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Edited by Zouhair O. Amarin

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Meet the editor

Zouhair Amarin is a Professor of Obstetrics and Gynaecology at the Jordan University of Science and Technology. He was previously a lecturer at the University of Glasgow, senior lecturer at the University of Nottingham, and dean of the Faculty of Medicine at Mutah University. Professor Amarin is a fellow of the Royal College of Obstetricians and Gynaecologists and the Faculty of Public Health, London. He holds master's degrees in Medical Science and Medical Education. He is a pioneer in IVF and was the first to develop microsurgical epididymis sperm aspiration for clinical use. He also discovered a surgical procedure for critical ovarian hyperstimulation syndrome. Professor Amarin has published more than 120 papers and has received 8 awards.

Contents

Preface

Family planning is paramount in maintaining good health in women, children, and families. Public health monitoring, scientific assistance, and research all play a role in reproductive health. Family planning reduces the need for abortion as well as maternal and perinatal morbidity and mortality.

Family planning used to be a one-track process. However, times have changed. Nowadays, social media is a prominent communications platform that gives family planning organizations new channels to distribute advice and information. As such, this book on family planning adds to the advancement of reproductive health globally.

Safety, effectiveness, accessibility, affordability, and acceptability are important when choosing a contraceptive method. The content of this book covers some aspects of family planning and deals with a number of issues that pertain to reproductive health.

I would like to thank all the authors for their invaluable efforts and contributions. I also wish to thank Author Service Manager Marina Dusevic at IntechOpen for her support and advice.

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Section 1

Family Planning: Past, Present and Future

Chapter 1

Introductory Chapter: Family Planning: Past, Present, and Future

Zouhair O. Amarin and Mahmoud A. Alfaqih

1. Background

Going back to the old world, the history of family planning covers methods that were used by ancient civilizations and cultures to prevent conception or to terminate pregnancies that were already established [1, 2].

The ancient societies of Egypt, Greece, and Rome practiced birth control methods as, in general, they preferred small family sizes [1].

2. The past

In ancient Egypt, family planning is documented on the Elbers papyrus of 1550 BC and the Kahun papyrus of 1850 BC. These papyri describe various methods of family planning, such as the placement of lint, honey, and acacia leaves pessaries in the vagina to impede the function of seminal fluid [3, 4].

These methods have been tested in recent times and have been shown to be effective spermicidal agents. In addition, other modalities have been advocated in ancient Egypt, such as the application of honey and sodium bicarbonate in the vagina or acacia gum to the cervix. Of interest is the fact that lactational amenorrhea was known to the ancient Egyptians and was advocated as a method of family planning [5].

Coitus interruptus was anciently referenced as a means of family planning as it was practiced by a minor biblical person in the Book of Genesis. This person spills his seed on the ground as a method of contraception with his deceased brother's wife [5].

Generally, ancient cultures viewed the application of family planning as being the responsibility of the women, such as the use of pessaries and emulets [5].

Historians cite the legend of Minos in 150 AD which suggests that the condom was used in ancient times when he used the bladder of a goat to protect his partner from the serpents and scorpions contained in his semen [5].

In the ancient Near East and Greece, the rare silphium plant was used as an oral contraceptive, the effectiveness of which was greatly exaggerated. Other plants used for the same purpose include Queen Anne's lace, date palm, and willow [6].

In addition to the application of cedar oil in the female genitals, coitus interruptus was practiced during the times of Aristotle and Hippocrates [7].

Other than coitus interruptus, coitus reservatus and coitus obstructus were known to the ancient Chinese and Indians, in addition to the use of oral mixtures of oil and quicksilver [8].

In the medieval period, Middle Eastern and Indian civilization in general, the medical polymaths, Al Razi and Avicenna greatly influenced the advancement of

medical science. Contraceptive issues were described by them in the form of coitus interruptus and the use of pessaries of various components that included elephant dung and various plants [8, 9].

In contrast, medieval Europe was influenced by Catholicism, where contraception was deemed immoral [5].

