

ORIGINAL ARTICLE

PERSPECTIVE OF ETHICAL ISSUES AND CHALLENGES OF BIOTECHNOLOGY IN DEVELOPING COUNTRY

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ABSTRACT

Advanced biotechnology should be paralleled with advancing ethics to address its implications. In the Middle East and North Africa (MENA) region, ethics of research and advanced biotechnology is not well-developed among scientists. There is also a lack of religious scholars' knowledge about advancing technology to make 'fatwa' (religious edict in Islam) to the public regarding the use of such biotechnology. The purpose of this study was to investigate the perception of scientists and religious scholars in Iraq regarding the ethics and religious perspectives of different biotechnology experiments. A convenient non-probability sampling cross sectional study was carried out in Iraq to figure out the Islamic and scientific scholar's views on technology advances in science including stem cell research, cloning, genetically modified crops, human gene editing, smartphone technology for health services and other advances in biotechnology research. A sample size of 125 science and 34 Islamic scholars were recruited from universities. Face to face interviews were used to collect the data. Descriptive statistics include the use of frequencies, and means, to present the results. Among 159 science and Islamic scholars only (18.2%) think religion can help using such technology by giving guidance and advice. A majority (52.8%) think unexpected and unknown results are the most important ethical questions to such research. Participants heard the most about vegetable genetic modification biotechnology (80.5%) while only (31.4%) heard about mosquito gene modification. The risk of environmental corruption was the most important ethical challenge among scholars (42.6%). More than one-third (35.8%) of participants believed that faith and religious belief have an impact on such biotechnologies but they also said no specialized individual is dealing with such research. Furthermore, (41.5%) of them think it is important for the public to know about ethical matters related to biotechnology research to protect their health and future. There are misconceptions and lack of information about the ethical issues concerning advanced biotechnology experiments among science researchers and Islamic scholars. However, there was awareness about ethical challenges related to some of these technologies.

Keywords: Perspective, Ethics, Biotechnology, Challenges

INTRODUCTION

The beginning of national ethical codes in medical research was the Nuremberg Code, issued in 1947⁽¹⁾. There has been growing debate over the ethical challenges resulting in the establishment of research and clinical ethics guidelines in many countries. Clinical ethics consultation should be pragmatic and problem-centered said Richter G. (2014), and can be defined as an ethically qualified and informed conflict management to resolve normative problems in the care of patients⁽²⁾. Katherine W. et al., 2013 highlighted in their paper that ethical issues do arise in clinical practice such as withholding management, and patient autonomy⁽³⁾. Anna and Kenneth (2003) mentioned that approximately one genetic mutation occurs with each cell division with stem cell-based therapies, and if this division continues uncontrolled, it may lead to tumor genesis and other serious health problems such as graft rejection⁽⁴⁾.

In comparing Middle East countries with international documents, Ghiath Alahmad et al. concluded that most of the research ethics documents in use in this region show a lot of

defects⁽⁵⁾. In addition, a study in Jordan showed the region lacks awareness of other ethical issues concerning the ethics of using participants' social media data for scientific studies⁽⁶⁾.

Advances in biotechnology and medical science raised questions about whether these technology applications are impacted by faith values and views. For example, cloning is a matter of public discussion, and it has been associated with many unanswered questions. Such science causes debates and challenges not only among scientists but also among religious scholars⁽⁷⁾. Islam promotes carrying out research, if it adds cure and value to human beings and is useful for advancing to science. In the Islamic religion, ethical instructions of research conducted from the standards of Islamic law (Shari'a)⁽⁸⁾. Religion guided by norms, and beliefs are often codified into a religious code such as the Bible or the Quran. These codes provide people with behaviors within some acceptable borders⁽⁹⁾. In Jordan, a study of nursing students at Jordan University of Science and Technology showed a higher perception of the dangers of research misconduct among graduate nursing students who were more religious⁽¹⁰⁾.

Studies that describe ethical challenges of genetics research or practice are limited in the Middle East and North Africa (MENA) region and involving members of religious groups in such items is also restricted ⁽¹¹⁾.

