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Review Article

Male Contraceptives: A New Frontier in Contraception Medicine

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Abstract

In the field of contraceptive studies, discussions primarily focus on the practice of women's health and contraception. While it is true that unintended pregnancies and sexually transmitted diseases/infections (STI) pose major challenges in global public health, historically the burden of preventing these has largely fallen on women. Assuming that sexual intercourse requires an equal contribution between two partners, we hold that contraception and STI prevention should be a shared responsibility. Additionally, the ideal contraceptive method should prevent both unplanned pregnancies and STIs simultaneously. While abstinence remains the only 100% proven method of achieving such goals, it is not always practical or achievable in sexually active consenting or nonconsenting individuals. Because pregnancy occurs in a woman's body, contraception has been regarded as a women's health issue and not a general health issue. This dynamic is shifting. There is currently a paucity of male contraceptives and STI prevention methods on the market, but current trends in research and clinical practice promise to equally enable both women and men when making contraception choices. This paper aims to provide a comprehensive review of the male contraceptive methods currently available, as well as to highlight some of the most recently published work in the area of male contraceptive research.

Keywords: Male contraceptives; Sexually transmitted diseases/infections; Contraceptive methods

Introduction

Contraception is a polarizing issue in the United States. Often the conversation centers on "a woman's right to choose". In popular culture as well as the political world, the discussion is female centric. Frequently, this discourse fails to engage men, who are equally responsible for the act of conception. This dynamic fails to adequately explore the issues of unintended pregnancy and sexually transmitted infections and diseases (STIs/STDs) in the United States, by involving only half of the participating parties. As research into male contraception continues to advance, an unfair burden has been placed on women as the perceived party responsible for pregnancy. This is supported in international studies interviewing adolescent males who overwhelmingly believe that a majority of the responsibility for the prevention of pregnancy lies in the hands of females [1]. As previously mentioned, a myriad of projects are directed at novel hormonal male contraception methods. Cross-cultural data suggests a wide range of opinions of men on this matter, but that male acceptance of this method is high [2]. Contraception use continues to rise globally and most anticipated increased adoption in the coming years is expected to occur in sub-Saharan Africa and Oceania where contraceptive use is less common [3]. Between 2006 and 2010, male teenagers age 15 to 19 used condoms more frequently than in previous data sets, though the same percentage of young men were having sex [4]. This may reflect an improvement in knowledge about contraceptive methods, a shift in the gender responsibility, or both. It is imperative that men are educated on all methods of contraception available to them. As the conversation of gender equity and reproductive rights

continues to intensify in the United States, it is likely that men will need to educate themselves on all methods of contraception in order to fully participate in the family planning process. The aim of this review is to provide a comprehensive summary of Food and Drug Administration (FDA) approved contraceptive methods, a discussion of the ethical implications of contraception and to comment on the future of male contraceptive methods.

Contraceptive Methods

Male condoms

Male condoms are thin, stretchy coverings that are placed on the male genitalia during sexual intercourse. These are the most accessible forms of contraception and protection against sexually transmitted diseases [5]. Condoms are available in latex, as well as other alternative materials such as lambskin, polyurethane, and polyisoprene for those who suffer from latex allergies. A thin barrier of latex (or alternative material) is placed over the penis in a glove like fashion to prohibit semen from entering the vagina during vaginal intercourse [6]. A single condom is placed on the shaft of the penis before engaging in sexual activity to avoid depositing semen into the vaginal canal as shown in Figure 1. Similarly, female condoms are thin latex sheaths that are placed inside the vagina before sexual intercourse [7]. When applied properly and utilized regularly, condoms can be an effective method of avoiding pregnancy and decreasing one's chance of contracting sexually transmitted diseases, although not completely effective [7,8]. When used with other forms of contraception, using male and/or female condoms use can tremendously diminish one's

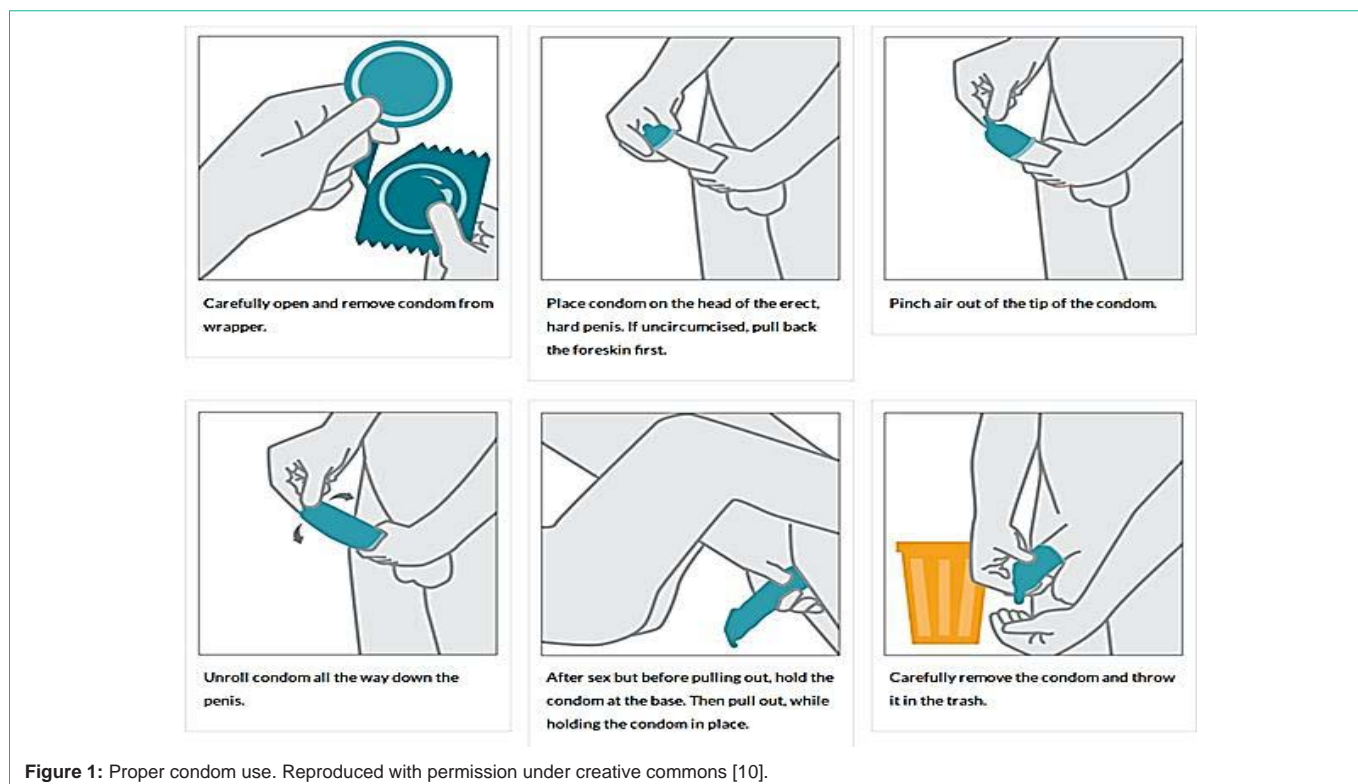


Figure 1: Proper condom use. Reproduced with permission under creative commons [10].

chance of becoming pregnant or developing an unwanted sexually transmitted disease.