These practices went on until the political issues of "voluntary motherhood" and women's emancipation movement of more recent centuries. It was in the very late eighteenth century when Thomas Malthus advocated chastity and late marriages that would result in greater economic stability and improve the standards of living without affecting Christian morality [10].

The birth control movement of the nineteenth century in Britain resulted in the reduction of the birth rate from 35.5 per 1000 in the 1870s to 29 per 1000 within 20 years [11].

The Graafian follicle was discovered and widely published in the second half of the eighteenth century. Even after van Leeuwenhoek discovered sperm around the same time (1677), about 200 years passed before it was clear to scientists how conception and early embryology worked. It was no surprise that the rhythm method was not yet understood. On the other hand, condoms and diaphragms made of vulcanized rubber were available [11].

In the United States, there had been few social and legal ramblings throughout most of the nineteenth century. This culminated in the foundation of the first birth control league in America. In synchrony, Marie Stopes clinic, the first birth control clinic in Britain was established in 1921 [12].

In the twentieth century birth control faced the issue of having to separate sexual activity from family planning, in addition to it becoming related to the feminist movement. Furthermore, there was a clash between the liberal and the conservative camps in relation to issues related to personal freedom, welfare, traditions, values, morality, religious beliefs, family size, politics, and state intervention [13].

Late in the twentieth century the combined oral contraceptive pill was developed in the United States and became commercially available in the 1960s. For termination of unplanned pregnancies, prostaglandin analogs became available in the 1970s and mifepristone in the 1980s [14].

The birth control pill literature, and the birth control pill were met with considerable legal bans in France and the Republic of Ireland as met in France, 1960s, and 1980s, respectively [15].

3. The present

Currently, among women of reproductive age worldwide, the vast majority need family planning. Women that have an unmet need for contraception greatly outnumber these using contraceptive methods [16, 17].

Access to contraceptive methods advances health and other social benefits, especially when births are separated by 2 years or more [18].

The demand for family planning has been on the increase. It is estimated that over one billion women are current users with a contraceptive prevalence rate of about 50% [19].

There has been a slow increase in the proportion of women of reproductive age who have their need for family planning satisfied by modern contraceptive methods. Reasons for this include various barriers such as difficulty accessing services by the

young and poor, limited choice of methods, fear of side effects, bias against some methods, cultural or religious opposition, poor quality, and limited access to services [19].

The various methods of contraception are classified by their effectiveness as commonly used by the number of pregnancies per 100 women as very effective (0–0.9), effective (1–9), moderately effective (10–19), and less effective (20 or more), as follows [20]:

Combined oral contraceptives	7
Progestogen-only pills	7
Implants	0.1
Progestogen only injectables	4
Monthly injectables or combined injectable	3
Combined contraceptive patch and combined contraceptive vaginal ring (CVR)	7 (for contraceptive vaginal ring)
Intrauterine copper device	0.8
Intrauterine levonorgestrel device	0.7
Male condoms	13
Female condoms	21
Male sterilization (vasectomy)	0.15
Female sterilization (tubal ligation)	0.5
Lactational amenorrhea method (LAM)	2 (in 6 months)
Standard days method (SDM)	12
Basal body temperature (BBT) method	No reliable data
Two day method	14
Sympto-thermal method	2
Emergency contraception pills	1–2
Calendar method or rhythm method	15
Coitus interruptus	20

4. The future

The future of family planning is highlighted by the fact that it is an important component of national health promotion and disease prevention programs. Research on improving family planning service delivery is closely related to the broader research effort that relates to the betterment of the general quality of health care that would inform practitioners about best practices. It is, therefore, necessary to foster research that results in improving family planning's effective and timely dissemination of information to service providers.

The future of family planning revolves around the prediction that methods would become 100% effective, especially those used a day after coitus, and producing vaginal spermicides that are bactericidal and virucidal against sexually transmitted infections. Albeit, the advancement of contraceptive pills or injections for men would be influenced by the reluctance of men from certain cultures and societies to adopt such methods.

