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PERSPECTIVE

Islamic Viewpoints on Opportunistic Sex Selection of IVF Embryos upon doing Preimplantation Genetic Testing for Preventing Genetic Diseases

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Abstract

In recent years, preimplantation genetic testing (PGT) of IVF embryos have gained much traction in clinical assisted reproduction for preventing various genetic defects, including Down syndrome. However, such genetic tests inevitably reveal the sex of IVF embryos by identifying the sex (X and Y) chromosomes. In many countries with less stringent IVF regulations, information on the sex of embryos that are tested to be genetically normal is readily shared with patients. This would thus present Muslim patients with unintended opportunities for sex selection based on personal or social biases without any pressing need or valid medical reason. Additionally, there are other patients who claim using PGT for preventing genetic defects as a pretext or "convenient excuse," with a secret intention to do sex selection when it is banned in their home country. Currently, non-medical sex selection is a highly-controversial and hotly debated issue in Islam, because there is generally a strong preference for having sons over daughters due to widespread cultural norms of elderly parents depending on their sons for financial support, as well as the need for male heirs to continue the family lineage within the backdrop of local patriarchal cultures. There is a risk of gender imbalance and social disequilibrium occurring in Islamic societies due to prevalent sex selection. Hence, the question is whether opportunistic sex selection with PGT would contravene Islamic ethics and principles, which will thus be discussed here.

Keywords Aneuploidy · Reproductive ethics · Gender discrimination · Preimplantation Genetic Testing · Islamic Bioethics · Sex selection

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Introduction

In the modern era of new reproductive technologies, various medical techniques now give prospective parents a choice to deliberately select the sex of their offspring for non-medical or social reasons (Rai et al. 2018). These include sperm sorting, preimplantation genetic testing, artificial intelligence-based analysis of microscopy images, and sex-selective abortion after ultrasound diagnosis or prenatal testing (Dondorp et al. 2013).

Currently, in the Islamic world, there is generally a strong preference for having sons over daughters due to widespread cultural norms of elderly parents depending on their sons for financial support, as well as the need for male heirs to continue the family lineage within the backdrop of local patriarchal cultures (Bokek-Cohen and Tarabeih 2020). Consequently, widespread use of such new technologies for sex selection has led to highly skewed population sex ratios in many Muslim countries over the past few decades (Misachi 2021), thus generating much controversy and resulting in many jurisdictions banning sex selection for non-medical reasons (Rai et al. 2018).

The focus of this article will be on preimplantation genetic testing (PGT) of in vitro fertilization (IVF) embryos, which has gained much traction in clinically assisted reproduction for preventing various genetic defects in newborns, including chromosomal abnormalities such as Down syndrome, and monogenic disorders such as β-thalessemia (Fesahat et al. 2020). However, in doing such genetic tests, the sex of the IVF embryos is inevitably revealed through the identification of the sex (X and Y) chromosomes (Ethics Committee of the American Society for Reproductive Medicine 2018). Indeed, PGT is widely considered to be the most reliable among the various techniques of sex selection that do not involve either abortion or infanticide. If a woman can get pregnant via IVF combined with PGT, then the success rate of sex selection is close to 100% (Ethics Committee of the American Society for Reproductive Medicine 2022).

Because information on the sex of IVF embryos is a secondary finding that is not the originally intended diagnostic target of doing PGT for medical reasons, such as preventing Down syndrome in older women (Kalia et al. 2017), there has been much heated debate and controversy on whether patients should be given access to such secondary findings that is of no relevance to their original intentions for undertaking diagnostic testing in the first place (Kalia et al. 2017). Pretest counseling is currently recommended by the American College of Medical Genetics and Genomics (ACMG) for patients to discuss with their doctors or genetic counselors on the implications of "secondary" findings, such as sex of their IVF embryos (American College of Medical Genetics and Genomics 2014), with patients being given the right to opt out of knowing the results of such secondary findings (American College of Medical Genetics and Genomics 2014). An outright ban on the sharing of secondary findings in PGT such as the sex of IVF embryos would be highly controversial, as this would obviously impinge on parental autonomy and reproductive liberty (Knoppers 2014; Burke et al. 2013; Wolf et al. 2013). Additionally, there are also other ethical issues to consider,

such as best interests of the child, and principle of non-discrimination (Knoppers 2014; Burke et al. 2013; Wolf et al. 2013).

