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Review

Comparative Study on Gender Selection: Persian Medicine and Modern Medicine

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Abstract

Gender selection has emerged as a controversial issue in different countries and in this respect, a wide range of studies and international symposiums have been dedicated to this subject. A comprehensive literature review was performed without restriction on publication date. Also, the credible Persian Medicine (PM) resources such as "*Exir-e-Azam*" (The Great Elixir), "Qarabadin-e-Kabir" (Great Pharmacopoeia), and "al-Qānūn fīl-tibb" (The Canon of Medicine) were completely studied. It was found that both nutritional factors such as glucose and electrolytes and non-nutritional factors including female tract, sperm, age, the timing of sexual intercourse, maternal body mass, stress, pH, estrogen, temperature, and testosterone can be used as important indicators in the gender selection. Most recommendations provided by PM for gender selection were found to be in good agreement with those reported by modern medicine.

Keywords: Gender selection; Modern medicine; Persian Medicine

Introduction

Gender selection or specific gender preference for unborn children is still remained as a controversial issue in different countries due to various reasons as far as a wide range of research studies and international symposiums have been dedicated to this subject [1]. Gender selection has been considered from different points of view. One is related to the history of sexually transmitted genetic diseases that occur in a particular gender, such as hemophilia, plantar fasciitis, Duchenne muscular dystrophy (DMD), Lesch-Nyhan syndrome, and ectodermal dysplasia [2,3]. However, gender selection probably is helpful for families to have healthy children. The historical issue associated with controlling the gender of the offspring comes back to the effect of gender ratio on the cultural, social, economic conditions of societies as well as ensuring male propagation of family name [4]. Cultural issues from specific gender preference seem to be distinguished in various countries and preference for boys over girls has often led to family violence, female abortion, and divorcing or remarriage [4-6].

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Recently, various studies have been designed to determine the important factors involved in gender selection. Different studies have confirmed the effect of female tract [7], sperm [8], age [9], the timing of sexual intercourse [8, 10], maternal body mass [11], glucose [12], stress [12], electrolytes [13-15], pH [16], estrogen [17], temperature [16], testosterone [18], and artificial fertilization [19] on gender selection. Also, there are reproductive technologies for this purpose including chorionic villus sampling (CVS), ultrasound, sperm sorting and preimplantation genetic diagnosis (PGD), and a sperm-sorting technique (MicroSort). However, there is increasing concern that some reproductive technologies for gender selection are being disadvantaged due to different side effects [5,20].

Persian Medicine (PM) has offered efficient, safe, and usually accessible medical approaches to prevent and treat diseases, based on the medicinal plants. Gender selection is also one of the topics which have been addressed in different references. As there are different safe and user-friendly prescribes, it merits discussion and comparing with studies reported in modern medicine. It should be noted that different factors such as time, stress, nutrition and consuming some medicinal plants have been fully considered in gender selection [21-26]. In this study, these factors comparing with their counterparts in modern medicine, are discussed.

Search Method

Herein, credible Persian Medicine references such as "*Exir-e-Azam*" (The Great Elixir) [21], "*Qarabadin-e Kabir* "(Great Pharmacopoeia) [22], "*al-Qānūn fīl-tibb*" (The Canon of Medicine) [23], "*Tohfat al momenin*" (A Gift for the Faithful) [24], "*Kholassat-al- Hekmah*" (The Principal's of Traditional Iranian Medicine) [25] and "*Qarabadeen-azam*" [26] were studied using keywords including "*Tadbir al-azkar*" and "*Tadbir al-anas*". In addition, recent developments were reviewed in modern medicine using search engines such as PubMed, Google Scholar, Scopus, Noor database and Iranian databases using keywords such as "sex selection", "gender determination", "gender selection", "gender preference", "age", "timing", "male-selective", and "female-selective". Materials related to study criteria were extracted and analyzed in a comprehensive manner.