As with the health care system as a whole, the family planning future agenda should include some key aspects that relate to safety, effectiveness, patient-centered care, efficiency, and equity of health care.

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Section 2

Society and Contraception

Chapter 2

Perspective Chapter: Factors that Influence Young Women's Decision-Making in Contraceptive Use in Ashiedu Keteke of Accra, Ghana

Naomi N.K. Abbey

Abstract

Every young woman has the right to reproductive health care. It is quite important for every woman to make an informed decision when choosing contraception. This is because women of today face a lot of challenges when it comes to the issue of reproductive health care. Young women choose contraception to prevent unwanted pregnancies and other reproductive health-related risks. The increase in abortion and pregnancy complication rates among young women is far too much and needs to be critically addressed to reduce maternal deaths (MD) and infant mortality. The decision made on the use of contraception by many young women has interfered with some factors that prevent them from making the right decisions. This piece is to identify those factors that influence young women's reluctance of using contraception and how to promote contraceptive usage among Ghanaian women.

Keywords: contraception, contraceptive use, young women, maternal deaths, decision-making

1. Introduction

1.1 Background

The issue of teenage pregnancy is a global public health concern, especially in developing countries like Ghana. It is generally asserted that teenage pregnancy is a global public health concern. During the developmental stages of life, adolescents' sexual instincts increase and they may engage in risky sexual activities, which may, in turn, lead to unintended pregnancies. However, it is confirmed that pregnancy during adolescence predisposes young women (YW) to a lot of risks, which may include unsafe abortion, maternal mortality, mental retardation and sexually transmitted infections (STIs).

The issue of childbirths among young women is a socioeconomic canker, which has a greater impact on the mother, family and the entire community. This comes from the unpreparedness of young women giving birth because their bodies may not be ready

for a full-term baby, and may be dependent on their families and the social service providers, which also bring shame to the young women. According to Sedgh et al. [1], unplanned pregnancy globally is said to be 84.9 million and more than half of these seek abortion. A recent report states that apart from the complications mothers bear, newborn babies are also predisposed to risks of low birth weight and congenital abnormalities [2]. The global record for unintended pregnancies is reported to be 44% [3] and more than 56% of these result in abortions [4]. Meanwhile, a significant number of these come from the Sub-Saharan African (SSA) region [5]. According to Sedgh [6], about 11% of maternal mortality are a result of unsafe abortions. Sexual and reproductive health (SRH) care is one of the factors for reducing poverty in every nation.

For some decades, there has been a consistent reduction in the use of contraception among young women in Ghana. The study of Ashiedu Keteke in the Accra Metropolitan Assembly in the Greater Accra Region of the Republic of Ghana has a population of 149,185 with divergent ethnic groups from all walks of life [7]. Bain et al. [8] report 87% of unsafe abortions among young women within the community.

Recent studies by other studies have also recorded the promiscuous lifestyle of some adolescents who engage in coital activity at the early stages of life [9]. However, the World Health Organization [10] defines unsafe abortion as a procedure carried out to terminate unplanned or unwanted pregnancy by unskilled individuals or in an environment with less standard of medical care. It is a preparatory ground for gender equality as well as women's empowerment. The inability of women to decide on the choices of their sexual and reproductive health needs is the root cause of their health-related problems. Women are denied their bona fide rights to choose from possible courses of action for fear of the 'so-called' societal norms.

Sexual and reproductive health decisions on contraception are essentially significant. Every individual who wants to start contraception has the right to choose, opinion, information, safety and access to quality service. A lot of young women face challenges when choosing contraception. The key mandate to contraceptive uptake is the woman's ability to make a decision. Interestingly, one may ask if the decision to use contraception is taken by the woman or both the woman and the male partner? By what means can this be influenced if decisions on sexual and reproductive health care are taken by both parties?

Decision making (DM) is described as the study of finding out from possible alternatives and picking out the most convenient for a purpose. It is perceived as a cognitive study due to its functional role in mental reasoning or straight-thinking. Consequently, decision making is a process that limits uncertainty to a desirable level but not all uncertainty can be reduced; sometimes it has to be removed. This is because most decisions may involve some quantity of risks that needs to be obliterated [11].