In many countries with less stringent IVF regulations, information on the sex of embryos that are tested to be genetically normal by PGT is readily shared with patients. Hence, this would thus present Muslim patients with the unintended opportunity for sex selection based on personal or social biases, without valid medical reason or pressing need (such as gender balancing of families lacking children of one particular sex (Malpani et al. 2002)), despite their original sincere intention of doing PGT to prevent genetic defects rather than for sex selection. Hence, the dilemma facing Muslim patients is whether doing such opportunistic sex selection of IVF embryos (without any pressing need or valid medical reason) would contravene Islamic principles, which will thus be discussed here.

Then, there are also some Muslim IVF patients with secret intention to do PGT for sex selection, while claiming that they want to screen for genetic defects in their IVF embryos (e.g., Down syndrome) with PGT, as a pretext or "convenient excuse" to get around the ban on non-medical sex selection in their home country. Hence, it is also necessary to examine the duplicitous behavior and motives of such deceitful patients, from the perspective of Islamic principles and ethics.

Encroaching on Allah's Domain

Regarding sex selection for non-medical reasons, Muslim scholars are divided into two opposing viewpoints based on their subjective interpretations of scriptural evidence and prophetic traditions (i.e., Quran and Sunnah), together with differing theological and juristic opinions and legal reasoning (Table 1) (Saed Al-Nadi et al. 2018).

Opponents of non-medical sex selection argue that knowing/trying to know the sex of the unborn child is itself an offence as it encroaches on Allah's domain. They view the Quran and Sunnah (prophetic traditions) as confining the knowledge of what is within wombs to Allah only. The Qur'an says: "Indeed, Allah [alone] has knowledge of the hour and sends down the rain and knows what is in the wombs." (Qur'an Chapter 31, Verse 34). The Prophet said, "The keys of the unseen are five, and none knows them but Allah: (1) None knows what is in the womb, but Allah: (2) None knows what will happen tomorrow, but Allah; (3) None knows when it will rain, but Allah; (4) None knows where he will die, but Allah (knows that); (5) and none knows when the Hour will be established, but Allah. (Saḥiḥ Bukhārī, Chapter 4, Ḥadith No. 7379)".

In light of these (and similar) texts, they argue that only Allah has the right and power of knowing what is within the wombs, and if humans claim this knowledge, then it contradicts with the Quran and Sunnah. However, this view is often counteracted with the claim that Allah's knowledge is so vast that it covers every minute detail about the fetus, from its beginning to its death, including if the person is successful or not in the hereafter. Hence, Allah's knowledge is not just confined to the sex of the fetus but comprises everything. Additionally, Allah knows the sex even before fertilization.

Table 1 Summary of Islamic religious arguments for and against non-medical sex selection

Arguments against non-medical sex selection	Arguments for non-medical sex selection
Only Allah knows and has the right to determine the sex of the unborn child, so sex selection is an encroachment on Allah's domain (Based on Quran Chapter 31, Verse 34; and Chapter 42, Verse 49).	Allah will ultimately decide whether what man had originally planned will be successful. Hence, sex selection is permissible because the success of such a human endeavor is subjected to Allah's will (Based on Quran Chapter 81, Verse 29).
Sex selection by medical intervention is tantamount to altering or tampering with Allah's creation (*taghyir khalq Allah*), which is explicitly forbidden by the Quran and considered as Satan's act (Based on Quran Chapter 4, Verse 199).	The Quran mentions an individual (Prophet Jacob) praying to Allah to grant him a child of specific gender (Based on Quran Chapter 19, Verses 5 and 6).
Disequilibrium in society due to gender imbalance with widespread and unregulated sex selection.	There are no specific prohibitions against sex selection, neither in the Quran nor *Hadiths*. The majority of Islamic scholars agree that whatever is not explicitly prohibited (*haram*) is by default permissible (*halal)* (Based on *Sunan Al-Tirmidhi*, *Hadith* No. 1726).
Unnecessary and unwarranted risks of muddling of lineage (*nasab*) upon sex selection by medical intervention in couples without pertinent infertility problems. For example, the egg may be accidentally fertilized by the wrong sperm. Such risks may only be warranted if the couple has genuine fertility problems. Otherwise, Islamic principles would favor the prevention of harm by avoiding unnecessary risks.	In some patriarchal societies, there is genuine hardship faced by couples without a son, who can be a financial provider for them in their old age. Islam does not intend to impose unnecessary hardship on anyone due to religion (Based on Quran Chapter 22, Verse 78).