Results

Literature survey showed that different nutritional and non-nutritional factors are directly involved in the gender selection [13]. There are also similar factors recommended by PM which play important roles in the gender selection. Some nutritional factors (medicinal plants) which have been found to be effective, are reported in Table 1. They usually include consuming nutritious and hot foods by men and women especially by men, low water intake, consuming sweet foods such as honey, low consumption of pickles, and using some special medicinal plants or their combinations before fertilization. Non-nutritional factors recommended by PM usually include the interval between fertilization and the end of menstruation, fertilization time, the female tract, male fertility status, physical condition, and female health [21-25]

Among the reported nutritional factors, glucose and electrolytes were found to be crucial [12, 13]. Non-nutritional factors usually include selective force of the female tract [7], sperm [8], age [9], the timing of sexual intercourse [8, 10], maternal body mass [11], stress [12], pH [16], estrogen [17], temperature [16], testosterone [27], and artificial fertilization [19] (Table 2).

Female tract

In PM, the female tract has been considered as a significant factor in gender selection. In this respect, virginal use of some herbal formulations containing *Pistacia atlantica, Pistacia lentiscus, or Crocus sativus* before fertilization has been recommended [21-23]. The importance of the female tract has been fully considered in modern medicine. It has been indicated that females have great control over fertilization and the female tract is a formidable selective force on the sperm concentration and integrity that reach the egg. Potent mechanisms that may facilitate female control over-fertilization include sperm release from the oviductal epithelium, chemoattractants, cumulus biochemistry, cumulus phenotype, and egg surface proteins [7]. In addition, the normal physical and chemical characteristics of cervical mucus increase spermatozoan locomotion and conception leading to the birth of males. In the absence of normal conditions, there is an increase in female children if the cervical mucus has characteristics other than optimal [8]. The results revealed that females with larger anogenital distance delivered male-biased litter in both species [28].

Sperm

As mentioned in PM resources, the suitability of semen is one of the important factors in the gender selection of the offspring. It is recommended to consume particular nutritious foods and some herbs to increase sperm concentration as a high concentration of sperm leads to the male fetus [23].

A wide range of studies have found that there are distinguished biological diversities, and differences in the nuclear morphology and behavior of cytologically normal human spermatozoa. Also, if the ovum is in the outer part of the tube and the path through the

Table1. Some medicinal plants recommended for gender selection in Persian medicine

Iranian name	Common name	Family	Scientific name	Gender	Part used	Reference
Botm	Mt. Atlas mastic tree	Anacardiaceae	*Pistacia atlantica* Desf.	Male	Leaf	[21,22]
Meeah Saelah	Styrax	Styracaceae	*Styrax officinale* L.	Male	Resin	[21,22]
Sonbol ol teyb	Valerian	Valerianaceae	*Valeriana officinalis* L.	Male	Root	[21,22]
Darchini, Salikhah	Cinnamon	Lauraceae	*Cinnamomum zeilanicum Nees.*	Male	Bark	[22,26]
Mastaki-e romi	Lentisk pistache	Anacardiaceae	*Pistacia lentiscus* L.	Male	Resin	[22,26]
Ud qamāri	Spiny broom	Fabaceae	*Calicotome spinosa* (L.) *Link.*	Male	Wood	[26]
Afyun	Opium	Papaveraceae	*Papaver somniferum* L.	Male	Plant sap	[26]
Darounaj aqrabi	Great leopard's bane	Compositae	*Doronicum pardalianches* L.	Male	Root	[26]
Sadhaj hendi	Tejapatta	Lauraceae	*Cinnamomum tamala* Nees & Eberm	Male	Leaf	[26]
Udol salib	Common peony	Paeoniaceae	*Paeonia officinalis* L.	Male	Root, flower	[26]
Gole-sorkh	Red rose	Rosacae	*Rosa damascena* Mill.	Male	Flower	[22,26]
Toronj	Bergamot	Rutaceae	*Citrus bergamia* Risso.	Male	Bark	[26]
Soád-e Kufi	Nut grass	Cyperaceae	*Cyperus rotundus* L.	Male	Root	[26]
Qaranfol	Clove	Myrtaceae	*Syzygium aromaticum* (L.) merill.	Male	Fruit	[26]
Hholbūb	Annual mercury	Euphorbiaceae	*Bupleurum rotundifolium* L.	Female plants for female male plants for male	Leaf	[24]
Za'feran	Saffron	Iridacea	*Crocus sativus* L.	Male	Seed	[22]
Morr	Myrrh	Burseraceae	*Commiphora myrrha* (Nees) Engl.	Male	Resin	[22]
Zanjabil	Ginger	Zingiberaceae	*Zingiber officinale* Rosc.	Male	Rhizome	[22]
Āqer qarhhā	Pillitary of spain	Compositae	*Anacyclus pyrethrum* DC.	Male	Root	[22]
Ketirā	Tragacanth	Popilionaceae	*Astragalus* (tourn.) L.	Male	Resin	[22]
Khardal-e sefid	Mustard	Cruciferae	*Sinapis* alba L.	Male	Seed	[22]
Kondor	Frankincense	Burseraceae	*Boswellia carteri* Birdw.	Male	Resin	[22]
Ud-e balasān	Balsam apple	Cucurbitaceae	*Momordica balsamina* L.	Male	Branch	[22]
Balasān	Balsam apple	Cucurbitaceae	*Momordica balsamina* L.	Male	Bark	[22]
Ustukhuddus	Lavender	Labiatae	*Lavandula stoechas* L.	Male	Flower	[22]
Sisalius	Lovage	Umbelliferae	*Levisticum officinale* Koch.	Male	Seed	[22]
Qost	Greater Galangal	Zingiberaceae	*Alpinia galanga* (L.) Villd.	Male	Root	[22]
Kamaphytus	Yellow bugle	Labiatae	*Ajuga chamaecistus* Ging. ssp. *tomentella* (Boiss.) Rech. f.	Male	Aerial parts	[22]
Qennah	Galbanum	Umbelliferae	*Ferula gummosa* boiss.	Male	Resin	[22]

