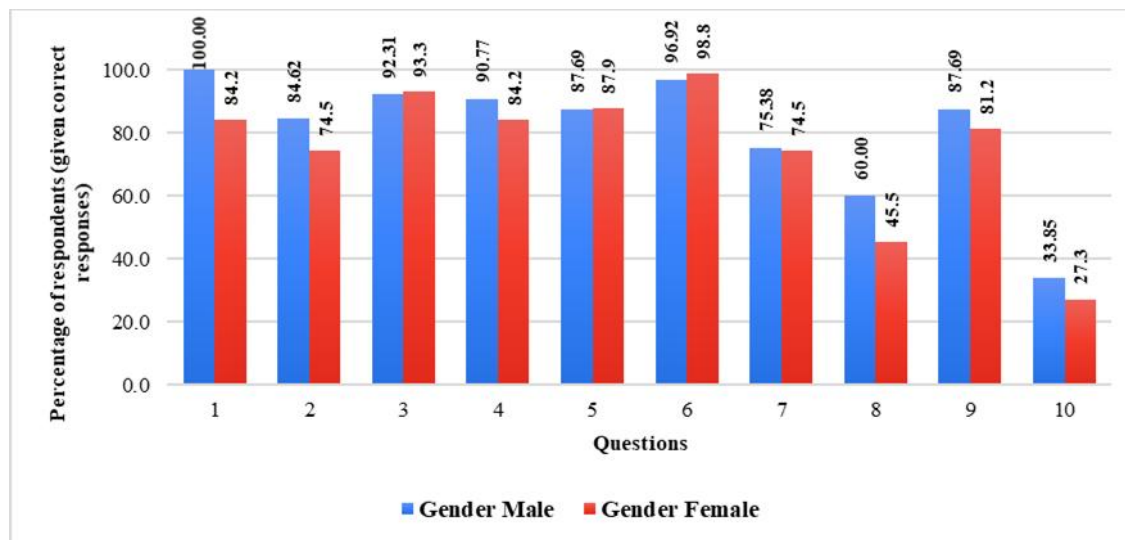


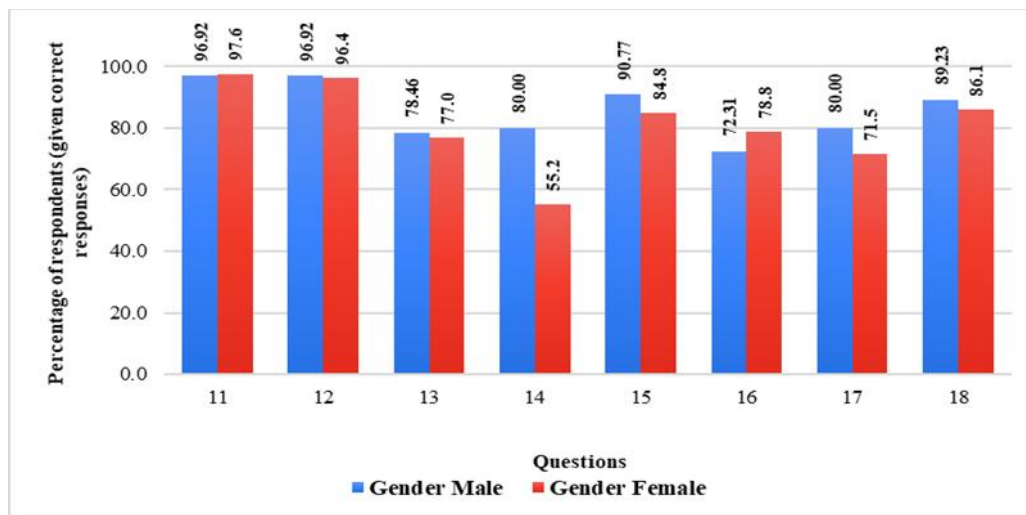
Table 4: Percentage analysis of responses on disease-related concepts based on gender