Therefore, the following report is an attempt to identify the Islamic scholars and researchers' views towards different significant biotechnology issues such as embryonic stem cell therapy, cloning, vector, and molecular biology, gene therapy. The aim is to find how faith might shape perspectives on biotechnologies themes and overview the opinion of target population towards biotechnology research, also examining researchers' understandings of and attitudes towards faith and technology, and whether they are willing to take into consideration the view of Islam and its scholars if applying to such technology. It is hoped that the findings of this study will assist religious scholars, and researchers in the field to outline research ethics guidelines relevant to such technology from an Islamic point of view to clarify and identify the appropriate approaches and actions.

Research Hypothesis

There are weak perceptions and lack of information about the ethical issues concerning advanced biotechnology science among researchers and Islamic scholars in the MENA region, including Iraq.

Research questions

- 1- What is the knowledge among researchers and Islamic scholars of ethical challenges regarding biotechnology ?
- 2- Whether there is an effect of faith on advanced biotechnology issues among researchers and Islamic scholars.

METHODS

This study was carried out in Iraq. Both Islamic Sharia scholars and scientific researchers are the target population for the study and were enrolled in the survey.

A cross-sectional study was carried out during the year 2019. The study used a convenience (non-probability) sample that included selection of Islamic scholars who meet the degree of high level of Islamic education to be able to give 'Fatawa'. Questionnaire about ethics of biotechnology and science was used and applied to people who self-identified as Islamic Sharia scholars, and who had knowledge of the view of Islam in technology. In addition scientes from different scientific Universities in Iraq completed the questionnaire as well. The questionnaire

included closed-ended questions to participants through face-to-face interview. The study was anonymous to protect privacy and confidentiality. All data were collected in person and then the author transcribed the collected data into a database in a password secured computer. Questions were included about stem cell research, mitochondrial replacement, cloning, cord blood banking, human gene editing, the fertility of malaria-transmitting mosquitos, genetically modified crops, neuroscience advances, and other biotechnology research advances. The questionnaire asked about participants' experiences and knowledge regarding the ethical and faith considerations relevant to using such technology, whether they had experienced any conflict between the requirements of their faith and the use of such technology, and whether religious resources are helpful for them in their research and can be used to make their decisions. A sample of 125 science scholars and 34 Islamic higher degree scholars to the degree of 'fatwa' were enrolled in the study through in person recruitment at their universities. The collected data was entered into a database computer for storage and analysis. Descriptive statistics include the use of frequencies, and relative frequencies tables and means using excel and the SPSS program version 25. Ethical approval was granted by the University of Anbar, College of Medicine. Permission to collect data and informed consent taken from Imam Azam Abu Hanifa University at Baghdad city, Imam Azam College at Anbar province, different colleges at the University of Anbar. Informed consent obtained from all individual participants included in the study, they were given the opportunity to participate or refuse/withdraw from the survey.

RESULTS

Among 159 participants in the study, 102 (64.2%) were males and 57 (35.8%) were females. The socio-demographic characteristic of scholars and researchers in the study sample described. The participants enrolled were from different Colleges including College of Islamic studies. In addition, more than half of participants hold a Ph.D. degrees and teaching positions at universities (see Table 1).

Figure 1 shows different biotechnology experiments that people in the study hear about. Most of participants heard about vegetable modification biotechnology (80.5%), while only (31.4%) heard about mosquito gene modification 31.4%.