Dār felfel	Long pepper	Piperaceae	*Piper longum* L.	Male	Fruit	[22]
Usareh-Lehhy-at-ot tays	Buck's beard	Compositae	*Tragopogan pratensis* L.	Male	Root	[22]
Lehhyat-ot tays	Meadow sweet	Rosacae	*Filipendula ulmaria* (L.) maxim	Male	Root	[22]
Javshir	Hercu-les-all-heal	Apiaceae	*Opopanax chironium* (L.) W.D.J.Koch.	Male	Leaf	[22]
Felfel sefid	Black pepper	Piperaceae	*Piper nigrum* L.	Male	Fruit	[22]
Felfel siyah	Black pepper	Piperaceae	*Piper nigrum* L.	Male	Fruit	[22]
Suranjān	Wild saffron	Colchicaceae	*Colchicum automnale* L.	Male	Root	[22]
Osghordion	Water germander	Lamiaceae	*Teucrium scordium* L.	Male	Root	[22]
Jódah	Yellow bugle	Lamiaceae	*Ajuga reptans* L.	Male	Aerial parts	[22]
Duqu	Wild carrot	Apiaceae	*Daucus carota* L.	Male	Seed	[22]
Eklil ol malek	European milk vetch	Papilionaceae	*Astragalus hamosus* L.	Male	Aerial parts	[22]
Jantiānā	Gentian	Gentianaceae	*Gentiana lutea* L.	Male	Root	[22]
Farfyun	Sunspurge	Euphorbiaceae	*Euphorbia helioscopia* L.	Male	Plant sap	[22]
Moghl	Bdelium	Burseraceae	*Commiphora mukul*	Male	Resin	[22]
Sadāb	Rue	Rutaceae	*Ruta graveolens* L.	Male	Leaf	[22]
Idkhir makki	Camel's hay	Gramineae	*Cymbopogon schoenanthus* sperng.	Male	Root	[22]
Oshaqq	Dorema	Umbelliferae	*Dorema ammoniacum* D. Don.	Male	Resin	[22]
Sunbul rumi	Alpine Valerian	Valerianaceae	*Valeriana celtica* L.	Male	Flower	[22]
Samgh arabi	Gum arabica	Mimosaceae	*Acacia senegal* willd.	Male	Resin	[22]
Fotrasalion	Parsley	Apiaceae	*Prtroselinum crispum* (Mill.) Fuss	Male	Seed	[22]
Qardmānā	Common wild cumin	Apiaceae	*Lagoecia cuminoides* L.	Male	Seed	[22]
Rāzeyāneh	Fennel	Umbeliferae	*Foeniculum vulgare* Mill.	Male	Seed	[22]
Mashk-e tara-mashi	Oregano	Lamiaceae	*Origanum vulgare* L.	Male	Leaf	[22]
Anisun	Ammi	Umbelliferae	*Pimpinella anisum* L.	Male	Seed	[22]
Wajj	Sweet flag	Araceae	*Acorus calamus* L.	Male	Root	[22]
Sagbinaj	Sagapenum	Umbelliferae	*Ferula persica* Willd.	Male	Resin	[22]
Asarun	Asarum	Aristolochiaceae	*Asarum europaeum* L.	Male	Root	[22]
Fuwvah	Madder	Rubiaceae	*Rubia tinctorium* L.	Male	Root	[22]
Acazia	Black Locust	Fabaceae	*Robinia pseudo acasia* L.	Male	Flower	[22]
Ghariqun	Agaric blanc	Polyporaceae	*Polyporus officinalis* Fr.	Male	Mush-room	[22,25]
Helyawn	Asparagus	Asparagaceae	*Asparagus officinalis* L.	Male	Seed	[22]