Condoms have been used for centuries as a form of contraception and protection from sexually transmitted diseases. While initially constructed using animal intestines, latex condoms have been available since the 1920s [9]. The accessibility and relatively low cost of condoms has made them a very common barrier method of contraception. Condoms are used before initiating sexual intercourse and are meant to be used only once. If one wishes to have sex more than once, a new condom is required with each sexual act. Tearing and/or slipping of the male condom can occur during vaginal intercourse, which increases the chance of having an unexpected pregnancy or developing a sexually transmitted infection [7]. After intercourse, the condom is removed and disposed of in the trash [9].

The use of condoms is noninvasive. No medical procedures, prescriptions, or injections are necessary for condom use. In addition to being noninvasive, male condoms are just one of a few reversible methods of male contraception. Fertility is retained after safe sexual intercourse. Condoms rarely cause any negative side effects, making them a relatively harmless form of contraception. However, they are not the most efficient form of contraception. Misuse or breakage can result in pregnancy up to 4% of the time, and the sole use of condoms as a form of birth control results in higher rates of unintentional pregnancy [9]. According to the World Health Organization, the risk of unwanted pregnancy within one year when using a male condom is 14% [10,11]. Combining various methods of contraception (i.e., birth control, spermicide, copper IUD, etc.) with regular condom use can lower the rate of unwanted pregnancy. In addition, some men may forego using a condom because they find it difficult to use or believe that it ruins the sexual experience; increasing the risk of the

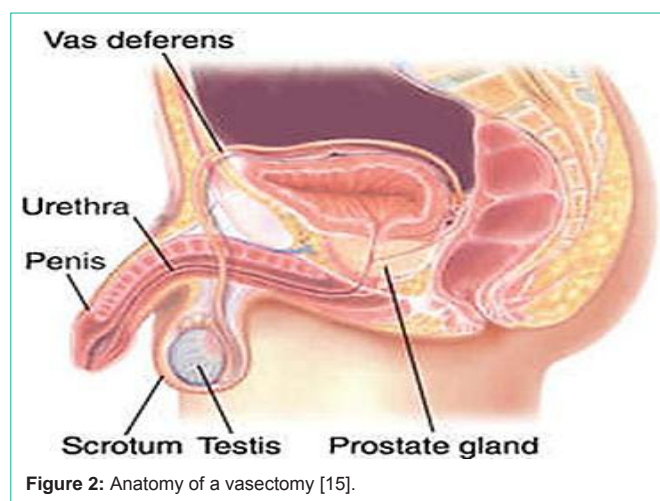


Figure 2: Anatomy of a vasectomy [15].

aforementioned consequences [9].

Latex allergy is among the most common reasons for avoidance of condom use. Symptoms of a latex allergy include skin rash, itching or in severe cases anaphylaxis. “Alternative materials from latex condoms include those manufactured from lambskin; these condoms, however, are inferior to latex condoms because they do not protect against sexually transmitted diseases” [6,7].

Compared to injectable contraception, intrauterine devices (IUDs), and surgical procedures, condoms are relatively inexpensive [7]. An average of \$21.77 is spent on male condoms per woman per year. Other contraceptive methods such as the pill, IUDs, and implants can range from \$90 to \$400 annually, including the cost

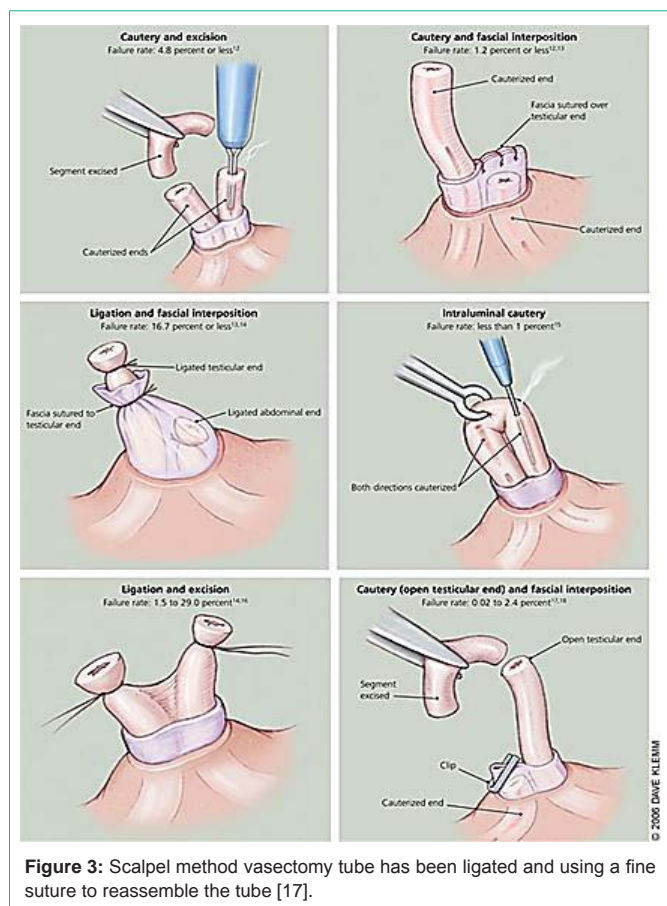


Figure 3: Scalpel method vasectomy tube has been ligated and using a fine suture to reassemble the tube [17].

of consultations, follow-up appointments, and removal procedures [12]. International guidelines suggest that condoms have a shelf life of up to five years [13]. Male condoms are not as cost-effective as other forms of contraception. More expensive forms of birth control (i.e., IUDs, hormonal birth control, injectable drugs, etc.) tend to be more efficient against unwanted pregnancies. However, condom use generally reduces overall costs for young adults [14].