Table 1: Socio-demographic characteristics of participants

		No	%
Age (years) Mean± SD 42.0±9.0	<30y	15	9.4
	30---39	48	30.2
	40---49	60	37.7
	50---59	30	18.9
	=>60y	6	3.8
Gender	Male	102	64.2
	Female	57	35.8
College	Science	51	32.1
	Agriculture	18	11.3
	Education	12	7.5
	Pharmacy	12	7.5
	Dentist	17	10.7
	Medicine	15	9.4
	Islamic	34	21.4
Educational level	Bachelors	19	11.9
	Master	59	37.1
	PhD	81	50.9
Occupation	Teaching staff	98	61.7
	Friday imam speaker and teaching staff	19	11.9
	Researcher	42	26.3

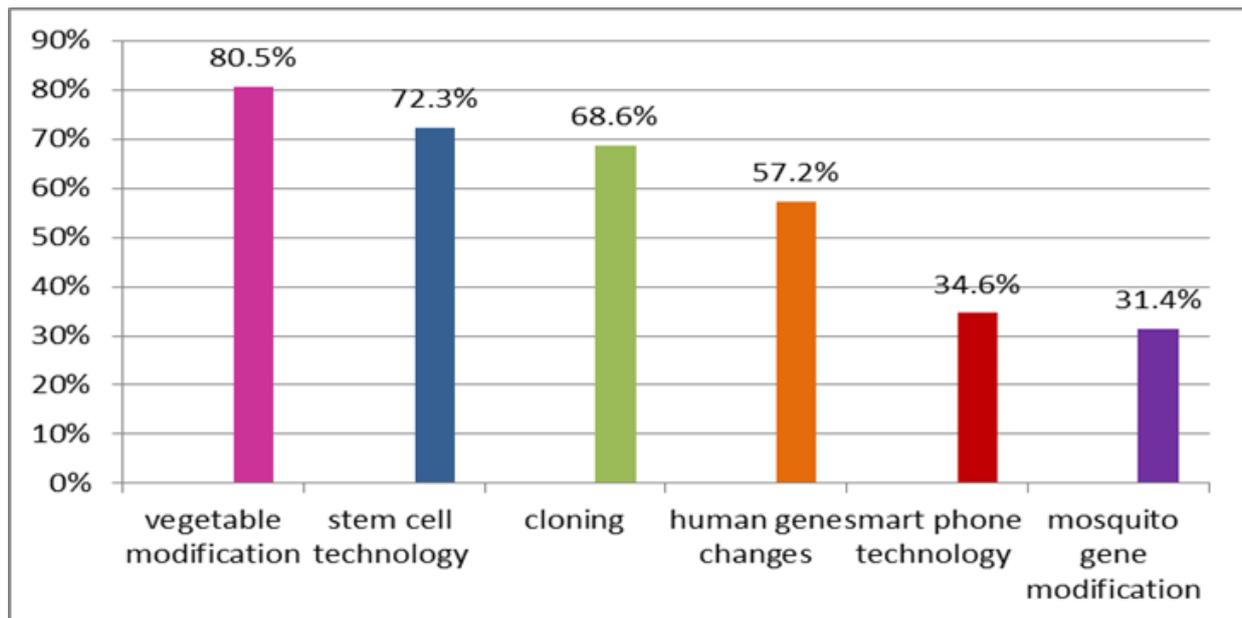


Figure -1 The type of biotechnology experiments that participants heard of.

Both questions of 1) mosquito modified genetically and 2) biotechnology to prevent sexual reproduction for mosquito were correctly identified as the best sentence to describe mosquito-spread through genetic biotechnology by (40.7% Only (18.6%) described prevention as modified genetics to a human exposed to malaria. The highest rated concern of genetic

mosquito modification among scholars and researchers was environment corruption (42.6%). For smartphone technology for health care, (66%) did not hear about this technology. Only 37% of them think this technology has ethical challenges such as loss of confidentiality. Other finding all illustrated in table 2.

Figure 2 shows the different colleges involved in study and responses of its staff about not being aware of human gene changes issue. Those from colleges of Medicine (33.3%) and dentistry (11.8%) where the least to report not hearing about human gene changes.

A large percentage heard about stem cell (72.3%) and cloning biotechnology (68.6%). Half of the scholars and researchers describe the meaning of stem cell biotechnology is beneficial for humans in both disease resistance and treatment. While about one-third of them describe cloning is sheep cloning (see Table 3)

Table 2: Genetic and smartphone technology, their meanings, and ethical challenges.

