

The Perception of Orthodontists toward the Genetics and Orthodontic Treatment

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Abstract

Background: Orthodontists now have a better understanding of the role of genetics in the etiology of dentofacial diseases and traits. **Objective:** The aim of the study was to assess the perception of Iraqi orthodontists toward genetics and orthodontics. **Materials and Methods:** An e-survey was designed and sent to members of the Iraqi Orthodontic Society. The 14 questions survey was divided into four parts representing information about the socio-demographic status of the orthodontists, knowledge about the genetics and their effects on malocclusion, opinion about the gene therapy and the willingness to have more information about the genetic application in orthodontics. The chi-square test was used to test the association between different variables and socio-demographic factors. **Results:** A total of 162 of the Iraqi orthodontists completed the questionnaire. The data revealed that the majority of the respondents (91.4%) agreed that genetics play a crucial role in the etiology of malocclusion. About half (53.7%) of respondents were not sure about the possibility of using gene therapy as a treatment option. Two-thirds (64.2%) of participants thought the cost of introducing gene therapy will be an obstacle. Most of the orthodontists (74.1%) did not receive continued education programs about gene therapy usage in orthodontics, (91.3%) would like to have more information, and (88.3%) recommended adding genetic-related topics to the curriculum. However, gender, educational level and years of clinical experience had some effects on the knowledge and opinion of the respondents. **Conclusion:** This study reported a fair attitude toward genetic/gene therapy among Iraqi orthodontists and suggested the need to develop more awareness about the genetic effects of malocclusion.

Keywords: Genetics, malocclusion, orthodontics, perception

INTRODUCTION

Malocclusion is a multi-factorial variation of normal growth and development that affects the muscles and bones of the face during infancy and adolescence.^[1,2] It could be attributed to skeletal irregularities, dental arch abnormalities, and abnormal dental arch relationships.^[3,4] According to the World Health Organization, malocclusion is the third most common oral health issue after dental caries and periodontal disorders.^[5]

Several etiological factors for malocclusion have been proposed. The main contributing elements in this context are genetic, environmental, and ethnic factors; genetic inheritance and class III malocclusion are tightly connected.^[6,7] Dental malocclusion is a morphologic variation from a recognized human species norm, whereas skeletal type refers to the inherited size, shape, and alignment of the upper and lower jaws, malocclusion is typically an

inherited disease, which means it can be passed down from one generation to the next.^[8] The prevailing assumption is that malocclusions having an “environmental cause” are more likely to respond to therapy than those with a “genetic cause.” The likelihood that orthodontic treatment would be successful decreases as the genetic component increases.^[9]

Orthodontists now have a better understanding of the role of genetics in the etiology of dentofacial diseases and traits. One of the effective methods for examining genetically influenced malocclusion factors is the twin study.^[10] Regarding the part that inheritance plays in malocclusion,

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the study of twins' craniofacial relationships has yielded a wealth of insightful knowledge. The method is based on the fundamental principle that observed differences between a pair of monozygotic twins with identical genotypes are caused by the environment, and those between a pair of dizygotic twins with 50% gene complement sharing are caused by both genotype and environment.^[11,12] Genetic influence on malocclusion is likely autosomal dominant with incomplete penetrance and variable expressivity.^[10] Since the first attempt at human gene therapy was made in 1980^[13] researchers and medical professionals have been conducting experiments continually.^[14] The idea of transferring genes to tissues for clinical applications has been discussed for nearly 50 years, but the ability to manipulate genetic material through recombinant DNA technology has brought this goal to reality.^[15] Gene therapy is now at the forefront of medical research due to advances in biotechnology, using tumor viruses, the viability of gene transfer was first proven.^[16] As a result, techniques for genetically altering somatic cells were developed using both viral and non-viral means. The use of gene therapy to treat dental and oral issues serves as an example of the potential impact this technology could have on dentistry, the field of gene therapy is still nascent, and the majority of human clinical trials are still in the research phase. Oral health professionals may soon frequently act as "gene therapists" with therapeutic targets outside the oral cavity if the applications of oral gene transfer are extended to systemic disorders.^[16] Even though earlier studies have shown highly encouraging findings, more in vivo research and clinical trials are required before applying gene therapy to treat oral and dental disorders.^[17] One of the easiest-to-reach areas for the therapeutic use of gene therapy for different oral tissues is the oral cavity. Because of its advantages over alternative therapy approaches, the concept of genetic engineering has grown more intriguing.^[17]