ovulatory reproductive secretions to be traveled by the spermatozoa is long, then there are more male conceptions. This may arise from the greater number, greater rate of locomotion, and smaller head of the Y-chromosome containing spermatozoa [8].

Dried and unstained spermatozoa are divided into two distinct populations (Y and X) regarding shape, head and nuclear size, differentiation of light, and chromo-

somal pattern. The smaller heads contain the Y- and the larger types contain the X-chromosome [29].
Spermatozoa are divided into two types, those bearing the Y chromosome (Y spermatozoa) and the X chromosome (X spermatozoa), based on the chromosomal content. Certain differences in X and Y spermatozoa may exist which the most important difference in their DNA content as well as some of proteins and genes are differentially expressed between X and Y spermatozoa [30,31].

Age

PM believes that young women are prone to give birth to a male-biased litter. Also, it is believed that the lower interval between the first menstrual period and pregnancy increases the probability of male-biased litter [23]. However, a study on voles indicates older females and those who have had more births are more likely to have a male baby and the probability increases with each passing day [9]. As reported by Shettles, no significant difference was observed in the gender ratio among the various age groups [8].
The results of a study by Monclús et al. on yellow-bellied marmots indicated that older females from high predator pressure colonies were more likely to have a girl fetus during pregnancy. This study showed that younger females with high fecal corticosteroid metabolites (FCM) levels had sons that were less probability to disperse than those of younger females with low FCM levels, whereas older females with high FCM levels had sons that were more likely to disperse than those of older females with low FCM levels [32]. A positive relationship between predator pressure and glucocorticoid (GC) levels is commonly seen in vertebrates [33]. It should be considered that age increasing affects various factors such as enhancing vaginal pH, body mass index (BMI), sexual intercourse without barrier contraception, dryness, irritation symptoms, decreasing physical or professional activity, and hormone replacement therapy [34]. Also, higher age is closer to menopause and a higher level of follicle-stimulating hormone (FSH) [35,36].

The timing of sexual intercourse

As recommended in PM, if the timing of sexual intercourse is five to eight days after menstruation, the gender of the offspring becomes female, and if it is eight to fifteen days after menstruation, the gender of offspring becomes male [23]. This fact has been also investigated in modern medicine. It has been

Table 2. Non-nutritional and nutritional factors effective in gender selection

Entry	Factors		Gender*	Reference
1	Female tract	Larger anogenital distance	Male	[8,28]
2		Normal physical and chemical characteristics of cervical mucus	Male	
3	Sperm	long travel by the spermatozoa	Male	[8]
4	Age	Young mothers	Male	[9]
5	The timing of sexual intercourse	Insemination immediately before to ovulation	Male	[37]
6	Maternal body mass	Great maternal body mass	Male	[11]
7	Glucose	High glucose	Male	[9]
8	Stress	Maternal stress	Female	[42]
9	Electrolytes	High levels of sodium and potassium	Male	[14]
10		High levels of magnesium and calcium	Female	
11	pH	Alkaline pH	Male	[8]
12	Temperature	High temperature in vaginal / High temperature in environment	Male	[54,55]
13	Testosterone	High levels of testosterone	Male	[59]