Vasectomy

Vasectomy is a simple outpatient procedure to surgically cut or block the male tubes that allow sperm to mobilize from the testicles to the penis as seen in Figure 2.

These tubes are called the vasa deferentia. In these ducts, sperm mix with seminal fluids to form semen. The procedure is done under local anesthesia. The vas deferens is located, isolated, and brought outside of the scrotum through a small incision and ligated as seen in (Figures 2 and 3) [15,16].

Other variations of this procedure utilize a “no scalpel technique” which makes a simple puncture at the scrotum, minimizing blood loss, hematomas, infection and recovery time [17,18]. Overall, these procedures prevent a man’s sperm from ever reaching and mixing with the seminal fluids, and are found in the ejaculation. Vasectomies are commonly performed throughout the world. Roughly fifty million men have undergone the procedure, while in the United States it estimated that between 175,000 and 550,000 men a year have a vasectomy [19]. This procedure was first conducted on dogs during

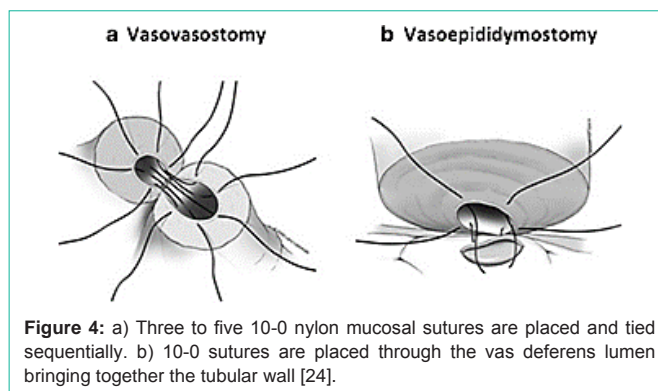


Figure 4: a) Three to five 10-0 nylon mucosal sutures are placed and tied sequentially. b) 10-0 sutures are placed through the vas deferens lumen bringing together the tubular wall [24].

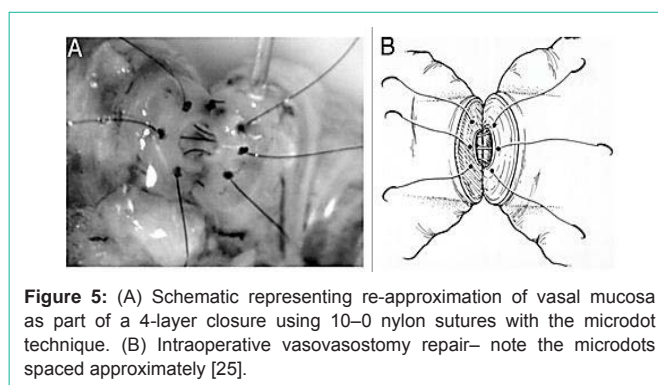


Figure 5: (A) Schematic representing re-approximation of vasal mucosa as part of a 4-layer closure using 10-0 nylon sutures with the microdot technique. (B) Intraoperative vasovasostomy repair– note the microdots spaced approximately [25].

the early nineteenth century in the United Kingdom. It was during the late nineteenth century when it first came into clinical practice as a treatment for prostatic enlargement [19]. However, the first use of this procedure in the United States on criminal populations and on the mentally ill, not as contraception, but as a eugenic alternative to castration [19]. This form of population control was used until the second half of the twentieth century and elective vasectomy became more popular throughout the United States [19].

Conventional vasectomy is the standard technique and requires a urologist to make an incision in the scrotal skin. Surgeons performing this procedure must locate the vas, separate it from surrounding structures (spermatic cord), and then tie it off with sutures [20]. Finally, the skin of the incision site is stitched together, taking in total roughly 30 minutes [20]. The no-scalpel technique as the name implies it uses a special tool to grab and isolate the vas through the skin without having to make an incision [20]. Using a high pressure spray, lidocaine aesthetic is applied to the surface and surrounding tissue and a small puncture is made. Once the surgeon moves away vital nerves, titanium clips are inserted that block off the vas, which are then cut and cauterized [18]. This creates a gap between the segments of vas, preventing regrowth [18]. Finally, the vas is put back in the scrotum and a bandage is placed over the puncture area. This procedure takes roughly ten minutes to perform, while patient pain is minimal and recovery time is decreased [18].

Even though this procedure is intended as a permanent contraceptive method, due to advances in technology, microsurgical intervention can repair vasectomy [21]. Many males undergo Vasectomy Reversal (vasovasostomy) in which the vas deferens tubes that were previously severed during a vasectomy are reconnected [22].

Vasectomies are utilized by approximately 6-8% of married couples, involving roughly 42-60 million men worldwide [23]. Annually about 500,000 vasectomies are done in the USA and 3-6% of these men will undergo reversal [24].

Currently there are two forms of reversal. The most common is a one or two layer vasovasostomy, and the more complex procedure is intussuscepted epididymovasostomy [24]. The single layer vasovasostomy is done by stitching the outer layer of the vas deferens where the tube has been ligated and using a fine suture to reassemble the tube as seen in Figure 4 and 5 [24,25].

This technique is faster to perform, but has worse outcomes with higher rates of failure and complications [24]. The double layer vasovasotomy technique, however, requires stitching of the inner layer of the vas tubes first, then final stitching outside the layer to reconnect and properly form a seal, a more technically challenging and time consuming process [24]. Vasoepididymostomy procedure involves anastomosis of the vas deferens to the epididymis, thus creating a bypass for any obstruction in the epididymis as seen in Figure 5 [25]. Currently, future trends utilizing robotic assistance are being adopted in the pursuit of improved surgical accuracy, better outcomes, and decreased operative time [25].

This procedure is safe and lasts for life. It will not change the man's hormone production. It does not affect a man's ability to attain and maintain an erection, sexuality, sex organs, or sexual pleasure. Men are able to ejaculate seminal fluid without sperm, and overall this form of contraception has a very low failure rate [26,27].

Some potential risk includes bleeding into the scrotum, blood in semen, sperm granulomas, infection, testicular pain, and fertility. Side effects such as mild pain or discomfort for two to three days, swelling, or bruising may occur [28]. This procedure can cost up to \$4,000 including the cost of follow up sperm count. This depends on many factors including location, anesthesia, surgical technique used, payment method, and the choice of the physician to use income-based sliding scales [29].