To our knowledge, no information about the opinions, beliefs, and attitudes of orthodontists regarding genetics/ gene therapy and orthodontics is present in the literature. Understanding how the orthodontic community feels about this novel field of therapy is crucial. The purpose of this survey was to evaluate how Iraqi orthodontists view genetics and the potential use of gene therapy in orthodontic treatment. Although gene therapy research is a new area in the oral sciences and appears to have a lot of potentials, this study is a step toward raising awareness of gene therapy among orthodontists.

MATERIALS AND METHODS

This cross-sectional research used an online questionnaire survey of orthodontists in Iraq. The survey was conducted from the middle of July 2022 to September 2022. No names or other identifying information was gathered; the questionnaire was created on the Google platform and shared with members of the Iraqi Orthodontic Society.

The ethical approval of the study was agreed upon by the ethical committee at the University of XXX, College of Dentistry, Orthodontic Department in accordance with the Helsinki Declaration for human research (Ref. number: 590422).

The sample size was calculated according to the following formula:

$$N = (N / 1) + Z^2 \times P(1 - P) / E^2 N,$$

where, N : population size, Z : z score for % confidence interval, E : margin of error, P : the population proportion (0.5).

Thus, the calculated sample size was equal to 152 at 95 confidence interval and 5% margin of error.

The study design

A questionnaire (cross-sectional close-ended questionnaire) that was adapted and modified from other studies and surveys was used to online survey the participants.^[18,19] To reduce unclear or ambiguous questions, a pilot study was performed using the same questionnaire on 15 academics and experienced orthodontists. To guarantee scientific accuracy, the topics were therefore reviewed and changed.

These parts were set out to be evaluated by the questions:

1. Information about the participant's gender, educational level by specialization and number of years of clinical experience.
2. Participants' knowledge about genetics and their effects on malocclusion.
3. Participants' opinions about gene therapy, side effects, obstacles, and the possibility of usage in the future.
4. Willingness and desire to have more information about genetics application in orthodontics, receive continued education about gene therapy, and adding genetic-related topics to the curriculum.

Statistical analysis

For the purpose of data analysis, both descriptive and inferential statistics were used. All categorical data were defined using descriptive statistics in the shape of counts and percentages. The significant link between socio-demographic factors and all other variables was examined using the Chi-square. All studies were carried out using the statistical package for the social sciences program (Version 22, IBM, USA). Statistics have been considered significant for P values below 0.05.

Ethical consideration

The study was conducted in accordance with the ethical principles that have their origin in the Declaration of Helsinki. It was carried out with patients verbal and analytical approval before sample was taken. The study

protocol and the subject information and consent form were reviewed and approved by a local ethics committee according to the document number 590 dated 10/04/2022 to get this approval.

RESULTS

Response rate

The Iraqi Orthodontic Society's 225 current members received an electronic questionnaire. A total of 162 people replied anonymously, yielding a response rate of 72%.

Profile of the respondents

As shown in Table 1, the results of the survey showed that 82 respondents (50.6%) of the total, were male, and 80 respondents (49.4%) were female. Master's degrees made up the bulk of specialty education levels ($n = 105$, 64.8%), followed by diplomas and certificates ($n = 32$, 19.8%), and finally PhDs ($n = 25$, 15.4%). Less than five years was

the most common amount of expertise ($n = 74$, 45.7%), then five to ten years ($n = 47$, 29%), eleven to twenty years ($n = 32$, 19.8%), and finally, more than twenty years ($n = 9$, 5.6%).