Sl No		Gender			
		Male N	Male (%)	Female N	Female (%)
11. Some diseases are caused by genes, environment and lifestyle.	Incorrect	2	3.1	4	2.4
	Correct	63	96.9	161	97.6
12. A gene is a disease.	Incorrect	2	3.1	6	3.6
	Correct	63	96.9	159	96.4
13. Healthy parents can have a child with an inherited disease.	Incorrect	14	21.5	38	23.0
	Correct	51	78.5	127	77.0
14. A person with altered (mutated) gene may be completely healthy.	Incorrect	13	20.0	74	44.8
	Correct	52	80.0	91	55.2
15. All serious diseases are inherited.	Incorrect	6	9.2	25	15.2
	Correct	59	90.8	140	84.8
16. The child of a person with an inherited disease will always have the same disease.	Incorrect	18	27.7	35	21.2
	Correct	47	72.3	130	78.8
17. Altered (mutated) genes can cause disease.	Incorrect	13	20.0	47	28.5
	Correct	52	80.0	118	71.5
18. A genetic test can tell you if you have a higher chance to develop a specific disease	Incorrect	7	10.8	23	13.9
	Correct	58	89.2	142	86.1

Gender wise analysis on the participants of this survey on genetic diseases shows that most of the questions had almost equal percentage of correct answers by both genders. Two questions 11 and 12 had a large percentage of both males (96.92%, 96.92%) and females (97.6%, 96.4%) who answered correctly. However, question 14 that states 'A person with altered (mutated) gene may be completely healthy',

the number of females who answered incorrectly (44.8%) was more than twice the number of males (20%). Overall, both males and females exhibit moderate knowledge of genetic diseases and their rudimentary concepts like not all serious diseases are inherited, mutations in genes can cause diseases, and that taking a genetic test can help one to identify the chances of developing specific disease.

Figure 4 Graph representing percentage of responses on disease-related concepts based on gender



Objective-3 To study the knowledge of common people about genetic facts and disease related concepts based on age.

Table 5: Percentage analysis of responses on genetic facts based on age

		Age											
		10-15 years		16-19 years		20-30 years		31-40 years		41-50 years		51-60 years	
		N	%	N	%	N	%	N	%	N	%	N	%
1	Incorrect	0	0	10	11.1	9	10.8	4	16.0	3	14.3	0	0.0
	Correct	8	100	80	88.9	74	89.2	21	84.0	18	85.7	3	100.0
2	Incorrect	5	62.5	15	16.7	21	25.3	5	20.0	6	28.6	0	0.0
	Correct	3	37.5	75	83.3	62	74.7	20	80.0	15	71.4	3	100.0
3	Incorrect	1	12.5	4	4.4	8	9.6	3	12.0	0	0.0	0	0.0
	Correct	7	87.5	86	95.6	75	90.4	22	88.0	21	100.0	3	100.0
4	Incorrect	0	0	13	14.4	14	16.9	2	8.0	2	9.5	1	33.3
	Correct	8	100	77	85.6	69	83.1	23	92.0	19	90.5	2	66.7
5	Incorrect	1	12.5	9	10.0	10	12.0	4	16.0	4	19.0	0	0.0
	Correct	7	87.5	81	90.0	73	88.0	21	84.0	17	81.0	3	100.0
6	Incorrect	1	12.5	0	0.0	3	3.6	0	0.0	0	0.0	0	0.0
	Correct	7	87.5	90	100.0	80	96.4	25	100.0	21	100.0	3	100.0
7	Incorrect	2	25	20	22.2	23	27.7	9	36.0	4	19.0	0	0.0
	Correct	6	75	70	77.8	60	72.3	16	64.0	17	81.0	3	100.0
8	Incorrect	4	50	42	46.7	43	51.8	14	56.0	12	57.1	1	33.3
	Correct	4	50	48	53.3	40	48.2	11	44.0	9	42.9	2	66.7
9	Incorrect	1	12.5	15	16.7	14	16.9	4	16.0	4	19.0	1	33.3
	Correct	7	87.5	75	83.3	69	83.1	21	84.0	17	81.0	2	66.7
10	Incorrect	7	87.5	57	63.3	67	80.7	19	76.0	11	52.4	2	66.7
	Correct	1	12.5	33	36.7	16	19.3	6	24.0	10	47.6	1	33.3

Table 5 and Figure 5 show the percentage analysis of genetic facts based on age from 10 to 60 years. Most respondents of 16-19 years age range answered most questions correctly followed by 51-60 and 41-50 years ranges. Participants of all age groups were fully aware of the chief notion that genes control traits like height,

eye colour etc. however, 12.5% and 3.6% of early teens and 20-30 year olds respectively were not aware of it. Hence, respondents from 10 to 60 years, especially adolescents 16 years and above, have an adequate grasp of genetic facts.