		No	%	
Heard about genetic intervention for mosquito	Yes	54	34.0	
	No	105	66.0	
The best sentence to describe prevention mosquito-spread through genetic biotechnology	Mosquito modified genetically	22	40.7	
	Modified genetics to a human exposed to malaria	10	18.6	
	biotechnology to prevent sexual reproduction for mosquito	22	40.7	
	Environment corruption	23	42.6	
The ethical challenges for such genetic mosquito modification	may lead to mosquito resistance to insecticides spray	9	16.7	
	May be used in warfare to develop biotechnology weapons	3	5.6	
	Don't Know	6	11.1	
	Both Environment corruption & mosquito resistance to spray	6	11.1	
	Both Environment corruption & used in warfare	5	9.3	
	Mosquito resistance & warfare use	2	3.7	
	Yes	54	34.0	
	No	105	66.0	
Heard about biotechnology using a smartphone for primary health care	Yes	54	34.0	
	No	105	66.0	
The primary health care smartphone technology	Simple health solving problems	14	26	
	Health education, instruction, and advice through SMS text without going to a clinic	27	50	
	Emergency cases	2	3.7	
	Following patient condition	2	3.7	
	Application for disease control and prevention and vaccination camps	4	7.4	
	Program supervised by the ministry of health	2	3.7	
	Using special applications	1	1.9	
	Entering new program technology towards health	1	1.9	
	Communication between a doctor and his patient and deciding any referral to hospital	1	1.9	
	The ethical challenges for such phone technology	Yes	20	37.0
		No	31	57.4
		I don't know	3	5.6

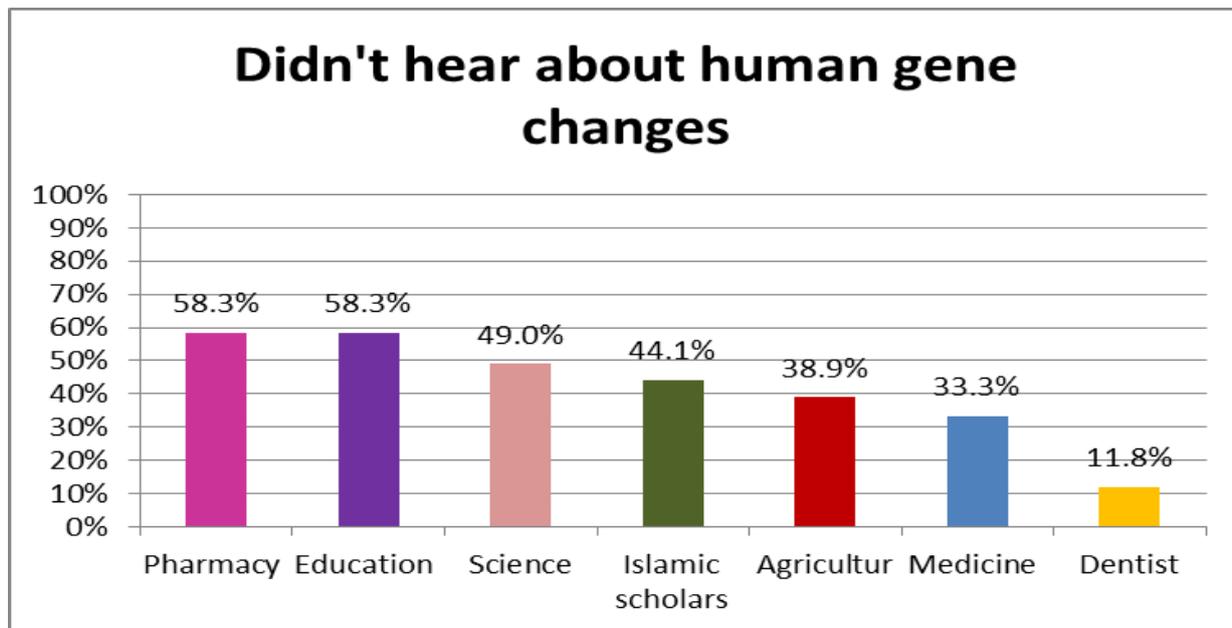


Figure 2: Didn't hear about Human gene changes

Table 3: Stem cell and cloning biotechnology, their meanings, and ethical challenges.