Participants' knowledge about genetics and their effects on malocclusion

The majority of the respondents ($n = 148$, 91.4%) agreed with genetics role in the etiology of malocclusion, whereas a very low percentage did not agree ($n = 7$, 4.3%), and only seven participants (4.3%) were not sure. There was no statistically significant difference between all the variables as shown in Table 2. Both genders, all levels of education and different experience years agreed with this role. Most of the Iraqi orthodontists ($n = 154$, 95.1%) thought that genetic and/or environmental factors are involved in the etiology of cl III malocclusion [Table 3]. A statistically significant difference was found only between the level of education and factors involved in the etiology of cl III malocclusion [Figure 1], whereas no statistically significant difference among another three variables [Table 2].

Participants' opinions about gene therapy, side effects, obstacles, and the possibility of usage in the future

More than half ($n = 87$, 53.7%) of respondents were not sure about the possibility of using gene therapy as a treatment option, 58 respondents (35.8%) thought that and only ($n = 17$, 10.5%) were not thought of. There was no statistically significant difference between all the variables [Table 2]. About half of the respondents ($n = 80$, 49.4%) were not sure about the possibility of using of the gene therapy in orthodontic treatment within the next decade, 62 participants (38.3%) thought that, whereas only ($n = 20$, 12.3%) did not [Table 4]. A statistically significant

Table 1: Profile of the respondents

1. Gender	
a. Male	50.6% ($n = 82$)
b. Female	49.4% ($n = 80$)
2. Level of education	
a. Ph.D.	15.4% ($n = 25$)
b. Master	64.8% ($n = 105$)
c. Certificate and diploma	19.8% ($n = 32$)
3. How many years have you been in practice?	
a. <5 years	45.7% ($n = 74$)
b. 5–10 years	29% ($n = 47$)
c. 11–20 years	19.8% ($n = 32$)
d. >20 years	5.6% ($n = 9$)

%; percentage, n: number

Table 2 : Table of the chi-square test

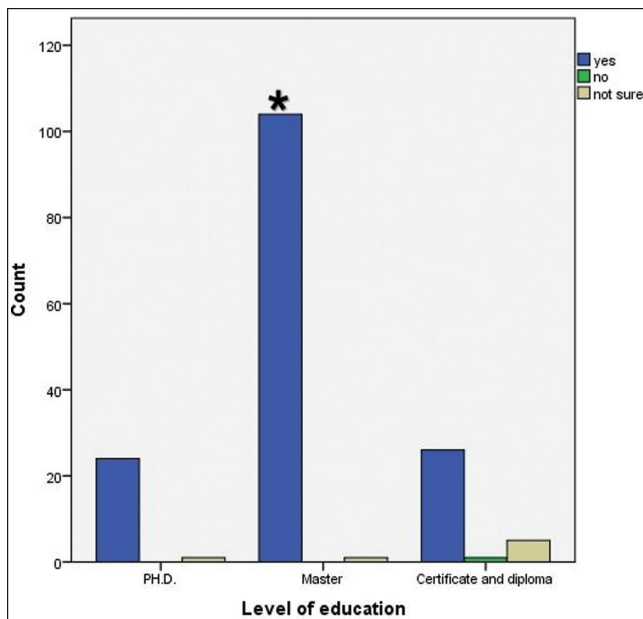
Question	Gender <i>P</i> -value	Level of education <i>P</i> -value	Experience years <i>P</i> -value
Q1) Do you think that genetics play a major role in the etiology of malocclusion?	0.878	0.261	0.054
Q2) Do you think that genetic and/or environmental factors are involved in the etiology of cl III malocclusion?	0.564	0.002*	0.209
Q3) Do you believe that gene therapy can be used as a treatment option?	0.746	0.221	0.808
Q4) Do you think that combining gene therapy with orthodontic treatment will increase the odds of success?	0.080	0.155	0.597
Q5) Do you think that gene therapy will be involved in orthodontic treatment the next 10 years?	0.036*	0.204	0.842
Q6) Do you think that gene therapy should be tested on animals prior to clinical testing?	0.346	0.027*	0.500
Q7) Will the cost of introducing genetic therapy be an obstacle for the patient to accept orthodontic treatment?	0.005*	0.012*	0.217
Q8) Are you concerned about any potential side effects regarding the use of genetic treatment?	0.320	0.325	0.548
Q9) Have you ever received continued education about gene therapy in orthodontics?	0.243	0.211	0.163
Q10) Would you like to have more information about the genetic application in orthodontics?	0.159	0.816	0.579
Q11) Do you think that adding genetic-related topics in the curriculum helps the orthodontists to be better able to gain knowledge about genetics?	0.031*	0.092	0.138