*These factors are probably involved in gender selection based on the studies in modern medicine.

reported that controlling the time of mating, gender ratios can be altered and the greater the number of male conceptions is more probable by getting closer to the ovulation [8]. Also, insemination immediately before ovulation causes a male fetus, whereas sooner insemination causes female fetus [37,38]. However, the results of a study by Wilcox et al. revealed that the timing of sexual intercourse in relation to ovulation has no effect on the baby's gender [10].

Maternal body mass

According to PM, it is believed that taller women with more body mass are prone to give birth to a son [23]. It has been also investigated in recent studies. Arnbom et al. reported that in the female southern elephant seals, the proportion of males among offspring rapidly increases with maternal mass, and smaller females of southern elephant seals vary offspring gender ratio in a way that is consistent with theories on adaptive offspring gender ratio [39]. In another study reported by Wauters, in both roe deer (*Capreolus capreolus*) and reindeer (*Rangifer tarandus*), greater maternal body mass has been associated with a greater chance of bearing male offspring [11].

Glucose and stress

As recommended in PM, the use of sugars, starches, and honey before intimacy has been mentioned as one of the approaches to male sexuality [23].

In a study, the determination of maternal preconception diet influencing fetal sex in humans was achieved by Mathews et al. It was found that the overall gender ratio in the population was approximately 1:1, but individual mothers had a male-biased if their nutrient intake was high previous to conception. The consumption of breakfast cereals was also intensely associated with having male offspring [12]. As maternal condition declines, male birth rates are declining [40].

However, in the study of Andrew et al. there were no differences in mothers of sons and daughters nutrition during pregnancy [41].

Linklater et al. demonstrated that sex-differential glucose metabolism and stress by the pre-implantation embryo likely played a role in facultative birth gender ratio adjustment. The results showed that more females than males were conceived by mothers stressed immediately before conception and stress induces female- and not male-biased conceptions in contrast to the first mechanism. Stress before conception appears not to increase conception rates by Y-sperm. In addition, in hyperglycemia because of stress, female embryos make more toxic agents like superoxide and H_2O_2 because key enzymes regulating the pentose phosphate pathway, are X-linked [42].

In another study, conducted by Helle et al., results showed that females with high serum glucose and testosterone levels delivered male-biased. The effects of maternal glucose and testosterone levels caused 19 and 2% elevates in the proportion of males in a litter per increase of 1 pg/mL and 1 mmol/L of glucose and testosterone, respectively. In addition, the litter gender ratio was not related to the female body condition. Male testosterone level was not related to litter gender ratio, but women who have spouses with high body mass tended to deliver male-biased litter [9].

Electrolytes

In PM, it is recommended that the couples consume milk before sexual intercourse to have a son [21]. It seems that the presence of Ca^{2+} can afford desired electrolytic moiety.

It has been reported that females subjected to a low-calcium diet throughout their lives displayed a long-term reduction in bone volume as well as a reduction in calcium reserves available for allocation to developing offspring. These females produced smaller fetus sizes and bore rather fewer male fetuses than female consuming a nutritionally complete diet [43]. Also, it was observed that rats fed with (Na^+, K^+) food yielded the maximum number of male offspring, while rats fed with normal food yielded the lowest number of male offspring [44]. Furthermore, various studies revealed the potential effects of electrolytes including sodium, potassium, magnesium, and calcium on the gender selection of offspring. Such that diet high in sodium and potassium yielded maximum number of male; while a diet rich in magnesium and calcium produced the maximum number of female offspring [14].

pH and estrogen

In PM, cold temperament, and hot temperament can affect gender selection in such a manner that cold temperament couples usually have a daughter, and hot temperament couples have a son. However, consuming a special diet affect temperament. It seems that the type of temperament can be associated with the pH of body fluids [21-23].

Reports show that the pH of the female sexual tract is graduated, with the lowest pH in the vagina, approximately pH 4.42, increases into the Fallopian tubes (FTs) at approximately pH 7.94, reflecting variation in the site-specific microbiome and acid-base buffering at the tissue/cellular level [16].