The young woman's decision on reproductive health care is a need to help prevent unplanned pregnancy as well as unsafe abortion and its complications which is a public health issue of international concern. These women request that their decision on contraception should be autonomously considered significant [12]. In Ashiedu Keteke a suburb of Accra, Ghana, a significant number of young women experience increased risks of sexually transmitted infections (STIs) and abortion-related complications as a result of unplanned pregnancy. Boah et al. [13] record that Ghana's abortion rate as of 2017 is recorded to be 26.8%. The leading cause of death among young women and adolescents is complications from pregnancy and childbirth [14].

Within the reproductive age group, young women are described to be sexually active and if care is not given during peer relationship, their promiscuous lifestyle will

likely increase the population growth of a nation as a result of an increase in the number of childbirths. A lot of these women are unable to develop academically, socially and economically and this affects the nation's manpower as well as young women's future growth and opportunities [15].

Consequently, the health and lives of these young women are undermined [16]. It also increases the economic burden of a nation because young women who become pregnant have to drop out of school without achieving their full potential in life. Across the globe, complications from pregnancy and childbirth are the leading killer of female adolescents and young women with 99% of maternal deaths [17].

Efforts made by the United Nations Fund for Population Activities (UNFPA) to support voluntary family planning (FP) among women of reproductive age (WRA) is an indication to secure human rights for sexually active women. The intention to decide when to become pregnant is a serious issue to consider in every woman's life since it has an immediate impact on a woman's health and well-being [18]. Ghana's prevalence rate on MC methods was recorded to be 33.2% [19]. Reasons for non-contraceptive use among young women in Ghana are what stands to influence their decision making on contraception.

2. Contraception

The practice of contraception in spacing-out childbirth is an intervention to delay pregnancies in the at-risk population of young women who usually go through pregnancy-related complications [20]. Getting access to contraceptive education is the human right of young adults. Contraception as we know is a device used in preventing unplanned pregnancies and it reduces abortion rates as well as complications due to pregnancies and childbirths [21]. Also, consistent and correct use of barrier methods like condom is an effective method in preventing and reducing sexually transmitted infections (STIs).

Sexual and reproductive health care are services adopted to control maternal and infant mortality as well as promote the education of family planning services across the globe. This is World Health Organization's core mandate to create awareness of "health issues for the young people" (Ibid); thereby making contraceptive devices more accessible, affordable, safe and effective.

Estimated results from recent studies also recorded that 218 women of reproductive age from the low and middle-income countries (LMICs) do not desire contraception, yet they wanted to avoid unintended pregnancy. Consequently, 171 sexually active women globally wanted to prevent pregnancy but feel reluctant to use any form of contraception [22] as a result of other health-related risks or side effects, misconceptions of some contraceptive methods, not being in a stable relationship or not having sex frequently [23]. Meanwhile, young women who use contraception are able to prevent maternal mortality as they limit or delay childbirth. As a service provider, clients who have accepted to use contraceptives are able to express the benefits gained after the use of modern contraceptive methods. This includes the restoration of their reproductive health after intermittent childbirths, engaging in gainful employment to raise their income and being able to further complete their education. Also, the number of contraceptive acceptors who happens to be young women prefer using more hormonal contraceptive methods (injectable, oral pills, implants) than the non-hormonal ones (condoms, EC, etc.) compared to older women.

3. YW's perception towards modern contraceptive usage

Consistent review from related studies posits that some women perceived orthodox medicine (contraceptive methods) to be unsafe, causing infertility and deaths; also mistrust of provider's information with the perception of not being competent could lead to low usage [24]. It is recorded that some women consider themselves naturally infertile, so no need for contraception, perception of being weak as a man to allow the woman to use contraception, perception of becoming promiscuous after using contraception, perception of low quality of service provision by healthcare experts, perception of becoming pregnant as a result of pre-ejaculation and misconceptions about methods of contraception or the perception of becoming sick when the number of children is limited [25]. Furthermore, some women perceive that women who engage in contraceptive usage give birth to abnormal babies, as well as making users disloyal or cheaters in their relationships [26].