*Significant at P -value ≤ 0.05

Table 3: Participants' knowledge about genetics and their effects on malocclusion

	Gender		Level of education			Practice			
	M	F	Ph.D.	Master	C/D	>5 years	5–10 years	11–20 years	<20 years
1. Do you think that genetics plays a major role in the etiology of malocclusion?									
a. Yes	74	74	21	96	31	68	47	27	7
b. No	4	3	3	4	0	3	0	2	2
c. Not sure	4	3	1	5	1	3	1	3	0
2. Do you think that genetic and/or environmental factors are involved in the etiology of cl III malocclusion?									
a. Yes	78	76	24	104	26	67	47	32	8
b. No	1	0	0	0	1	1	0	0	0
c. Not sure	3	4	1	1	5	6	0	0	1

M: male, F: female, C/D: certificates and diplomas

**Figure 1:** Answer of the question "Do you think that genetic and/or environmental factors are involved in the etiology of cl III malocclusion" regarding the level of education

* Significant

difference was only in the gender variable [Figure 2], 36 females ($n = 36$, 45%) more than males ($n = 26$, 31.7%) believed in the possibility of usage of gene therapy in orthodontic treatment within the next decade [Table 2]. Almost two-thirds of participants ($n = 109$, 67.3%) would agree that combining gene therapy with orthodontic treatment will increase the odds of success, 8 participants (4.9%) did not think if this combination will increase the success, whereas 45 participants (27.8%) were not sure. Most of the participants ($n = 153$, 94.4%) were willing that gene therapy should be tested on animals before clinical testing, only two participants were unwilling to test on animals (1.2%), and seven participants (4.3%) were unsure [Table 4]. A statistically significant difference was found with an increase in the level of education [Figure 3], certificate and diploma less than Ph.D. and master's [Table 2]. The majority of participants ($n = 104$, 64.2%) thought the cost of introducing gene therapy will be an

obstacle for the patient to accept orthodontic treatment, 42 participants (25.9%) were not sure, and only 16 (9.9%) were not thought. A statistically significant difference was found in both gender and level of education, men ($n = 14$) did not think that more than women ($n = 2$) [Figure 4]. The degree of agreement with this opinion was observed to increase with education level [Figure 5]. More than two-thirds of participants ($n = 114$, 70.4%) thought that side effects could be produced ($n = 29$, 17.9%) were unsure, and the remaining ($n = 19$, 11.7%) thought that side effects were not likely [Table 4].

Willingness and desire to have more information about genetics application in orthodontics and receive continued education about the gene

Almost a quadrant of the participants (25.9%) were already received continued education about gene therapy in orthodontics, and the remaining participants (74.1%) did not. The majority of participants ($n = 148$, 91.3%) would like to have more information about genetic application in orthodontics, 10 participants (6.2%) would not, and only four (2.5%) were not sure. The majority of the respondents ($n = 143$, 88.3%) recommended adding genetic-related topics to the curriculum better to help orthodontists to gain knowledge about genetics. A statistically significant difference was only in the gender variable [Figure 6], 76 females (47%) more than males ($n = 67$, 41%) recommended adding genetic-related topics to the curriculum better to help orthodontists to gain knowledge about genetics [Table 5].