Figure 5 Graph representing percentage of correct responses on genetic facts based on age

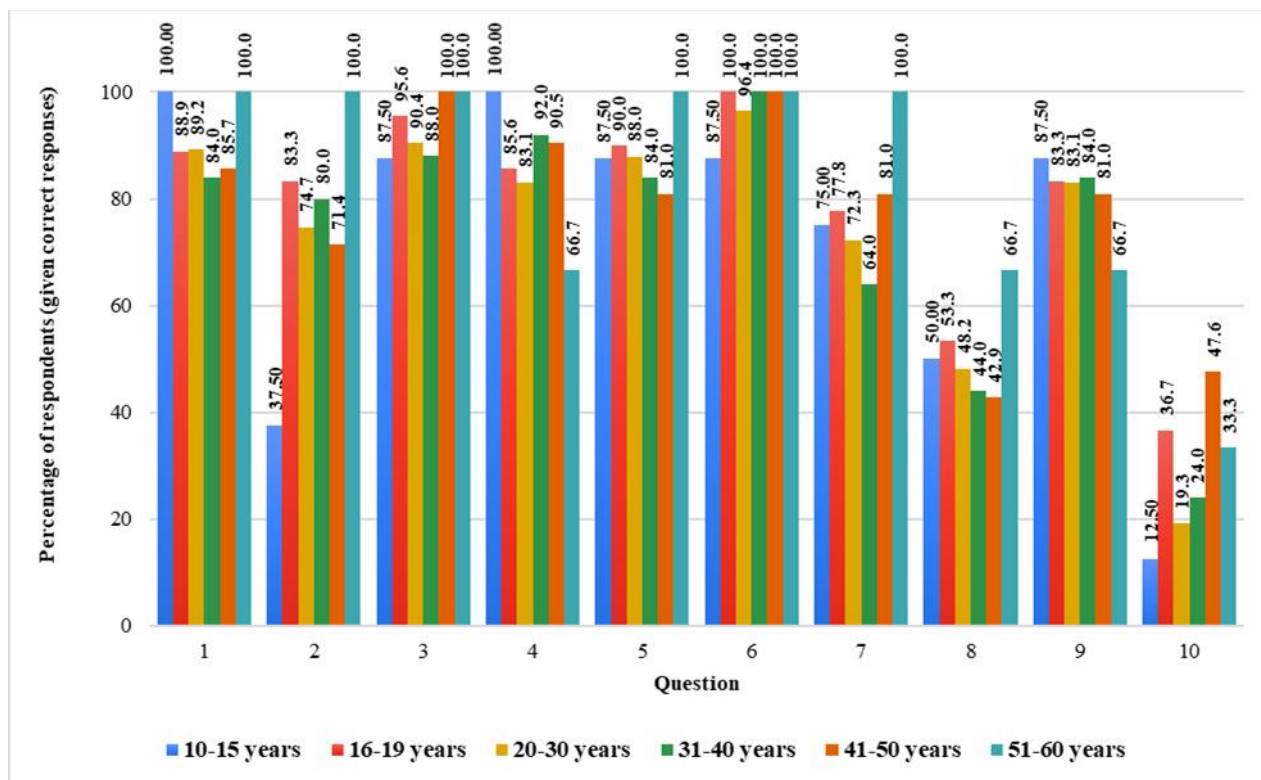


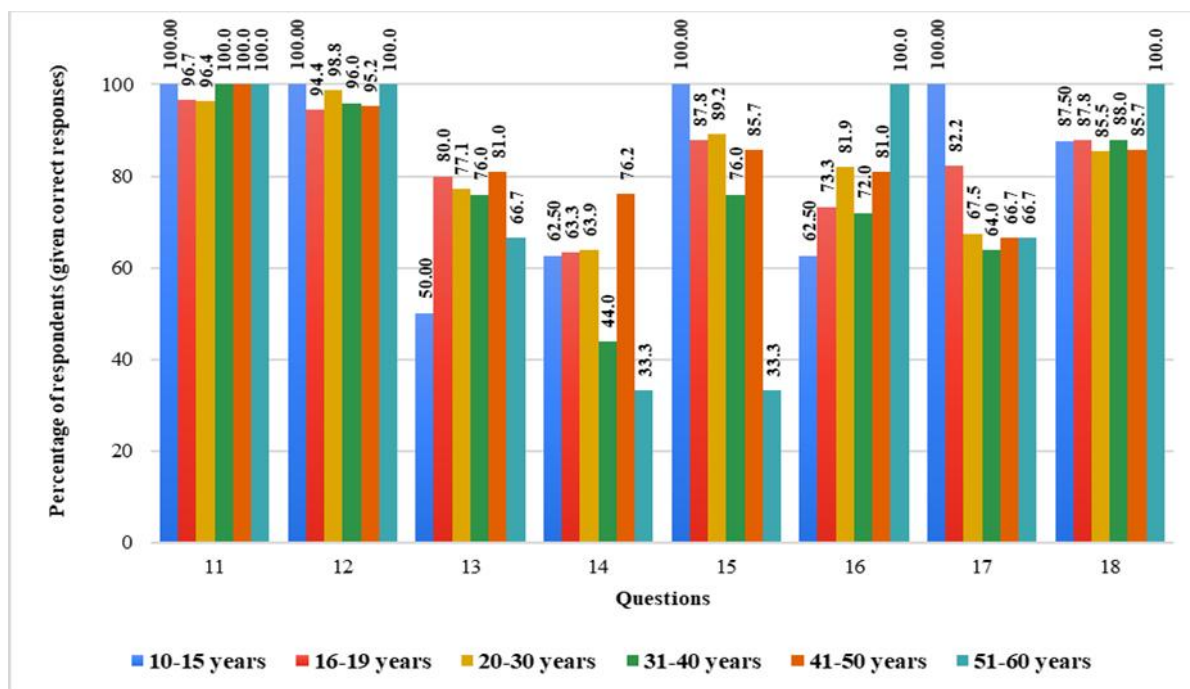
Table 6: Percentage analysis of responses on disease-related concepts based on age

		Age											
		10-15 years		16-19 years		20-30 years		31-40 years		41-50 years		51-60 years	
		N	%	N	%	N	%	N	%	N	%	N	%
11	Incorrect	0	0	3	3.3	3	3.6	0	0.0	0	0.0	0	0.0
	Correct	8	100	87	96.7	80	96.4	25	100.0	21	100.0	3	100.0
12	Incorrect	0	0	5	5.6	1	1.2	1	4.0	1	4.8	0	0.0
	Correct	8	100	85	94.4	82	98.8	24	96.0	20	95.2	3	100.0
13	Incorrect	4	50	18	20.0	19	22.9	6	24.0	4	19.0	1	33.3
	Correct	4	50	72	80.0	64	77.1	19	76.0	17	81.0	2	66.7
14	Incorrect	3	37.5	33	36.7	30	36.1	14	56.0	5	23.8	2	66.7
	Correct	5	62.5	57	63.3	53	63.9	11	44.0	16	76.2	1	33.3
15	Incorrect	0	0	11	12.2	9	10.8	6	24.0	3	14.3	2	66.7
	Correct	8	100	79	87.8	74	89.2	19	76.0	18	85.7	1	33.3
16	Incorrect	3	37.5	24	26.7	15	18.1	7	28.0	4	19.0	0	0.0
	Correct	5	62.5	66	73.3	68	81.9	18	72.0	17	81.0	3	100.0
17	Incorrect	0	0	16	17.8	27	32.5	9	36.0	7	33.3	1	33.3
	Correct	8	100	74	82.2	56	67.5	16	64.0	14	66.7	2	66.7
18	Incorrect	1	12.5	11	12.2	12	14.5	3	12.0	3	14.3	0	0.0
	Correct	7	87.5	79	87.8	71	85.5	22	88.0	18	85.7	3	100.0

Percentage of answers on concepts of genetic diseases based on age has been tabulated in Table 6 and graphically represented in Figure 6. Once again most of the questions were answered correctly by young adults followed by respondents in the range of 41-50 and 10-15 years. Half of the questions were answered correctly by all the respondents of the older generation (51-60 years) furthermore, all early teenagers (10-15 years) also answered 4 questions (11,12,15,17) correctly, indicating fair knowledge about causes of

diseases, fact that all serious diseases are not inherited and gene is not a disease. However, only 33.3% of 50-60 years old age group respondents were clear about the fact that, a person with altered (mutated) gene may be completely healthy (Q14) and not all the serious diseases are inherited (Q15). This indicates that participants, from young to old, have a good understanding of genetic diseases except for some complex concepts.