Withdrawal

The withdrawal method (*Coitus interruptus*), more commonly known as the "pull out method" is a widely used form of contraception around the world [30]. This method requires the male to remove the penis from the vagina just before the moment of ejaculation. However, this method isn't just limited to heterosexual couples; homosexual couples also utilize this method [31]. Though this method is widely used throughout different age, ethnic, and demographic groups; it is not effective in protecting against sexually transmitted diseases [32]. The withdrawal method is commonly practiced throughout the world for its ease of use at no financial cost, and spans many ethnic groups. Data shows that sexually active female high school students preferred using oral contraceptive pills (22.4%), even though condom usage was the primary means of preventing pregnancy (40.8%). Additionally, fewer female students use the withdrawal method (11.8%), than females who did not use any form of contraception (15.7%) [33,34].

From prehistoric times to modern day society, this method has been utilized as an alternative to unwanted pregnancy [35]. As medicine and technology have advanced, empiric evidence suggests that the withdrawal method is frequently used by approximately 60%

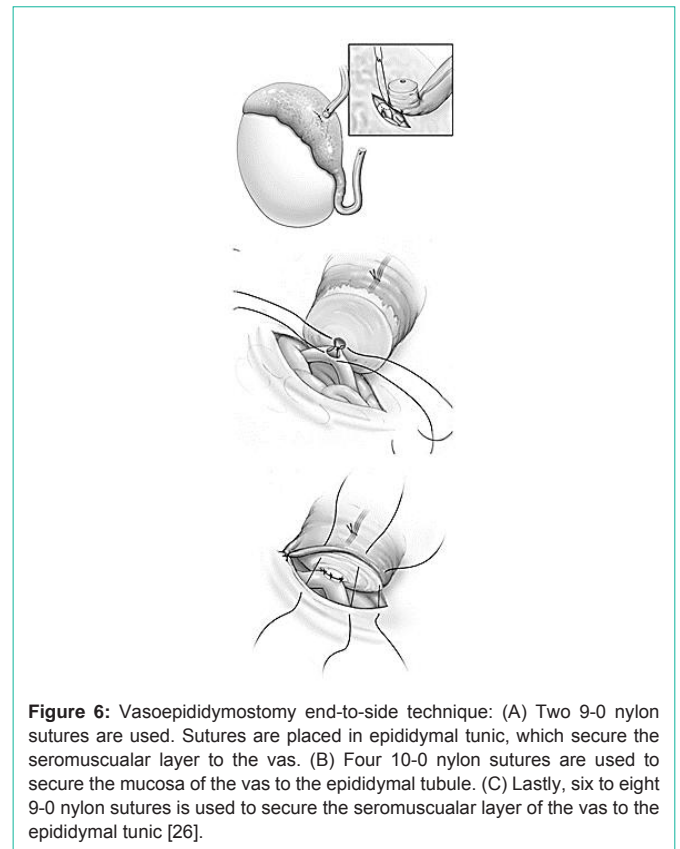


Figure 6: Vasoepididymostomy end-to-side technique: (A) Two 9-0 nylon sutures are used. Sutures are placed in epididymal tunic, which secure the seromuscular layer to the vas. (B) Four 10-0 nylon sutures are used to secure the mucosa of the vas to the epididymal tubule. (C) Lastly, six to eight 9-0 nylon sutures is used to secure the seromuscular layer of the vas to the epididymal tunic [26].

of adolescents as a form of temporary contraception [36]. It remains a viable method for birth control in environments where access to other contraception is limited or absent [37].

Data shows that from 1982-2010, women who are sexually experienced use condoms at roughly similar rates as the withdrawal method. While condom usage has increased over time the withdrawal method is still readily prevalent. The withdrawal method also increased significantly between 1982 and 2006-2010 [38].

This method can be used as long as the user is capable and takes effect immediately [39]. Withdrawal poses no harm to the male or female and it is easy, free, and convenient. Withdrawal can reduce potential risk for pregnancy when no other form of contraception is available. Withdrawal method can also be used in conjunction with other form of birth control to enhance the effectiveness [40,41].

The withdrawal method has no known side effects including medical or hormonal. However, it does have a relatively high failure rate when compared to other forms of contraception and does not provide any protection from STIs. Approximately, 18% of couples practicing withdrawal as their sole form of contraception may become pregnant in one year [37]. Potential risks include pregnancy or exposure to sexually transmitted infections (STIs). Evidence demonstrates that young adults from ages 15 to 24 years are the most likely to utilize withdrawal, and thus, have a greater likelihood of experiencing unwanted pregnancy or contracting STIs [42].

Outercourse

Outercourse includes any sexual activity that does not require

penetration of the vagina assuring that no sperm will come in contact with the female reproductive organs [43]. Some additional activities that are considered outercourse include: kissing, fantasizing, cybersex, masturbation, use of sex toys, oral sex, and anal sex [44].

Data from 14,000 surveys conducted by the National Longitudinal Study of Adolescent Health were analyzed to assess the sexual activities adolescents were participating in by the age of 18. The study reveals that 55.8% of males and 51.2% of females participated in both vaginal and oral intercourse. In addition, 11% of males and 9% of females participated in vaginal, oral, and anal intercourse. Vaginal sex alone was performed by 8% of males and 19% of females while oral sex alone was performed by 6% of males and 4% of females. Anal sex constituted a very minimal percentage, around 0.1% and 0.2% in males and females respectively [45]. This pattern of preference for sexual activity in males and females is summarized in Figure 7.

The same pattern of preference was supported in the data obtained by the National Survey of Adolescent Males in which a broader sample was obtained years earlier. The data yield 53%, 49%, and 11% for masturbation, oral sex, and anal sex respectively. This same study confirms that around 78% of adolescent males had partaken in both coital and non-coital intercourse [46].

In a more recent study on adolescent sexual behavior performed in 2008, the pattern of preference remained but there were more adolescents engaging in both coital and non-coital sex with 87% in non-virgins [47]. In addition, in a national survey conducted in 2010 with 5,865 participants, outercourse is proven useful across a person's lifetime. Masturbation was more common in different ages than vaginal sexual intercourse and oral sex was just as popular [48].

A survey conducted by Dr. Lisa Norman on 1,138 Puerto Rican women indicates that only 33% consider masturbation and only 16% consider the use of sex toys, both forms of outercourse, as fulfilling sex. This data seems to support the notion that the majority of people consider outercourse as sexual activity leading up to vaginal penetration, vaginal intercourse. Considering that penetration is the final stage of most sexual encounters, there is a rising concern for transmittable diseases and pregnancies. Educating people about outercourse and how it is an effective and pleasurable way to avoid vaginal intercourse is necessary if this risk is to be eliminated in the future [49].