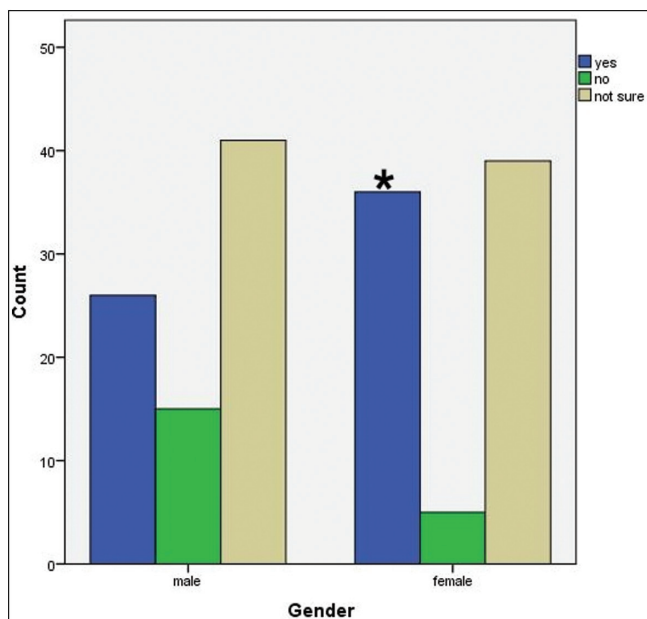
DISCUSSION

Gene and genetic treatment research has advanced quickly in recent years, gene therapy is increasingly being used for medical purposes.^[20] The range and uses of gene therapy are expanding as a result of further research. As this is a recent development, it is possible that the orthodontic education curriculum does not give this topic enough attention. Media such as news and commercials are helping to raise the general public's awareness about gene therapy. Hence, it is crucial that orthodontists understand how gene therapy can be used. Hence, a survey was carried out

Table 4: Participants' opinions about gene therapy, side effects, obstacles, and the possibility of usage in the future

	Gender		Level of education			Practice			
	M	F	Ph.D.	Master	C/D	>5 years	5–10 years	11–20 years	<20 years
3. Do you believe that gene therapy can be used as a treatment option?									
a. Yes	28	30	9	40	9	29	13	13	3
b. No	10	7	2	8	7	8	4	4	1
c. Not sure	44	43	14	57	16	37	30	15	5
4. Do you think that combining gene therapy with orthodontic treatment will increase the odds of success?									
a. Yes	55	54	17	73	19	51	31	23	4
b. No	7	1	2	2	4	5	1	1	1
c. Not sure	20	25	6	30	9	18	15	8	4
5. Do you think that gene therapy will be involved in orthodontic treatment in the next 10 years?									
a. Yes	26	36	10	38	14	28	17	14	3
b. No	15	5	5	9	6	11	4	3	2
c. Not sure	41	39	10	58	12	35	26	15	4
6. Do you think that gene therapy should be tested on animals before clinical testing?									
a. Yes	76	77	24	102	27	69	44	32	8
b. No	2	0	0	0	2	2	0	0	0
c. Not sure	4	3	1	3	3	3	3	0	1
7. Will the cost of introducing genetic therapy be an obstacle for the patient to accept orthodontic treatment?									
a. Yes	51	53	19	73	12	52	24	23	5
b. No	14	2	2	9	5	8	4	3	1
c. Not sure	17	25	4	23	15	14	19	6	3
8. Are you concerned about any potential side effects regarding the use of genetic treatment?									
a. Yes	61	53	17	75	22	50	34	24	6
b. No	10	9	1	12	6	12	3	2	2
c. Not sure	11	18	7	18	4	12	10	6	1

M: male, F: female, C/D: certificates and diplomas

**Figure 2:** Answer of the question "Do you think that gene therapy will be involved in orthodontic treatment the next 10 years" regarding the gender

* Significant

to determine how Iraqi orthodontists felt about genetics, gene therapy, and malocclusion.