Figure 6 Graph representing percentage of responses on disease-related concepts based on age



Objective-4 To study the knowledge of common people about genetic facts and disease related concepts based on residential area.

Table 7: Percentage analysis of responses on genetic facts based on residential area

		Residential area					
		Rural		Urban		Semi-urban	
		N	%	N	%	N	%
1	Incorrect	8	44.4	12	6.3	6	30
	Correct	10	55.6	180	93.8	14	70
2	Incorrect	4	22.2	42	21.9	6	30
	Correct	14	77.8	150	78.1	14	70
3	Incorrect	3	16.7	8	4.2	5	25
	Correct	15	83.3	184	95.8	15	75
4	Incorrect	1	5.6	31	16.1	0	0
	Correct	17	94.4	161	83.9	20	100
5	Incorrect	4	22.2	20	10.4	4	20
	Correct	14	77.8	172	89.6	16	80

6	Incorrect	0	0.0	4	2.1	0	0
	Correct	18	100.0	188	97.9	20	100
7	Incorrect	6	33.3	46	24.0	6	30
	Correct	12	66.7	146	76.0	14	70
8	Incorrect	11	61.1	95	49.5	10	50
	Correct	7	38.9	97	50.5	10	50
9	Incorrect	3	16.7	32	16.7	4	20
	Correct	15	83.3	160	83.3	16	80
10	Incorrect	13	72.2	137	71.4	13	65
	Correct	5	27.8	55	28.6	7	35

Based on residential area, i.e., semi-urban, urban or rural, the percentage of respondents with most correct responses live in urban areas followed by semi-urban and rural regions. All participants of semi-urban areas are aware that genes are found inside cells and they determine our traits. A very high percentage of all the categories i.e., rural=100%, urban=97.9% and semi-urban= 100% know that genes determine traits such as height, eye colour and facial appearance. A very high Majority of the respondents of all the residential area categories i.e., rural, urban and semi urban were not clear about the fact that identical twins have different sets of genes as indicated by their correct response

percentage for question 8, i.e. (38.5%, 50.5%, 50% respectively). Similarly, majority of the respondents have a wrong impression that parents pass both copies of each chromosome to their child as revealed by the low correct response percentage for question 10, i.e. (27.8%,28.6, 35% respectively). Almost half the rural population of participants were unaware of the fact that a gene cannot be viewed by the naked eye. Hence, it can be concluded that the respondents have an all-right idea of genetic facts; however, are not aware of slightly higher concepts like-identical twins don't have different sets of genes and how parents pass on only one copy of each chromosome to their offsprings.

Figure 7 Graph representing percentage of responses on genetic facts based on residential area