According to the Association of Reproductive Health Professionals, outercourse has no side effects and is 100% effective in preventing unwanted pregnancies if semen does not come in contact with the female reproductive organs [50]. In this case, there is absolutely no risk of becoming pregnant [51]. However, according to an article from the American College of Obstetricians and Gynecologists, outercourse can still facilitate the transmission of Human Immunodeficiency Virus (HIV) and Acquired Immunodeficiency Syndrome (AIDS) since the exchange of any bodily fluid is possible when engaging in oral, vaginal, and/or anal sex. STIs including gonorrhea, chlamydia, herpes, human papillomavirus (HPV) and hepatitis can also be transferred between sexual partners. The use of condoms and dental dams are highly recommended. To prevent the likelihood of future infection/transmission of diseases, it is also recommended that proper cleansing of all sex toys is performed before and after use [52].

Anyone can practice outercourse since it has many benefits; including a feeling of intimacy with the prospective partner. Educational tools can be used to spread awareness on outercourse and thus establishing it as a substitute method of vaginal intercourse for those living with the HIV. This would minimize the rate of transmission for HIV and other sexually transmitted diseases [49]. Moreover, outercourse has no set length of practice since it is highly dependent on the sexual partners. According to an article issued by Planned Parenthood, outercourse can elongate the sexual pleasure for both men and women [53]. In fact, outercourse can allow women to orgasm multiple times in one sexual encounter. Outercourse is a natural form of contraceptive that may require nothing more than the body. Sexual pleasure and the prevention of diseases and pregnancy can be achieved free of cost through outercourse [54].

Abstinence

Abstinence can have various definitions depending on an individual's perspective of its meaning. To some, abstinence may be postponing sex, not engaging in intercourse; which includes vaginal, anal, or oral sex. According to Santelli, et al., several other actions may be abstained from, including kissing, holding hands, anal sex, and oral sex [55]. Within the scope of this section, we will consider abstinence as the practice of refraining from engaging in sexual activity with a partner.

Abstinence became a major practice during the 1990s and 2000s in order to address sexually transmitted diseases and pregnancy outside of marriage among young adults. During this time, practicing abstinence was considered the standard for sexual activity. As such, abstinence-only programs were developed to advise younger generations to refrain from sexual intercourse until marriage [56]. Section 510 of the 1996 Social Security Act outlines that abstinence-only sexual education (AOSE) should exclusively teach how abstinence is the only way to prevent STIs, pregnancies outside of marriage, and other health problems associated with sexual activity [55]. However, these programs may not be entirely beneficial. Stanger and Hall studied how abstinence-only education correlates with teenage pregnancy, and concluded that states in the United States of America that placed more emphasis on abstinence education had higher teen pregnancy and higher birth rates [57]. These programs do not provide education on other methods of contraception that may inform people on how to protect themselves from STIs and avoid unwanted pregnancies if they decide to engage in sexual intercourse. Simply stated, while being highly effective, abstinence is a practice that not everyone finds suitable. The shortcoming in restricted educational programs that emphasize abstinence is that they do not make any effort to explore any other forms of contraception. Over 15 forms of birth control exist ranging from hormonal methods – oral contraceptive pills, IUDs, and implants – to barrier methods – male and female condoms – and medical procedures – vasectomies and tubal ligation [7]. Many states with the abstinence only education program can be seen in Figure 8.

These states tend to not only stress abstinence, but also distort information regarding male and female reproductive health and provide misleading information about the effectiveness of contraceptive methods and the consequences of abortion [55]. Providing inaccurate information can put a student at risk of

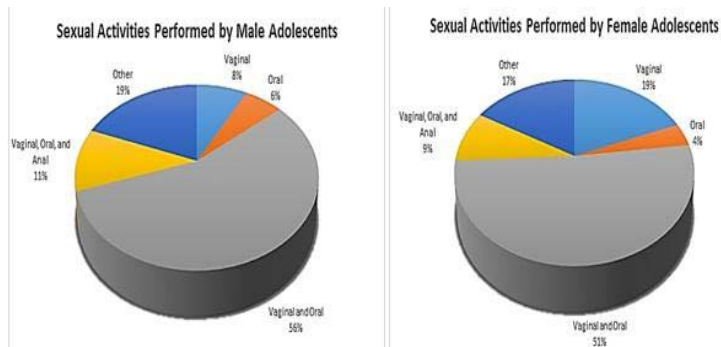


Figure 7: Percentage of male and females engaging in either vagina, oral, and/or anal sex. The “Other” category includes the percentage of the population who are not sexually active and those engaged in anal sex. Data from the national longitudinal study of adolescent health [45].

experiencing the consequences that arise while not practicing safe sex.

Many people decide to become abstinent in their teens before engaging in sexual intercourse [58]. Some teens adopt reasons based on their moral or religious beliefs, such as waiting until marriage or until they find the right person [55]. For instance, Christianity dictates that premarital sex is sinful, sex is only acceptable between a married man and woman, and refraining from sex is better than engaging in it [59]. These disapproving views can be shared among many different sects of Christianity, as well as other religions such as those of the Islamic faith [60]. Practicing abstinence not only allows for protection, but also gives an individual time to determine if they are ready to engage in a sexual relationship with another human being. One can also decide to stop being abstinent for a period of time, and then resume the practice when the individual sees fit [55]. Participating in abstinence is a non-invasive method of contraception.

Abstaining from sex is 100% effective in preventing unwanted pregnancy and STIs if practiced consistently [58]. It also does not result in hormonal or medical side effects in males or females. However, the primary challenge of abstinence is that very few individuals engage in long-term practice. In the United States, the first sexual encounter, on average, occurs at about 17 years of age, while marriage occurs at about 25 years of age [55]. Not having a clear definition of abstinence also poses an issue, especially to young adults. Because abstinence is a complex concept to depict, sex education programs should make an effort to allow students to develop their own definition of abstinence based on personal beliefs, religious or otherwise, and information from public health sources such as the Center for Disease Control [61].

Currently, no medical or behavioral reasons have been indicated for individuals to avoid practicing abstinence. However, research has shown that abstinence-only sex education programs are not as effective as programs that also teach about contraception [58]. Comprehensive sex education in the United States teaches individuals in middle school and high school about contraception and how to practice safe sex. As such, they are more likely to protect themselves and their partners against STDs and avoiding unwanted pregnancy. States that cover both abstinence and how to properly use condoms were found to have lower rates of teenage pregnancy, while states that primarily stressed abstinence had higher rates of teen pregnancy [57]. Therefore, practicing abstinence can be beneficial, but when taught

alongside contraceptive methods, it further decreases the risk of unfavorable outcomes.