Also, it has been shown that vaginal pH increases during menstruation and at other times of the cycle decreases to normal 4.0–4.5 [45].

Glycolytic metabolism of vaginal intermediate cells gradually increases throughout the proliferative phase of the cycle, which subsequently decreases vaginal pH due to an increase in the production of lactic acid. Then, during the secretory phase, glycolysis decreases and the pH increases [46]. A decrease in the pH be-

cause of the production of lactic acid, helps to maintain vaginal health [47,48].
It has been revealed that the gender ratio in animals and human beings may be affected by systemic pH, an increased chance of bearing male offspring, and a decrease in females. The use of the pre-intercourse douche to achieve the wanted fetus gender is supported based on the information of the behavior of the spermatozoa in relation to pH and viscosity of human cervical mucus. According to these findings, the use of alkaline douche causes the fetus to become a male, and the use of acid causes the fetus to become a female [8]. Also, it has been reported that a female diet plays an important role in determining the pH of the uterus and by changing the diet, the pH of the uterus can be changed. Such animals having a high protein diet, showed a lower pH in uterine fluid [49,50].
The effect of diet and estrogen on pH can be associated with the presence of active H^+ ions secreted by V-H^+-ATPase expressed predominantly in the apical cell membrane of Human vaginal- epithelial cells [17,51].

Temperature

In PM, body temperature as well as organ members temperature (in particular reproductive organs) have been found to be responsible for desired gender selection. It is believed that a higher body temperature leads to a male fetus and a low body temperature affords a female fetus. Also, there are various factors affecting body temperature including physical activity, spiritual conditions, and diet. In this respect, suitable physical activity, a calm and happy life, and consuming foods and medicinal plants possessing a hot temperament are recommended to have a son [21-26,52].
Norepinephrine released from the hypothalamic temperature control center stimulates the production of progesterone leading to the increase of basal body temperature which is reflected in oral, vaginal, axillary, or rectal temperature [53].
The effect of body temperature on gender selection has been also studied in modern medicine. It has been shown that female vaginal temperature is different within the day and the afternoon vaginal temperature is higher than the morning vaginal temperature. Also, the temperature variation in humans is cyclical through the day and month. The temperature is increased in the luteal phase and the temperature of the caudal region of the oviduct is 1-2 degrees cooler than the cranial portion. Vaginal temperature is affected by factors such as hormones, the density of pelvic/uterine vascular beds, and effectiveness of heat exchange locally. Vaginal temperature is crucial for sperm motility and fetal development. In addition, it was found that vaginal temperature significantly decreases for 3 days prior to estrus and significantly elevates at mid-cycle [16]. Khalifa et al. in a study on Zaraibi goats, demonstrated that the highest female ratio of offspring was obtained by decreasing the vaginal temperatures, and with an increase in vaginal temperature, the amount of male offspring increased [54].
The study of Ferguson et al. on Alligator mississippiensis showed that in this species, gender determination was depended on temperature, in such a way that at 30 °C producing all females and at 34 °C yielding all males [55].

Testosterone

PM comments usually have focused on the efficacy of medicinal plants. There are some suggestions to men to strengthen the sexual secretions which play important roles in gender selection. In this regard, medicinal plants possessing a hot temperament can increase the chance of male gender [21-26]. It seems that some medicinal plants such as *Pedalium murex* Linn., E*urycoma longifolia* Jack, and a composition of the six Japanese traditional medicinal plants including cinnamon bark, ginger and licorice affect the biosynthesis of various androgens and enhance the free testosterone level and sex hormones [56-58].
As reported by Grant *et al*., estradiol had no effect on gender determination in either primary or subordinate follicles. However, in another study on bovine ova from subordinate follicles that had follicular fluid with a high concentration of testosterone (*in vivo*) were later more probably to be fertilized by a Y-chromosome bearing spermatozoon (*in vitro*) [18,59].
Several studies have reported that in female animals such as ibex [55], field voles [7], and Barbary macaques, the male gender is more possible than female offspring when the level of androgens is high[59].
Studies have also shown that in some species, including humans [60], elephants [61], *Assamese macaques* [62], and yellow baboons [63], females carrying male fetuses have higher androgen levels, although not in others, such as red-fronted lemurs [64]. However, as reported by García-Herreros *et al*., the probability of an oocyte being fertilized by an X- or Y-bearing spermatozoon by the size of the follicle from which it was derived, or by the testosterone concentration in the follicular fluid was not affected [60]. Krackow et al. has suggested that testosterone-associated gender shift of offspring can be triggered by maternal dominance or environmental stress [61].
Various studies have established that the calcium ion levels are modified by the estradiol during the pre-fertilization Ca^{2+} surge and oscillations. Also, these Ca^{2+} cascades could be inhibited via androstenedione.
It has been shown that androstenedione affects the gender ratio probably via altering the metabolic and developmental potential of embryos [62].