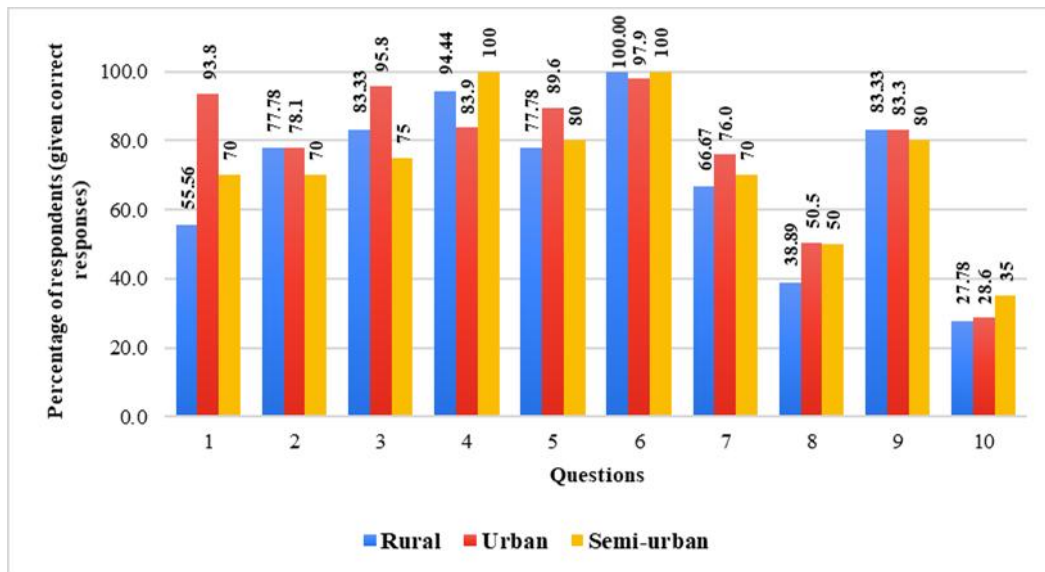


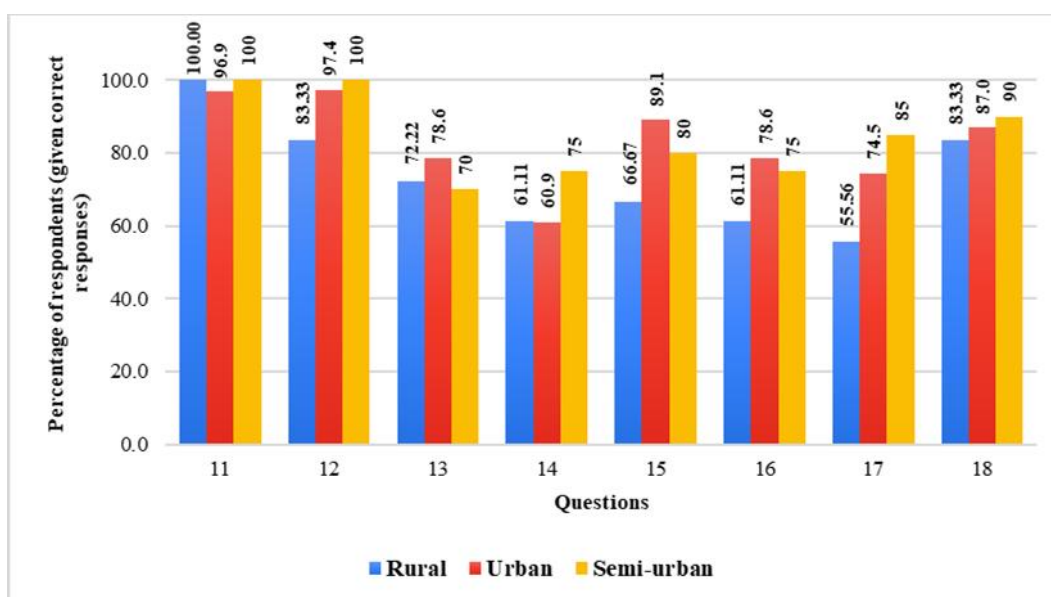
Table 8: Percentage analysis of responses on disease-related concepts based on residential area

		Residential area					
		Rural		Urban		Semi-urban	
		N	%	N	%	N	%
11	Incorrect	0	0.0	6	3.1	0	0
	Correct	18	100.0	186	96.9	20	100
12	Incorrect	3	16.7	5	2.6	0	0
	Correct	15	83.3	187	97.4	20	100
13	Incorrect	5	27.8	41	21.4	6	30
	Correct	13	72.2	151	78.6	14	70
14	Incorrect	7	38.9	75	39.1	5	25
	Correct	11	61.1	117	60.9	15	75
15	Incorrect	6	33.3	21	10.9	4	20
	Correct	12	66.7	171	89.1	16	80
16	Incorrect	7	38.9	41	21.4	5	25
	Correct	11	61.1	151	78.6	15	75
17	Incorrect	8	44.4	49	25.5	3	15
	Correct	10	55.6	143	74.5	17	85
18	Incorrect	3	16.7	25	13.0	2	10
	Correct	15	83.3	167	87.0	18	90