			No	%	
Heard about stem cell biotechnology	Yes		115	72.3	
	No		44	27.7	
Stem cell means;	Beneficial for human medicine including disease resistance and treatment		59	50.3	
	Development of tissue and organism and aging		34	29.6	
	Umbilical cord cells		2	1.7	
	I don't know		7	6.1	
	Wide range of research		13	11.4	
The challenges about such stem cell research	No		37	32.2	
	Yes		64	55.7	
	I don't know		13	11.3	
	May be		1	.9	
Heard about cloning	Yes		109	68.6	
	No		50	31.4	
The cloning means;	Copying human and animal		34	31.2	
	Means sheep cloning		35	32.1	
	Means copying and replicating DNA		20	18.3	
	Using somatic cells to create a zygote egg to create new creature resemble a parent		15	13.8	
	Finding different organism through their genetic contents		1	.9	
	Don't know		1	.9	
	Wide range of research		3	2.8	
The ethical challenges for such cloning research	Yes		96	88.1	
			No	13	11.9

Result identified that education and learning was the highest rate (44.7%) among the ways to improve decision made for biotechnology research. While the unexpected and unknown results of biotechnology research were the highest reported ethical concern (52.8%). Scholars under study think that religion can prevent such biotechnology (27.7%), and at the same time only (18.2%) of participants think

religion can help in giving guidance and advice to such advanced research. A third of scholars (32.7%) believe that faith should direct ethical decision to such biotechnology research. While those who believe that there is a relation but no specialized persons is dealing with such research was (35.7%). All other findings illustrated in table 4.

Table 4: ways to improve decisions made for biotechnology, most important questions related to such research, the religious effect on such research, and other related questionnaire.

		No	%
In his opinion, the ways to improve decision made for biotechnology research	Education and learning	71	44.7
	Evaluation of such research	34	21.4
	Depending on the safety and effectiveness of such research on human	22	13.8
	Don't know	19	11.9
	Both education & evaluation	7	4.4
	Both evaluation & depending on safety	2	1.3
	Both evaluation & depending on safety	2	1.3
	Education, evaluation & depending on safety	1	.6
The most important ethical questions related to such research	No answer	1	.6
	Dangerous on human health	57	35.8
	Unexpected and unknown results	84	52.8
	Evolution and scientific progress factor is more important than any other factor	6	3.8
	Don't know	7	4.4
	Both dangerous and unexpected	4	2.5
The religious effect and event in using such biotechnology research	Dangerous, unexpected & evolution	1	.6
	Religious can prevent such research	44	27.7
	Can allow such research only for those in chronic and intractable human conditions	53	33.3
	Can help in giving guidance and advice	29	18.2
	Don't know	23	14.5
	Religious & allow for chronic illness	4	2.5
	For chronic illness & help in guidance	5	3.1
	Religious & chronic illness & help in guidance	1	.6
The importance to participate in such research	Very important	44	27.7
	Important	76	47.8
	Not so important	26	16.4
Think it is important for the public to know about ethical consideration towards biotechnology research	Not important	13	8.2
	To protect their health and future	66	41.5
	It is their legal and moral right	64	40.3
	To take the right decision	15	9.4
	Don't know	6	3.8
Think that it is applicable to apply biotechnology at our society	Protect their health & right decision	5	3.1
	It is their legal & to take the decision	1	.6
	To protect their health & it's their legal	2	1.3
	Yes	91	57.2
	No	63	39.6
	Don't know	5	3.1
Think that faith and religious belief have:	Have no relation with such biotechnology research	19	11.9
	Faith should direct ethical decision to such research	52	32.7
	There is a relation but no specialized persons is dealing with such research	57	35.8
	Don't know	29	18.2
	Both faith direct ethical decision & there is a relation but no specialist	2	1.3