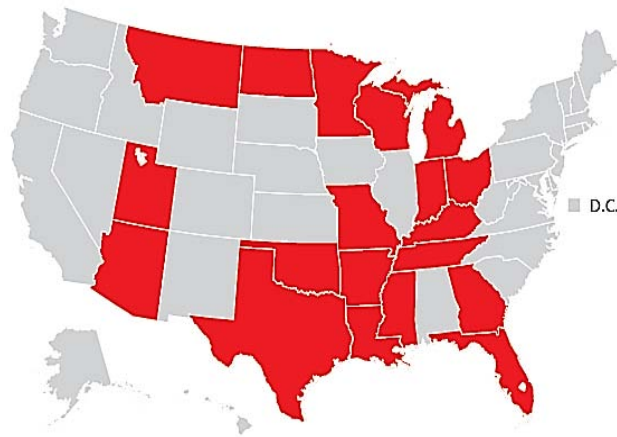
Under Title V, Section 510 of the Social Security Act of 1996, a total of \$178 million have been provided for abstinence-only sexual education programs. Practicing abstinence is a free method of contraception as opposed to using male condoms or having a vasectomy [62]. Abstinence has shown to be a poor cost-effective method of contraception. In comparison to other contraceptive methods used among males and females, participating in abstinence requires the least amount of money. However, contraceptive methods such as hormonal injections and drugs, as well as medical procedures like vasectomies and tubal ligation, are more cost-effective because it still allows an individual to engage in a sexual act. Hence, these methods yield the best results for avoiding unwanted pregnancy even though they are more expensive [63].

Ethical considerations

Virtue ethics refers to the bioethical study of an individual’s morality and principles defining socially acceptable behaviors [64]. Virtue ethics supports the use of contraceptives in both males and females since these allow consumers to enjoy of “procreative liberty”, or the right to decide the appropriate time to start a family [65]. The ethical dilemma arises when contraceptives are seen as a way of disrupting conception, which in many religions (Roman Catholicism, Amish Faith, Conservative Judaism and Islam, etc.) is considered the beginning of a life or distributed amongst minors without parental consent [66].

Abstinence refers to the act of completely refraining from sexual intercourse, due to personal or religious reasons [67]. Abstinence is one of the most efficient and cost effective forms of male contraceptives. Ethical issues arise when abstinence-only education plagues classrooms, restraining students from gaining knowledge about common contraceptive methods. Abstinence-only education became very popular during the 1980s, when sexual intercourse and preventative methods were not discussed in the classroom setting (Figure 8) [55]. This technique was later on argued to be unethical; withholding information from the students could come accompanied by unwanted pregnancies and sexually transmitted diseases (STDs) if the students decided to become sexually active [55]. In Florida and as many other states, it is unlawful for a person conscious of suffering from an STD to engage in sexual activity with a person unaware of

States Where Sex Education, If Provided, Must Include Information On Abstinence, But Not On Contraception



Note: Utah prohibits teachers from responding to students' spontaneous questions in ways that conflict with the law's requirements. In Mississippi, localities may include topics such as contraception or STIs only with permission from the State Department of Education.

Figure 8: States that require education about abstinence but not other forms of contraception. Reproduced with permission from the Guttmacher Institute [55].

their condition [68].

Withdrawal, commonly known as “pulling out”, is not a very effective contraceptive technique and has been categorized as a primitive practice in various countries [69]. A study showed that 18% of men that exclusively rely on withdrawal as a contraceptive method will impregnate their partner over the course of a year [37]. Issues with this form of contraceptive arise in Christian ethics where the method is seen as an interruption of conception [70]. Conservative Christians (Roman Catholics, Protestants, and Anglicans) believe that married couples that practice withdrawal have not consummated their marriage, taking away from the validity of their union [70].

Circumcision is a common practice worldwide that is associated with various ethical challenges. The reasons for circumcision range from personal to religious ideology [71]. Although physicians must respect patient autonomy, in this case the will of the parents, one of the guiding principles of bioethics underlines avoiding maleficence [71]. With little benefits to a child, and high risks of complications, circumcisions could be argued to be unnecessary and do more harm than good. Some complications include infection, bleeding, wound dehiscence, and death in extreme cases [72]. Some ethicists consider non therapeutic circumcision a form of mutilation and have even reached the point of labeling it “child abuse” [73].

The condom is the most advertised male contraceptive method. Ethical issues arise when condoms are distributed in schools without parental consent. The ethical conflict is between respects for autonomy versus the practice of beneficence for the prevention of an unplanned teen pregnancy [74]. Some believe that the autonomy of parents or legal guardians of a child is being ignored since they are not consulted prior to condom distributions in schools. However, school districts argue that their actions promote beneficence in the hopes of lowering the numbers of teen pregnancies and the spread of various STDs.

The male condom is not only used for pregnancy prevention but also protection from sexually transmitted diseases. Ethical issues surrounding condom distribution are not only seen in the classroom setting, but also US prisons. Less than 1% of US prisons offer condoms to their inmates [75]. Due to the high number of prison rape cases and HIV positive inmates, this practice appears to be a violation of state laws placed to avoid STD propagation [68]. Prisoners are often stripped of their rights as common citizens due to their criminal record, but condom distribution is seen as a way of inciting rape, since in this setting it would not serve as a contraceptive method [75].

Outercourse describes any non-penetrative sexual activity and is considered an effective contraceptive method as long as sperm does not enter the cervix having the possibility of reaching the uterus [76]. Since outercourse is a very general term, ethical issues come along depending on the sexual activity being discussed. Some paraphilias fall in the “outercourse category” and most of them come accompanied by ethical dilemmas. A list of common paraphilias includes: masochism (causes physical and emotional harm to an individual), kleptomania (the individual gets involved in illicit activity), voyeurism (violates an individual's privacy) and bestiality (considered animal abuse) [77].