4. Awareness, experience and knowledge of young women in modern contraception

Limitation in the knowledge of contraception was a result of a reduced rate of illiteracy, which contributed to the low use of contraception. The level of awareness of modern contraceptives was known to some women and they perceived some methods that cause infertility [24]. Inadequate knowledge of modern contraceptive methods is a barrier in the use of contraceptives [26]. Further to that, Hlongwa et al. [27] reported evidence on barriers to contraceptive use to be a lack of knowledge and understanding of contraceptive methods. It is recorded that the awareness of contraception, which was made known through peer relations, close relations, neighbors, mass media and providers of sexual and reproductive health care, is limited [28]. Also, modern methods of contraception are widely known to some women, whilst those with no level of education lack the awareness of modern methods of contraception [25]. However, individuals' exposure to appropriate information and education on contraceptive methods enhances informed decision making in contraceptive uptake [29]. In the same vein, young women are able to make rightful decisions on their reproductive health needs.

5. The impact of decision making on contraceptive use among women

Women's rights in decision making on sexual reproductive health care are undermined, making them unable to choose contraception [25]. In the same vein, women with higher decision-making autonomy accepted to practice contraception without the approval of partners [28]. However, women whose partners accepted contraceptive usage were very supportive of the cost involved as well as in managing side effects.

6. Hindrances to the use of contraception among young women

Giving account on my personal experience, women who discontinue the use of contraceptive devices or methods, do so as a result of significant occurrences; which include the experience of irregular menstrual flow or bleeding pattern, not being in a

stable sexual relationship, partner not in support of contraceptive use, pleasure in the coital activity being interfered and misconceptions and myths on some contraceptive methods.

Social influence (husband/partners, in-laws and other close relations), a limited number of qualified health providers, low income, no desire for birth spacing or limitation, lack of accessible sexual and reproductive health clinics, misconduct of service providers to clients, side-effects of some methods and increase in the number of stock-outs of methods are factors contributing to low contraceptive uptake [24]. Lack of funds to procure contraceptives, non-availability and equitability of sexual and reproductive health clinics offering contraceptive services, issue of consistent stock-outs and its associated cost, the uncomfortable nature of singles walking into sexual and reproductive health clinics, the aftermath side-effects of some contraceptive devices and issue of socioeconomic status affected modern contraceptive uptake [26].

It is considered that dissatisfaction with methods, unable to switch to the most appropriate methods during contraceptive method failure, stock-outs of current methods, unable to seek consent from partners on contraceptive uptake, personal health issues, poor quality of care, social influence from peers and other family members and side-effects of modern contraceptive interfere with its usage [28]. In addition to this, the duration of a relationship, partner's age difference, contraceptive methods availability, sexual experiment, poor attitude of providers towards clients and long hours of waiting influence the use of contraception [27]. Also, consistent abstinence in sex, the denial of family and partner's approval, non-availability and non-accessibility of modern contraceptive methods and services, desire to increase family lineage, getting used to traditional methods, side-effects or associated health risks, low stock-out rate, cost of contraceptive methods and some provider's adherence to cultural practices and demand for partners' consent interferes with contraceptive usage [25].

7. Types of contraception and the mechanism of action

Per the views of the World Health Organization [20], contraception is 'a core' issue of public health. It contributes to the reduction of family size as a result of birth spacing and also improves the health of mothers, infants and children. In the same vein, women are able to further their education, secure a career and promote economic growth as well as the lives of families and communities (Ibid).