DISCUSSION

Although in the field of advanced biotechnology research experiments is ongoing, and some of it which already applied (e.g. stem cell research) while others are still under trials (e.g. mosquito genetic modification), such research raises a lot of ethical challenges to consider. Key population sectors such as religious scholars, scientists, politicians, and ethicists have concerns and

insight that needs to be taken into consideration by scientists doing such research^(12,13). Our current study confirms a lower understanding of such advanced research in biotechnology among scholars and researchers in the MENA.

Although in this survey more than half of participants believe that it is applicable to apply these biotechnologies in their society, yet many scholars did not hear about such technologies

despite these experiments are within the same field of their expertise, for example, smartphone and mosquito gene modification. Maybe this is due to such researchers are not up to date regarding these new biotechnology experiments and are not applying these experiments in practical laboratories due to the absence of research funds. Lack of knowledge about these technologies by researchers and scholars results in a lack of interest and consequently lack of community participation. Minakshi and Darryl described modern biotechnology as a challenge in developing countries, for example, in India, more funding is spent on communicable and non-communicable diseases rather than into modern biotechnologies⁽¹⁴⁾. While in other developing countries in Africa such as Eritrea and Gambia high percentage of people uses traditional medicine due to cultural effect from the environment where they live and alternative to other medicines when seeking health⁽¹⁵⁾.

Mosquito gene modification is a new biotechnology experiment and it has been applied by scientists in places where the mosquito is a reservoir for some endemic diseases such as malaria affecting human health. It is a molecular intervention and includes transgenic modified mosquitoes that state anti-parasitic genes in mosquito's midgut epithelium, so making them inefficient vectors for the disease^(16, 17).

The World health organization in their latest guidance framework report that for testing genetically modified mosquitoes (GMM) clarified necessary steps and requirements to take in consideration while testing or implementation of GMM. These include the assessment of risk and harm of GMMs, ongoing safety, review, efficacy and effective approach in lowering parasite transmission, respect of communities during GMM testing or trials through identifying the ethical obligations of people and their concerns. Communication with communities about efficacy trials of GMM should be done before field testing⁽¹⁸⁾.

Our results indicate that among scholars in Iraq, environment corruption was the most important ethical challenges in GMM research, with some opinions stating that this experiment could be used in warfare biotechnology. Grisolia in his paper pointed out that Anopheles mosquito genetically modified organisms would lead to disturbance of gene network and genetic load, which in turn ethical consideration and implication can't be neglected⁽¹⁹⁾.

Concerning smartphone technology, this study shows some ethical challenges such as loss of confidentiality and loss of doctor-patient face to face interview, both considered important principles in medical ethics. Bhavnani et al predict that the development of new

technologies in diagnostics, imaging, and therapeutics using mobile health (mHealth) will be a major part of health care. He clarified that to translate these technologies to people, it needs clinical integration, patient engagement, data analysis, and to create an evidence base that assesses the impact of mHealth on healthcare quality, cost, and outcomes.⁽²⁰⁾.

Participants in our study though that cloning has more ethical challenges and harm to a human being than stem cell biotechnology. Ziga in his paper support this notion and questioned the impact of cloning on a human being, and if people aware of its consequences, and where it can lead to?⁽²¹⁾. De vries mentioned in his article that therapeutic cloning, embryonic stem cell, and tissue engineering in human is debatable in addition to the ethical challenges accompanying these biotechnologies⁽²²⁾. In addition, Volarevic et al indicate that differentiation of induced stem cells regarding stem cell-based therapy, which can be used in human cloning, has ethical controversies. Scientists should be extremely cautious before they apply their use clinically on human⁽²³⁾.