A vasectomy is a form of sterilization that can be successfully reversed by medical intervention [78]. However, less invasive contraceptive techniques are recommended to young adults planning to have children in the future by having the vasectomy reversed. Vasectomies become controversial when performed on people with intellectual disabilities; in these cases, a court order is necessary to approve the procedure [79]. The sterilization of intellectually disabled became a eugenic method during the Nazi Regime of WWII when over 300,000 people that were diagnosed with “feeblemindedness” were forcibly sterilized, men with vasectomies and women by ligation of their fallopian tubes. [81]. The practice was deemed cruel and unnecessary since the medical procedure had no justification, as the

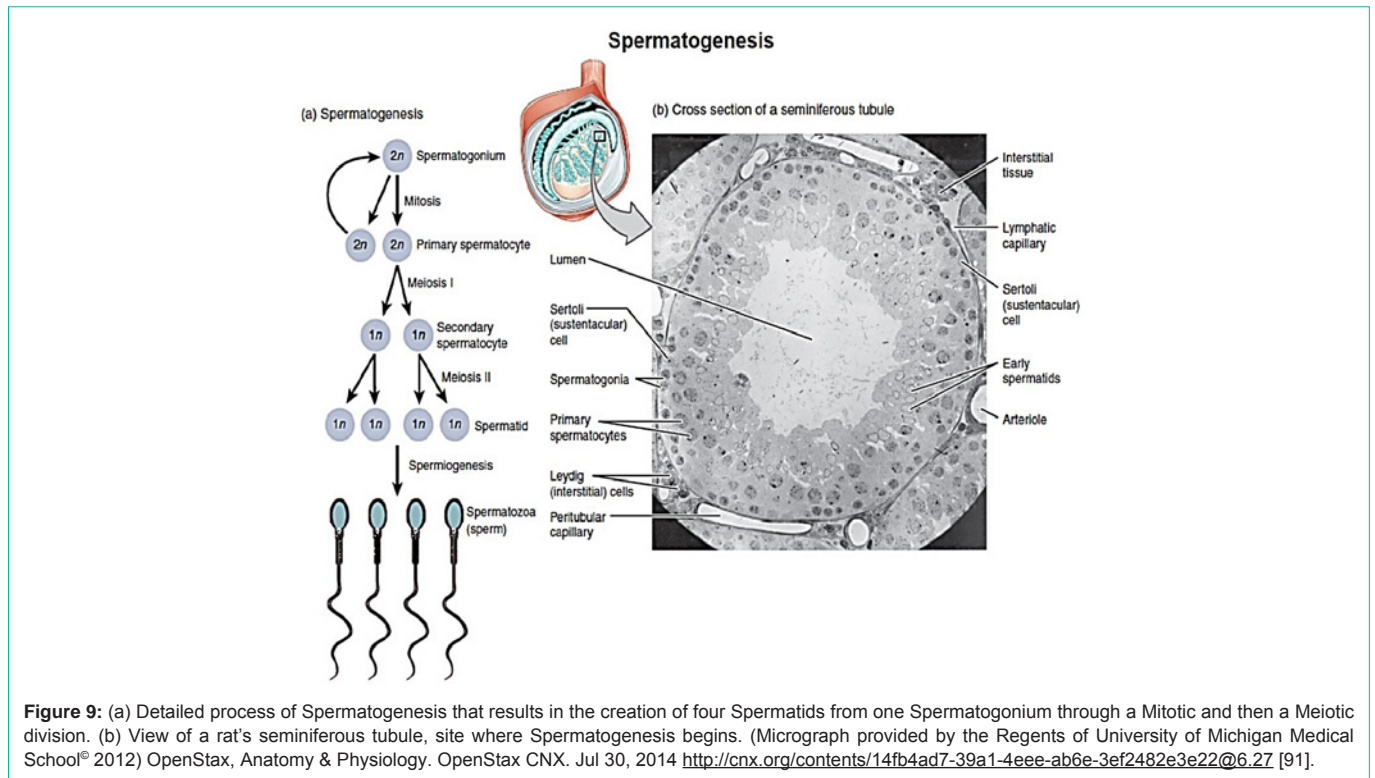


Figure 9: (a) Detailed process of Spermatogenesis that results in the creation of four Spermatids from one Spermatogonium through a Mitotic and then a Meiotic division. (b) View of a rat's seminiferous tubule, site where Spermatogenesis begins. (Micrograph provided by the Regents of University of Michigan Medical School® 2012) OpenStax, Anatomy & Physiology. OpenStax CNX. Jul 30, 2014 <http://cnx.org/contents/14fb4ad7-39a1-4eee-ab6e-3ef2482e3e22@6.27> [91].

patients subjected to the vasectomies were stripped of their autonomy and procreative liberty without consent [79].

Current Research

Effective female contraceptive methods have been developed since the nineteenth century, placing the majority of the responsibility of birth control on women and not men [80]. The only readily available male contraceptive methods are condoms, vasectomies, and withdrawal. Although it is believed that Ancient Egyptians and Romans used a form of condom, the idea of the condom didn't become commonplace until the late nineteenth century [81]. Vasectomies were also introduced as a possibility in the nineteenth century but were not frequently performed until the twentieth century [82]. However, due to the unpredictable tearing of condoms and the irreversibility of vasectomies, new and improved methods of male contraception are sought. Researchers from around the globe are experimenting with three different approaches to male contraception. These approaches include hormonal, chemical, and thermal technology.

After the success of female oral contraceptives, the demand for male oral contraceptives increased dramatically. By 1978, the French were already experimenting with an oral hormonal contraceptive that would inhibit spermatogenesis, the production of sperm. Such experimentation included the use of daily percutaneous testosterone (PT) and medroxyprogesterone acetate (MPA) doses to reduce spermatogenesis. These methods successfully reduced spermatogenesis by 90% in the first three months. Males who discontinued the treatment were able to recover sperm production. However, due to effects of treatment, this approach had to be modified. Inspiration from this clinical trial resulted in the generation of several other hormonal contraceptives which include

percutaneous dihydrotestosterone (DHP), testosterone patches, and testosterone gels [83]. Other treatments using testosterone enanthate, testosterone undecanoate, T buciate, and other forms of androgens have been performed in other clinical trials. Insufficient data in these trials paired with effects of treatment, such as cardiovascular and prostate involvement, have not allowed the mentioned hormonal approaches to achieve their goal [84]. Moreover, the use of JQ1, an inhibitor drug, attempted to disrupt spermatogenesis by targeting Bromodomain Testis Associated (BRDT), a gene coding protein. Thus, the administration of JQ1 injections would reduce the amount of sperm and greatly affect the motility of any produced. The JQ1 drug has been tested on rats which have proven effective. Although cessation of treatment will yield reversibility, the long term and generational effects have not been confirmed and remain a concern for researchers [85].