Contraception is a method used to prevent ovulation, which may intend to prevent unintended pregnancy leading to the reduction of induced abortion [30]. Some women prevent pregnancy as a result of delaying pregnancy, spacing out births and limiting the number of births they want to have. These are the reasons why contraception is used [31]. But then, one needs to consider the following factors while choosing the most suitable contraception. These include:

- Getting reliable information about the method to be used
- Knowing the benefits of contraception (including safety)
- The mechanism of action and the side effects of the method chosen
- Knowing the cost, accessibility and affordability of the chosen method

When these are made known, women would not be influenced when making a decision to use them. There are various types of contraception but when making a decision to use them, one needs to consider their needs and the circumstances involved. The commencement of these procedures can be done when there is no issue with pregnancy. These include:

- Short-term hormonal methods (HM) contraceptives like the birth control patch, vaginal ring, injection and the contraceptive pill.
- The long-term HM are the intrauterine system and implants
- Non-hormonal long-term methods like intrauterine device
- Non-hormonal barrier methods are the diaphragm, male and female condom
- Methods that are not reversible include vasectomy and sterilization
- Emergency contraceptive (EC) methods include the intrauterine device (IUD) and the EC pills
- Natural and traditional methods

The natural methods are the calendar, basal body temperature (BBT), cervical mucus and the symptothermal. Traditional methods are coitus interruptus and coitus reservatus which is done to prevent sperm from entering the body for fertilization to commence (Ibid).

Nevertheless, contraception is provided by a doctor or a trained nurse. These are how the various methods of contraception are provided. Short-term hormonal methods include patches, vaginal rings and injections. According to Trussell et al. [32], a hormonal patch is a method worn on the skin, either at the abdomen, buttocks or upper body, far from the breast to release hormones (estrogen and progesterone) into the bloodstream and it works for 3 weeks by changing it every week, and then removed in the fourth week during menstruation. The vaginal ring is a ring placed into the vagina for the release of estrogen and progesterone, then it is taken out in the fourth week to allow the flow of the menses before using it again. The patch and the vaginal ring keep the sperms apart from reaching the egg when estrogen and progesterone are released into the bloodstream.

There is also the hormonal contraceptive injection. The 'Depo-Provera' (150 mg), 'Sayana Press' (104 mg) and Noristerat are mainly progestin-based contraceptives. The Depo Provera is given intramuscular (IM) every 3 months at the buttocks or upper arm, while the Sayana Press is given subcutaneously every 13 weeks at the back of the hand, the front thigh or the abdomen, far from the naval. The Noristerat injection '(NET-EN)' is given IM every 2 months. The progestin-only pill is good for women who cannot take estrogen-based contraceptives. The other contraceptive to consider is the combined injection contraceptive (CIC), which contains estrogen and progestogen and is given IM every month at the buttocks or upper arm [33]. The effectiveness of hormonal-based contraceptives can be reduced with some medications (e.g., Rifampicin/Rifabutin). Its usage ceases ovulation making the ovaries inactive to release eggs to meet the sperm. They are highly effective in preventing pregnancy when the injection is taken consistently and contraception takes up to

seven (7) days to work effectively. Therefore, there is a need for a backup method during sexual intercourse.

The oral contraceptive pill is made up of the progestin-only pill (POP)/mini pill and the combined oral contraceptive (COC) pill. They are safe and effective when taken at the same time every day starting from the first day of menstruation and will need a backup method or abstain for the first 7 days [34]. It thickens the cervical mucus, ceases ovulation and also makes the uterine lining thin to prevent the passage of sperm for conception to take place. However, it is good to report to a service provider when a pill is missed or forgotten but condoms can be used as a backup method. The POP is good for lactating mothers. The COC pills are made up of 21 estrogen and progestogen pills and seven brown or iron pills per pack/cycle serving as iron supplements. There is a quick return to ovulation after stopping COC; good for the treatment of painful menstruation and gives protection against ovarian cancer [33].

The long-term hormonal IUD is a 'T-shape device' placed into the uterus to prevent pregnancy for 10–12 years. The copper component kills the sperm and thickens the mucus of the cervix preventing sperms from swimming to meet the egg. We also have IUDs that are non-hormonal. However, women eligible for IUD are those with no issue of pelvic infections, those whose uterus sound is more than 6 cm or less than 10 cm and those that are not allergic to copper. It is effective as soon as insertion is done. That's why it is used as emergency contraception (EC) (Ibid).