Figure 8 represents the percentage of correct responses by participants on disease-related concepts based on their area of residence. Partakers from semi-urban areas were followed by those from urban and rural areas in terms of percentage of most correct answers. Questions 11 and 12 were answered correctly by all the respondents (100%) of semi -urban area; indicating a decent knowledge that some diseases are caused by genes, environment and lifestyle and they also know

that gene is not a disease. Almost half (44.4%) the rural population were unaware that gene mutation can also lead to diseases. Furthermore, nearly same percentage of urban (60.9%) and rural (61.1%) participants believed that a person with an altered gene can be perfectly healthy. On the whole, respondents living in the different regions have a satisfactory understanding of genetic disease concepts.

Figure 8 Graph representing percentage of responses on disease-related concepts based on residential area



Major Findings

The results of this study show that the participants have a fairly good understanding of many of the genetic facts and disease related concepts.

Higher percentage of male respondents were having good understanding of genetic facts as compared to female respondents. Almost all male and female participants were aware of the fundamental role of genes in inheritance of traits. Overall, both genders have good knowledge of the basic principles of genes.

Both the genders had almost equal percent of correct responses on genetic diseases. However, the percentage of males with correct response was two times higher than females regarding the concept that '*A person with altered (mutated) gene may be completely healthy*'. Overall, both males and females exhibit moderate knowledge of genetic diseases and their rudimentary concepts like not all serious diseases are inherited, mutations in genes can cause diseases, and that taking a genetic test can help one to identify the chances of developing specific disease.

Most respondents of 16-19 years age range answered most questions on genetic facts correctly followed by 51-60 and 41-50 years ranges, revealing teens of 16-19 years of age group are most aware regarding genetics facts. Participants of all age groups were fully aware of the chief notion that genes control traits like height, eye colour etc. However, 12.5% and 3.6% of early teens and 20-30 year olds respectively were not aware of it. Hence, respondents from 10 to 60 years, especially adolescents 16 years and above, have an adequate grasp of genetic facts.

Most of the questions on genetic diseases were answered correctly by young adults followed by respondents in the range of 41-50 and 10-15 years. Overall, it indicates that participants, from young to old, have a good understanding of genetic diseases except for some complex concepts.

Respondents with most correct responses on genetics facts belonged to semi-urban areas followed by urban and rural regions. All participants of semi-urban areas are aware that genes are found inside cells and they determine our traits. A very high percentage of all the categories know that genes determine traits such as height, eye colour and facial appearance. A high majority of the respondents of all the residential area categories i.e., rural, urban and semi urban were not

clear about the fact that identical twins have different sets of genes.

Similarly, majority of the respondents have a wrong impression that parents pass both copies of each chromosome to their child. Almost half the rural population of participants were unaware of the fact that a gene cannot be viewed by the naked eye. Hence, it can be concluded that the respondents have an all-right idea of genetic facts; however, are not aware of slightly higher concepts like- identical twins don't have different sets of genes and how parents pass on only one copy of each chromosome to their offsprings.

Partakers from semi-urban areas were followed by those from urban and rural areas in terms of percentage of most correct answers on disease-related concepts. Respondents from semi-urban area were found to have a decent knowledge that some diseases are caused by genes, environment and lifestyle and they also know that gene is not a disease. Almost half (44.4%) the rural population were unaware that gene mutation can also lead to diseases. Furthermore, nearly same percentage of urban (60.9%) and rural (61.1%) participants believed that a person with an altered gene can be perfectly healthy. On the whole, respondents living in the different regions have a satisfactory understanding of genetic disease concepts.

Conclusions

It can be summarized that among the group of respondents, most are aware of genes, genetics and genetic diseases. However, when analysed based on different categories, it is observed that male respondents have answered more accurately than female respondents. Moreover, students between the ages 16 to 19 years were found to be a lot more aware than participants of other age groups. This indicates that adults should also be made to understand these concepts to allow them to have enough knowledge to take an informed decision when dealing with genetic diseases. Despite urban areas having supposedly better education, participants from semi-urban areas had a better understanding of genetics. Partakers from the rural regions had the least understanding which leads us to conclude that education, especially on topics related to genetics, should be improved to give everyone a fair chance in taking important decisions.

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