Discussion

Gender selection has become a controversial issue for couples due to cultural and social problems as well as medical reasons that have been distinguished in the history of a particular sexually transmitted disease in the family for avoiding a serious gender-linked disorder [65]. It should be noted that sex-specific genetic disorders can also cause reproductive, physiological, and somatic diseases. Increasingly rapid advances in the field of genetic sciences and the identification of diseases depending on a particular gender have been achieved within thirty years [66,67]. Paternal exposure to toxins leads to a lower gender ratio at birth than maternal exposure. There is a clear connection between particular environmental toxins such as PCBs, dioxins, and pesticides and its effect on the gender ratio at birth through the disruption of the hormonal or endocrine system [68]. Also, in the study of Sindiani et al., it has been observed that greater variability in the female-to-male embryonic ratio is produced in couples having predominantly female offspring [69].

Recently, various reproductive technologies have been developed for gender selection. They include chorionic villus sampling (CVS), sperm sorting and preimplantation genetic diagnosis (PGD), a sperm-sorting technique (MicroSort), gender selection kits such as GenSelect and Smart Stork, based on the timing of intercourse, *in vitro* maturation (IVM) and fertilization (IVF) [5,20,70]. Some of these technologies are expensive and people cannot afford to pay for services [1]. Also, some of them such as MicroSort shifted to 90% X or 75% Y after sorting toward the 50:50 X:Y ratio in unsorted spermatozoa [63]. Some methods such as IVF usually lead to Female Sex Bias [64]. It has been observed that there is a relationship between the number of oocytes retrieved in IVF and the secondary outcome variable gender distribution and the number of oocytes retrieved, up to approximately 20 oocytes be associated with a higher rate of fetus males. However, the higher number of oocytes retrieved is associated with an increase in serious side effects such as severe ovarian hyperstimulation syndrome [71]. Also, the addition of 17β-estradiol or progesterone during sperm pre-incubation, *in vitro* maturation (IVM), and fertilization (IVF) significantly increased the proportion of murine male embryos [19]. It has been found that when lower blastocyst rates were experienced in the system, the proportion of male embryos also decreased [62]. In this respect, data obtained from both traditional and modern medicine indicated that nutritional and non-nutritional factors are involved in gender selection. Many of these recommended factors for gender selection in traditional medicine, such as female tract [11,44], electrolytes [14,43,44], glucose, stress [9, 42], maternal body mass [11,39], and testosterone [1,61] have been proven in modern medicine. However, some factors such as age [8, 32] and the timing of sexual intercourse [10, 37,38] have shown different results. Also, some factors such as aromatherapy and low water intake have been recommended in PM for desired gender selection, which have not been addressed in the articles.

In PM, smelling certain plants during sexual intercourse has been considered for gender selection. In this regard, it is recommended to smell saffron during sexual intercourse to have male offspring [23]. Also, it is recommended that couples should avoid drinking too much water and drink it little by little to have a son [23].

Conclusion

In conclusion, PM recommendations have absorbed a great deal of attention for gender selection. Most of these comments have been proven in recent studies indicating their efficiency in this subject. Various medicinal plants and formulations have been recommended by PM for gender selection that need further investigations as they may be helpful for couples who need special gender for medical and non-medical reasons.

Conflict of Interests

The authors report no conflicts of interest.

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