Hence, opponents of non-medical sex selection claim that deliberately selecting the sex of the fetus is encroaching on Allah's domain of choice because Allah grants the offspring by His wisdom and proportions. He grants to whom he wills females, and he grants to whom he wills males. It has to be natural without human intervention. This is countered by the opposing viewpoint that choosing the sex of the fetus does not in fact go against Allah's will as he gives to whom he wills, females or males, through any means, and that can be with medical intervention. Medical intervention will thus also be considered to be under Allah's plan.

On the other hand, proponents of non-medical sex selection put up various arguments that knowing the sex of the fetus within the womb is not against Allah's will. For example, the Prophet permitted coitus interruptus to avoid conception. Jābir ibn 'Abdullāh narrated: We used to practice coitus interruptus while the Qur'an was being revealed. Sufyān said: "If it had been something unlawful, then the Qur'an would have prohibited us from practicing it" (Sahih al-Bukhari 5208, 5209). In another hadith, the Prophet said, "Withdraw your penis from her if you wish for what is decreed for her will come to her" (Sunan Abi Dawud 2173). If coitus interruptus is allowed for avoiding conception and explained as not contradicting the will of Allah, then sex selection is not in contradiction with the will of Allah in the first place. In addition, knowing the sex of the child is not offending Almighty's will because Allah's will must ultimately manifest on

earth regardless of whatever man had originally planned. This is not an assault on God's will nor a claim of knowledge of what is in the wombs, but only relying on various means to achieve a desired goal, subject to the will of God.

There is generally a greater diversity of opinion on the issue of non-medical sex selection among Muslim scholars of the Sunni tradition of Islam (Bokek-Cohen and Tarabeih 2020; Saed Al-Nadi et al. 2018), as compared to the Shia tradition of Islam that appears more favorable to this action provided there exists a necessity or hardship to do so, as attested by the literature (Dezhkam et al. 2014; Eftekhaari et al. 2015). The best example of such necessity or hardship is a family with only daughters, who desperately need a son to be a financial provider for parents in their old age, particularly within patriarchal societies where women are economically disadvantaged (Dezhkam et al. 2014; Eftekhaari et al. 2015). Currently, non-medical sex selection is permissible in Shia-majority Iran, whereas it is banned by Sunni Muslim religious authorities in Israel and Palestine (Bokek-Cohen and Tarabeih 2020).

Sex Selection without Medical Intervention

In general, the majority of Muslim jurists agree on the permissibility of sex selection without medical intervention. It can be, for example, by scheduling intercourse at specific timepoints around ovulation. This view is deduced from various textual pieces of evidence described below.

In a story mentioned in the Quran, the prophet Jacob prayed "I am concerned about the faith of my relatives after me, since my wife is barren. So, grant me, by Your grace, an heir. Who will (truly) represent me and represent the posterity of Jacob" (Chapter 19, Surah Maryam, Verses 5 & 6). This would obviously refer to a male heir, because, by heir, he meant to have a son to be a prophet who can guide the people after him. In Islam, all prophets are men. Hence, in the above prayer, seeking specific sex of the conceived child has been portrayed. In addition, it was reported that the Prophet Muhammad was upset and wept when all his male children passed away in their early childhood.

The Prophet gave some insights into the resemblances of a child to the father or the mother. "As for the child's resemblance to its parents: If a man has sexual intercourse with his wife and gets discharged first, the child will resemble the father, and if the woman gets discharged first, the child will resemble her (Sahih Bukhari, Book 55: Number 546)." He explained the reasons for child resemblance in sex or other genetic features, which can be attempted by people, and he did not prohibit using this method.

Hence, in the light of Islamic legal maxims, sex selection without medical intervention seems permissible. The maxim "the basic and original ruling of all things is permissibility or ḥalāl" applies here, with sex selection through natural means not being prohibited, and there is no proof from the Quran and Sunnah that seeks to change this original ruling.