According to the findings of the current study, the majority of Iraqi orthodontists concur that genetics have a significant influence on the etiology of malocclusion. Also, nearly all responders believe that environmental and/or genetic factors contribute to the development of cl III malocclusion. The advances in human quantitative genetics and molecular biology over the past ten years had given researchers the privilege to develop a more comprehensive understanding of how our genes and the environment contribute to a variety of dental diseases and malocclusions that display multifactorial etiology. In accordance with the knowledge we will soon have regarding the hereditary basis of diseases affecting the oral hard and soft tissues, the challenge for dental researchers and orthodontists will be to improve preventive and treatment techniques for the general public. Additionally, orthodontists can gain a lot of knowledge about the interactions between genes and the environment during development by examining twin pairs who visit either public or private dental offices.^[21] Orthodontic gene therapy research in Iraq is still in its infancy stages, and

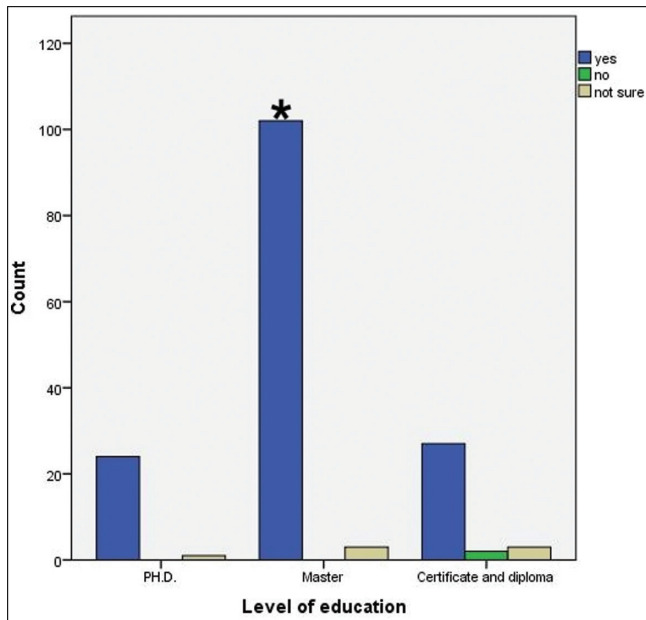


Figure 3: Answer of the question “Do you think that gene therapy should be tested on animals prior to clinical testing” regarding the level of education

* Significant

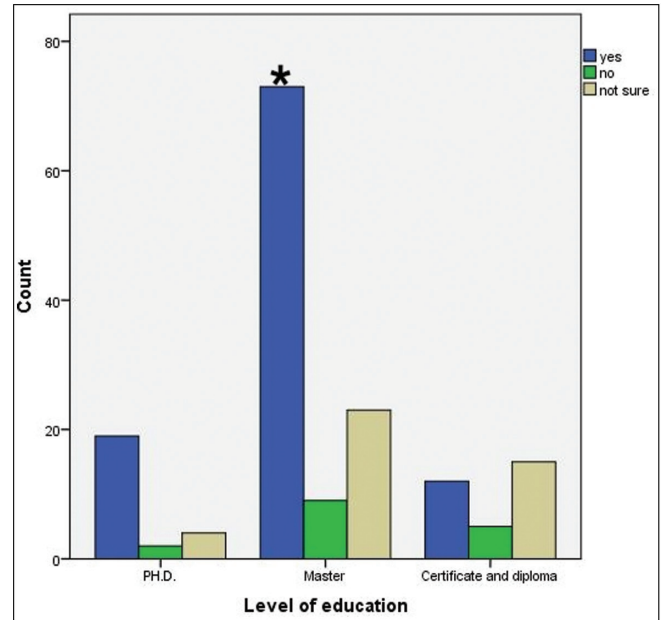


Figure 5: Answer of the question “Will the cost of introducing genetic therapy be an obstacle for the patient to accept orthodontic treatment” regarding the level of education