Since the rise and the beginning of Islam, the Holy Qur'an and the Prophet Mohammed (peace be upon him) have been urging people to learn about science continuously. In the Qur'an, the first verse that was read by the prophet was 'Iqra' which means 'Read'. In addition, a lot of hadith by the prophet Mohammed mentioned the great role, benefit, and reward of scientist and learning⁽²⁴⁾. Therefore Islam religion, its faith, and his scholars are not against using such modern biotechnology, instead, it is allowed for those in chronic and intractable human health conditions. This was highly supported by participants in this study. Meanwhile, Mossa argued that the political, cultural diversity of Muslim societies, civil wars, and Muslim ethical

practices under pressure, make consensus on these technologies a difficult and risky issue⁽²⁷⁾. At the same time Islamic religion can prevent such technologies if the experiment is trusted (it doesn't have unexpected and unknown results and this was more than half of people concern in our study), not misused against humanity and human instinct and this is judged and diligence by the 'fatwa' that is produced or used by high level of religious education of Islamic scholars called 'mufti'. Saifuddeen et al mentioned in his article that fatwa acts as an essential solution and guideline for Muslims in many areas including biotechnology applications. He describes fatwa as an important matter to Muslims in handling issues, which are not mentioned in the Holy Quran and the customs or curriculum of the prophet⁽²⁵⁾.

In Malaysia, departments from Islamic universities, researchers and experts from

ministries and institutes shared dialogue and collaboration to discuss and solve fatwa and bioethical issues. Also under the National Bioethics Council (Majlis Bioetika Negara) religion and science are met where Islamic scholars and scientist's talk and conversations are taking place about such important issues related to human beings' life destiny ⁽²⁶⁾. . Again, in Malaysia experts from both Islamic philosophy and science scholars in biotechnology issues revised many terminologies in this field of science. They agreed on ethical principles carrying values, which were guidelines to industries, researchers, and policy makers; for instance the protection of environment, and biological diversity, the protection and safety of future generations, maintained of moral and religious values, Non-maleficence, autonomy, and others ⁽²⁸⁾. A recent study in Malaysia suggest referring to "The Malaysian Code of Responsible Conduct in Research" with declaration regarding ethics issues when conducting indicators for the Noble Values principles ⁽²⁹⁾. These issues arises and discussed heavily to protect Malaysia from any offensive and out of morals effects of modern biotechnology.

CONCLUSIONS

In general, there is a misconception and lack of information about the ethical issues concerning advanced biotechnology experiments among scientists, researchers, and Islamic scholars. Genetic intervention for mosquito was among the highest technology that participants didn't hear about followed by smartphone technology. Cloning was among the main technologies that participants thought it has ethical challenges followed by human genetic modification. Both science and Islamic scholars should increase their meeting, learning, knowledge about biotechnology experiments. Islamic scholars should reach to the level of 'fatwa' for such important upcoming advanced biotechnology reaching their countries, and a bioethics committee council for such issues should be established in each developing and Islamic countries.

Middle East and North Africa (MENA) region should establish guidelines and clear identification of each biotechnology experiment and trial for both humans and animals. Further studies are needed in this significant field of research and each ethical issue mentioned in this manuscript can be studied with further details. In addition more countries in MENA region can be involved in the same context of research to compare findings among them and to have a look on different perspective of these important ethical issues and their challenges. Improving scientists, scholars, students and public' knowledge and awareness about such advanced ethical experiments, their challenges through different channels whether lectures, research,

workshops and open discussion. The US National Institute of Health has funded several training grants on research ethics education, including one in Malaysia, and one in Jordan. Our study can motivate initiatives in less developed countries to build a scientific-religious committee to discuss such issues, establish guidelines for each bioethical subject, and make it easier for scientists to navigate them ethically.

List of abbreviations

(MENA): Middle East and North Africa region.

(mHealth): mobile Health.

SPSS: Statistical Package for the Social Sciences.

GMM: Genetically Modified Mosquitoes

Competing interests

The author have no financial involvement with any organization or affiliation or entity with a financial interest in or financial conflict with the subject matter or materials discussed in the manuscript apart from those disclosed.

Informed Consent

Informed consent was obtained from each individual participants included in the study

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