Sex Selection with Medical Intervention

PGT–based sex selection of IVF embryos would obviously involve medical intervention. Contemporary Muslim jurists have agreed upon the prohibition of sex selection with medical intervention, if it is implemented on a whole community or at large for all members of a country. It is impermissible to do so, as it will cause disorder in the functioning, order and equilibrium of the world, through a highly skewed population sex ratio (Shaia et al. 2020).

However, if sex selection with medical intervention is done at an individual level, there are two opposing viewpoints as follows:

Sex selection with medical intervention is permissible

This view is supported by the prophet Jacob's prayer mentioned above. In addition, the Quranic verse "He has not laid upon you any hardship in religion" (Chapter 22: Verse 78), is often quoted to underline the view that some families lacking children of one particular sex might face genuine hardship that needs to be addressed (Qāsim 2001). The best example would be a family with only daughters, who are living in a society whereby patriarchal tradition dictates that the son should take care of his elderly parents. Under such circumstances, as the parents get older and gradually marry off their daughters one by one, they would face genuine hardship without a son to financially support and care for them in their old age.

This group of scholars often cites the hadith related to child resemblance, mentioned above, to strengthen their viewpoint. However, it was counteracted that the method suggested by the Prophet Muhammad does not involve any external or medical intervention, relying instead on nature only. Additionally, it is also claimed that sex selection, even with medical intervention, at the individual level will not have any effect on world order, as sex selection occurrence is uncommon (Saed Al-Nadi et al. 2018).

Also, this view is supported by the hadith, "The lawful is what Allāh made lawful in His Book, the unlawful is what Allāh made unlawful in His Book and what He was silent about; then it is among that for which He has pardoned" (Sunan Al-Tirmidhi, Ḥadīth No. 1726). It means that whatever Allah is silent about is permissible, including sex selection via medical intervention (Al-Shuwayrikh 2007). Nevertheless, it is often counterargued that medical intervention necessitates exposing awrah (private part) without a necessary situation (*ḍarūrah*), which is a prohibited action. This argument is countered with the legal maxim "A ḥājat (need) possibly falls under the category of necessity (*ḍarūrah*) whether it is in general or specific form." Therefore, in the presence of a valid need, exposing awrah is permissible to meet that particular need only.

Sex selection with medical intervention is not permissible

This view is based on the premises mentioned above, that knowing/trying to know the sex of the unborn child is an offence as it encroaches on Allah's domain. This view is supported by the Quranic verse, "To Allāh belongs the dominion of the

heavens and the earth; He creates what He wills. He gives to whom He wills female [children], and He gives to whom He wills males [children]" (Chapter 42, Verse 49). Sex selection is, therefore, an encroachment on Allah's will. Nevertheless, it can be counterargued that this does not deny Allāh's will, as nothing happens in his dominion without his will, as Allāh says: "And you do not will except that Allāh wills" (Chapter 81 Verse 29). In addition, medicine cannot guarantee the success of the treatment and selection procedures.

This view suggests that sex selection with medical intervention is the alteration or tampering of Allah's creation (*taghyīr Khalq Allāh*), which is explicitly prohibited by the Quran that calls it Satan's act (Chapter 4, Verse 199). This view can, however, be counteracted by the argument that changes in creation involve adding and cutting off, for example, some of the organs of a creature. In the laboratory method, fertilization occurs similarly as in vivo, and the success and failure of the medical intervention are according to Allah's will (Al-Bazz 2001).

It has also been argued that medical intervention for sex selection might cause muddling of lineage/genealogy (*nasab*), for instance, a medical error might occur by fertilizing the egg with the wrong sperm. To avoid this, the technique is considered impermissible. Nevertheless, it can be counter-argued that current biomedical technology is advanced enough to avoid such issues and mistakes.

Discussion

In light of the above scriptural evidence, it is posited that the Islamic ruling on sex selection before becoming an embryo (prior to fertilization) is based on *fiqh al-muwāzanah* (jurisprudence of comparing the pros and cons of action and choosing the dominant beneficial choice). If the positive impacts of sex selection outweigh the negative effects, it is permitted on an individual level. But if otherwise, it is prohibited. It means there is no single and general ruling on the issue. Rather, the ruling varies according to the case and need at hand. The need is not necessarily medical rather it could be familial or social. The need could be to balance families, if most/all of the children are of one sex and parents want to have children of a different sex.