Non-hormonal chemical methods are also in the process of development. The use of gossypol, derived from the cotton plant, has been examined as a male contraceptive after its casual discovery in the late 20th century. Clinical trials using this drug yielded the absence of sperm in semen, called azoospermia, for 90% of the males. Negative side effects such as permanent infertility occurred in some subjects [86]. It is important to note that lowering the dose of gossypol administered to the test subjects was effective in reducing the infertility caused by the treatment [87]. Further, another clinical trial used compounds B41, B42, B4, and B4 R1 to inhibit EPPIN, a protein located in spermatozoa involved in motility [88]. Vasalgel, yet another potential chemical contraceptive, forms a barrier that doesn't permit sperm from exiting the vas deferens. The barrier produced is a hydrogel that has effectively caused azoospermia in rabbits within a month and demonstrated a positive outlook regarding reversibility

Table 1: Quicktable Guide Male.

Male Contraceptives								
Technique	Usage	Adverse reactions	Length of Action	Invasiveness	Reversibility	Cost	Patient Considerations	Important facts
Male condoms	Condoms are applied to the shaft of the penis before every sexual encounter, and removed and disposed of after ejaculation [19].	Adverse reactions may occur if either sexual partner has a latex allergy. If so, alternative options include polyisoprene, polyurethane, and lambskin [20].	During sexual intercourse	Minimally invasive	One of few available reversible methods of contraception; others include vasovasostomy and hormonal contraceptives [22].	\$2-\$6 for 3; free from health clinics, doctor's offices, etc. [21].	Partners who want to have sex but avoid pregnancy and STDs [23].	Not 100% effective, over-the-counter, meant to be used one at a time [24].
Vasectomy	Procedure done to prevent a man's sperm from ever reaching and mixing with the semen, preventing possible fertilization of a female's egg. Can be done under local anesthesia with a small incision at the scrotum or done with a no scalpel technique [9,10].	Potential risks include: bleeding or cut inside the scrotum, blood in semen, sperm granulomas, infection, testicular pain, and fertility. Side effects can occur such as mild pain or discomfort for 2-3 days, swelling, or bruising [11].	For conventional vasectomy, procedure takes roughly 30 minutes to complete [12]. For no scalpel method, procedure takes about ten minutes [13]. Patient must wait to fully heal before engaging in sex [14].	Conventional method requires a small incision made to the scrotum [12]. No scalpel method is minimally invasive, not having to make an incision [13].	Even though attended as permanent form of contraception, of the 500,000 vasectomies done in the USA; 6% of men will undergo reversal [15]. There are two forms of reversal which is one or two layer Vasovasostomy [16]. However, better advances in technology are allowing the use of robotic assistance like the Da Vinci system [16].	Cost can range from 0-\$4,000 including the cost of follow up sperm count. This depends on many factors: location, anesthesia, surgical technique used, payment method, and if the doctor chooses to use income-based sliding scales [17].	Patients that want a permanent form of contraception by sterilization	This procedure is safe and last for life. It will not change the man's hormones production or masculinity. It does not affect a man's ability to get erect, sexuality, sex organs, or sexual pleasure. Men are able to ejaculate and it will look normal, and overall this form of contraception has a very low failure rate [18].
Withdrawal method	Anytime people engage in sexual activity. It can be used by different age, ethnic, and demographic groups [1].	Unwanted pregnancy may occur and is not 100% protective against STDs [1-4].	During sexual intercourse and effective for as long the user is capable. Takes effect immediately [5].	Poses no harm to the male or female, however can be invasive if there is no agreed consent between participants [6].	If elected not to be used	No cost [7].	Those that want a temporary form of contraception where proper contraception are limited or none existence [4].	Potential for unwanted pregnancy and contracting an STI is possible [8].
Abstinence	Abstinence is practiced among individuals who do not want to partake in any form of sexual activity.	None	Dependent on how long the individual wishes to abstain from any form of sexual activity	Non-invasive	Completely reversible; people can stop abstaining from sex at any time.	No cost	Beneficial for men and women to avoid pregnancy and/or STDs.	100% effective in preventing pregnancy and STDs if practiced consistently [25].
Outer course	Kissing, fantasizing, cybersex, masturbation, use of sex toys, oral sex, and anal sex [26].	No side effects and 100% effective in preventing unwanted pregnancies [27].	No set length of practice since it is highly dependent on the sexual partners [28].	N/A	N/A	No cost [29]	Anyone can practice outer course since it has many benefits; including a feeling of intimacy with the prospective partner [30].	Outer course can still facilitate the transmission of HIV and AIDS since the exchange of any bodily fluid is possible when engaging in oral, vaginal, and/or anal sex [31].

[89]. A study on the reversibility of Vasalgel was conducted which confirmed that spermatozoa were present in the semen of rabbits after cessation of treatment [90].

As shown in Figure 9, spermatogenesis requires mitosis followed by meiosis to produce spermatozoa, or sperm. This process can be affected by external conditions such as temperature. The ideal temperature for a male's testis is at least 1 to 2 °C below the regular body temperature of 37 °C [91,92]. Recent studies show that the

slightest heating of the body or just the scrotum was correlated to lower sperm count and motility. The trial used specifically designed underwear which aided in raising the testis temperature to a maximum of 2 °C for 15 hours every day. This was successful in reducing the presence of sperm in the semen. Drawbacks were encountered as men admitted to losing sexual desire. A similar study was performed on rams which supported the former conclusions but also provided additional information which suggests that even though the amount

and mobility of sperm remained unaltered, the genetic composition may be affected [93]. To date, there is not a conclusive alternative to male contraception but great strides have been made to suggest the development of an effective male contraceptive may not be farfetched in our future.

Conclusion

In conclusion, the research and development of male contraceptive methods other than the male condom is still in its nascence. However, in this paper we have demonstrated that a need within the health the community strongly exists for further exploration and would certainly benefit the ability to reduce unwanted pregnancies and transmission of sexually transmitted diseases. We have also provided a foundational health knowledge base for public use and student education regarding the currently utilized clinical practices and research methods currently being explored for male contraceptives.

“The provided summary table is intended to be used as a quick reference tool for both students and those looking to compare methods for personal use. The information provided above does not substitute for the judgment of a trained medical professional” (Table-1).

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Author Contributions

Dharam Persaud-Sharma conceived of the study, participated in its design and coordination and drafted the manuscript; Joseph Burns participated in its design and coordination and helped to draft the manuscript; Jeran Trangle participated in its design and coordination and helped to draft the manuscript; Ashley Gilbert helped to draft the manuscript; Ana Gonzalez helped to draft the manuscript; Marien Govea helped to draft the manuscript; Manuel Lorenzo helped to draft the manuscript; CV Rao helped to draft the manuscript. All authors read and approved the final manuscript.

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