* Significant

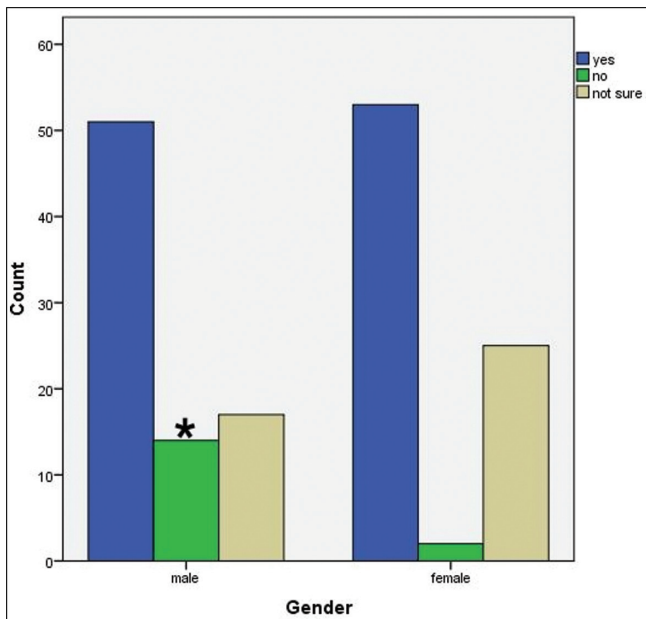


Figure 4: Answer of the question “Will the cost of introducing genetic therapy be an obstacle for the patient to accept orthodontic treatment” regarding the gender

* Significant

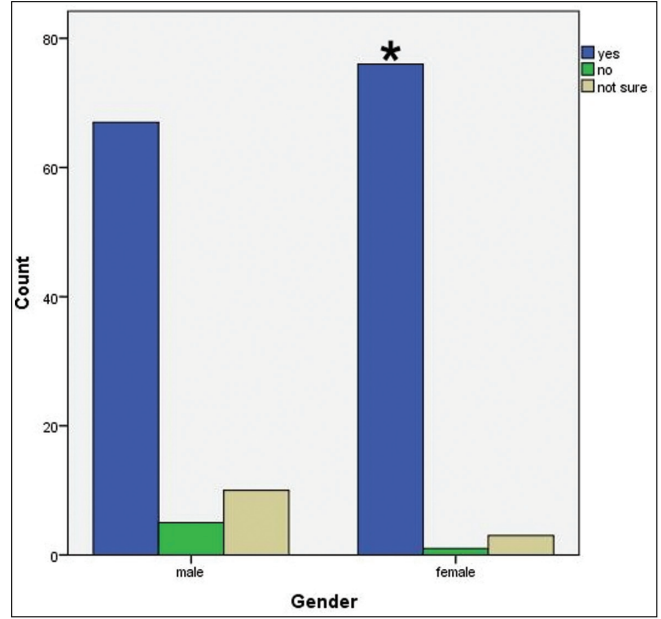


Figure 6: Answer of the question “Do you think that adding genetic-related topics in the curriculum helps the orthodontists to be better able to gain knowledge about genetics” regarding the gender

* Significant

it will be sometime before its full potential is realized in clinical practice. More than half of the respondents were unsure about the use of gene therapy as a treatment option, and nearly half were unsure about its potential use in orthodontic treatment during the next ten years, according to the participants, who emphasized this fact. Nevertheless, almost two-thirds of participants

believe that using gene therapy in conjunction with orthodontic treatment will increase the likelihood of success, and this belief is directly correlated with educational level, a possible explanation for this finding might be that higher degree specialists may previously have more educational courses than those with a lower degree.

Table 5: Willingness and desire to have more information about genetics application in orthodontics and receive continued education about gene

	Gender		Level of education			Practice			
	M	F	Ph.D.	Master	C/D	>5 years	5–10 years	11–20 years	<20 years
9. Have you ever received continued education about gene therapy in orthodontics?									
a. Yes	18	24	10	24	8	14	16	8	4
b. No	64	56	15	81	24	60	31	24	5
10. Would you like to have more information about genetics application in orthodontics?									
a. Yes	72	76	22	98	28	67	43	31	7
b. No	8	2	2	5	3	5	3	1	1
c. Not sure	2	2	1	2	1	2	1	0	1
11. Do you think that adding genetic-related topics in the curriculum helps the orthodontists to be better able to gain knowledge about genetics?									
a. Yes	67	76	22	96	25	64	42	31	6
b. No	5	1	2	1	3	4	0	1	1
c. Not sure	10	3	1	8	4	6	5	0	2