Sex selection, as some might argue, is not tantamount to the alteration or tampering of Allah's creation (*taghyīr Khalq Allāh*). However, gender selection should only be for meeting a valid need. Also, it has to be viewed from the perspective of each individual's needs and not as a binding law endorsed by the authorities that is applicable to all (Al-Bazz 2001). In addition, knowing or trying to know the sex of the fetus does not appear to be encroaching on Allah's domain. Instead, the Quranic verses and hadiths mentioned by both proponents and opponents of sex selection refer to the vast knowledge of Allah, which includes past, present, and future. He knows even what is hidden in the hearts. It should not be limited to the sex of the fetus only.

Therefore, if a person has a need and he/she is assured that the mixture of sperm and egg is done in a trusted (i.e., no mixture with an outsider of marital union (*ikhtilaṭ al-nasab*) and scientific and medically proven manner, and it does not involve committing a forbidden act (e.g., abortion or infanticide), and it does not

lead to revealing the private parts except for a necessity, then it would be permissible (Islamweb.net 2022).

However, if sex selection necessitates/leads to abortion, then the ruling is of prohibition in general. This would obviously not apply to PGT–based sex selection. According to the majority of contemporary Muslim jurists, abortion is prohibited at any stage of pregnancy without a necessity. Notwithstanding, some jurists from earlier and contemporary periods opined that abortion is allowed in the first 40 days or 120 days of pregnancy, even without a valid need (Arif 2011).

Conclusion

In conclusion, based on Islamic principles expounded by the Quran and Hadiths, unintended and opportunistic sex selection arising from PGT of IVF embryos to avoid harmful genetic defects such as Down syndrome should not be based on the whims and fancies of prospective parents, who may act according to social bias of their local traditional culture. This may disrupt the proper functioning, order, and equilibrium of their society in particular and the world in general, through a highly skewed population sex ratio. However, if there is a pressing need, such as balancing families that lack children of one particular gender, so as to provide prospective parents with a caregiver and financial provider in their old age, or a heir to take over the reins of the family business, then such opportunistic sex selection may be compliant with Islamic ethics and be permissible. In any case, it is imperative that the law of the land be respected, because laws are made for a specific reason and for promoting the public interest, in general. From a a religious perspective, a Muslim has to abide by the law of the land as mentioned in the Quran "O believers, fulfill all obligations"(al-Mā'idah: 1) and the hadith "Muslims are bound by their conditions, except a condition that forbids something permissible or permits something forbidden." (Ibn Maajah 2353). For example, many countries that have banned sex selection for non-medical or social reasons often have highly skewed population sex ratios, and such laws have therefore been enacted to address this demographic imbalance in their respective societies. Hence, the duplicitous claim of using PGT for preventing genetic defects such as Down syndrome by some patients, as a "convenient excuse" or pretext to secretly select the sex of IVF embryos, to get around local laws banning sex selection, will therefore contravene Islamic principles and ethics, which generally do not tolerate duplicity or deceitfulness of any kind. This is expounded by the hadith "Deeds are governed by intentions, and every person gets but what he has intended" (Sahih al-Bukhari: Islamic legal maxim "matters are judged by their objectives (intention)").

In Muslim countries that permit the use of PGT for non-medical sex selection on the condition of pressing or dire need, it is recommended that an ethics committee be set up by the local or regional health authority to oversee and approve non-medical sex selection by patients on a case-by-case basis, based on assessing the severity of their needs. Such an ethics committee should comprise a mix of clinicians, Islamic jurists and biomedical scientists specializing in IVF (i.e., embryologists)

and should rigorously verify and evaluate the circumstances of individual patients requesting non-medical sex selection. Besides balancing families with children of one gender, there may also be other extraordinary circumstances that warrant the use of PGT for non-medical sex selection, for example, if the health of the mother permits the birth of only one child with a high degree of medical risk, and there is a desperate need for the couple to have a son to be their financial provider in old age or to take over the reins of the family business, within the context of a patriarchal society. At the end of the day, the exact criteria that define pressing or dire need for non-medical sex selection will have to be determined by individual ethics committee based on prevailing socio-cultural values of the local Muslim community, which are bound to vary among different countries.

Declarations

Competing interests The authors declare no competing interests.

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