M: male, F: female, C/D: certificates and diplomas

The present study reported that most of the participants agreed that animal testing should come before clinical trials for gene therapy as researchers are more appreciative for using animals in research and knowing the consequences and importance of this type of study. Whereas the previous study has reported that public opinion is against the use of animals in research as it may affect the number of animals.^[22] A previous study reported that gene therapy is very expensive and thus out of the ordinary people's easy reach.^[23] Similarly, the present study found that two-thirds of participants believed the cost of introducing gene therapy would be an obstacle for the patient to accept orthodontic treatment. Despite the frequency of serious side effects noted in the clinical studies, gene therapy is on its way to fulfilling the early promises stated just two decades ago.^[24] The long-term implications of such therapy are unknown, and germ-line gene therapy research would involve too much scientific uncertainty and clinical risk.^[23,25] Hence, more than two-thirds of participants believed that adverse effects were possible.

Despite the fact that the majority of respondents had not previously received further education related to gene therapy or its use in orthodontics, nearly all respondents were interested in finding out more about the genetic application in orthodontics. This might be explained by the fact that gene therapy for orthodontic purposes is still in the research and development stage and has not yet shown all of its potential uses. There are not many practical courses or programs being offered in the profession. This is true despite the fact that several articles about its advancement and developments in the field have been published in scholarly and specialized journals across the globe. Orthodontic educators may benefit from taking into account strategies used by other medical professions, including medicine and nursing, in order to establish an effective genomics-related education model for orthodontic schools.^[26,27] According to the world health organization, which noted that genetic problems are on the rise, the majority of

respondents suggested including genetic-related themes in the curriculum to help orthodontists learn more about genetics. Genetic abnormalities have a significant social and economic impact on the individual, the family, and society. Investigating alternative methods to lessen the burden of genetic disorders are urgently needed. This is especially true for developing countries like Iraqi, where there is currently a shortage of medical professionals who are properly trained in genetic counseling. As significant growth and development changes in preadolescent and adolescent patients occur, dental professionals have a unique opportunity to examine these changes.^[28]

Generally, there were few differences in the percentage of answers between men and women for the majority of the questions. Yet, what is notable about the existing study is that more women than men believed that gene therapy may be used in orthodontic treatment within the next 10 years and that including genetic-related themes in the curriculum would be a better way to help orthodontists learn about genetics. A higher proportion of men was also not anticipated that the expense of introducing gene therapy would prevent patients from undergoing orthodontic treatment. This distinction may provide justification for the different decisions taken by both sexes. Respondents with higher levels of education were more likely to believe that genetic and/or environmental factors play a role in the etiology of malocclusion, that gene therapy should be tested on animals before being used in humans, and that the cost of implementing gene therapy will prevent patients from seeking orthodontic treatment. The fact that the majority of Iraqi orthodontists got degrees from the same academic institution and underwent comparable training programs may explain why these disparities were only slight.

CONCLUSION

In general, a fair attitude toward genetic/gene therapy was observed among orthodontic practitioners. An optimistic

perspective toward updating information about genetics and gene therapy and its relation to orthodontics has been displayed by the respondents. However, concurrently, the lack of in-depth genetic knowledge among the respondents was also noted. Therefore, it is advised that orthodontic students be exposed to and inspired by the concepts of genetics and gene therapy to be ready for future practice.

Limitations of this study

Consider that participants filled out a questionnaire to self-report the data that was gathered. Self-reported data is frequently unreliable and subject to bias due to people's tendency to overstate or understate their responses. The geographic representation of the study and the response rate limit the generalizability and applicability of the findings, which are restricted to orthodontists in Iraqi and cannot be predicted by orthodontists in other geographic areas.

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Nil.

Conflicts of interest

There are no conflicts of interest.

Author contributions

AMB and MA were responsible for research concept and design. AMB responsible for collecting the data and analyzing the results. All authors contributed in writing and approving the final draft of the manuscript.

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