The second hormonal method is the implant which is a 'thin rod' and is inserted subdermally into the left upper arm. They are of two types, the Implanon is one rod inserted under the skin of the upper arm for 3 years and Jadelle is a double rod inserted subdermally under the skin of the upper arm for 5 years. It also stops ovulation and makes the cervical mucus thick to prevent the sperm from reaching the egg. They are useful for women who are allergic to the use of estrogen hormones (Ibid). The IUD and the implant are conducted by a trained service provider.

The non-hormonal methods of contraception include the cervical cap (CC) or diaphragm, male and female condoms. The diaphragm or CC are placed inside the vagina to close or cover the cervix to prevent the sperm from reaching the eggs for conception to take place. This can be used in addition to spermicide to kill the sperms and is done before sex. Women who are allergic to spermicides cannot use it. The male and female condoms prevent the eggs from meeting the sperm for fertilization to place. The male condom is a 'thin sheath made of latex rubber', which is worn on an erected penis before inserting it into the vagina. The female condom is a 'soft loose-fitting' rubber sheath with two flexible rings. The inner ring is squeezed into the woman's vagina to cover the cervix and the outer ring at the surface of the vagina. The penis is guided into the condom during sex; and after sex, the outer ring is twisted, squeeze and pulled out from the vagina and discarded into a trashcan or waste bin making sure the sperm does not split (Ibid).

Vasectomy and female sterilization (tubal ligation) is a non-reversible method of contraception. This method follows a 'surgical procedure performed under local anesthesia' on a man or woman preventing him or her from producing additional children. The client is supposed to make an informed decision about the chosen method. The method required a signed consent form from the spouse or a witness before the procedure is being performed. The vasectomy does not allow the spermatozoa to flow into the seminal fluid during ejaculation. The tubal ligation prevents the egg through the fallopian tubes to meet the sperm. It is very safe and effective (Ibid).

The emergency contraceptive (EC) pills and the IUD are the contraceptive methods for emergencies. The EC pills are taken after unprotected sex and they prevent pregnancy from the starting day to 5 days [35].

The natural and traditional methods of contraception include: the lactational amenorrhoea method (LAM), which prevents ovulation through the practice of exclusive breastfeeding for 6 months [33].

The BBT method is used to study a woman's temperature to indicate if ovulation has occurred in order to prevent pregnancy during that period. Here the temperature is taken orally or rectally every morning waking up from bed and before any vigorous activity. The normal BBT to detect if ovulation is over is when 'BBT has risen from 0.2 to 0.5 degrees Celsius' with a constant elevation for 3 days and the readings should be higher than any of the previous days in that particular cycle. The rise in temperature will be constant until the beginning of the next period (Ibid).

The next method is the calendar method, which works like this: it requires the study of the cycle for 6 months to be able to indicate the longest and the shortest of the six cycles. This will help the client to tell which part of the month is fertile. An example is a client with the shortest cycle (SC) of 25 days and the longest cycle (LC) of 32 days. Here 20 will be deducted from the SC (25–20) = 5 and 10 from LS (32–10) = 22. For this reason, sex needs to be avoided from day 5 through to day 22 to prevent pregnancy (Ibid).

The cervical mucus method is a method used to detect when there is a feeling of wetness or mucus at the vulva to be able to tell when one is fertile in order to avoid sex. One can observe the mucus by wiping the vulva with a tissue or when there is wetness in the underpants. There is no sexual relation when mucus is found in the underpants or tissue paper. Consequently, the symptothermal method is the observation of the body temperature and the cervical mucus for the detection of fertile periods. This period ends 4 days after 'peak' mucus from the cervix or 3 days after a sustained rise in temperature. However, when not sure of the fertile period, abstain or use a condom for protection. Also, clients who have problems with the use of one contraception can be provided with a suitable alternative (Ibid). Contraceptive services are given by a practice service provider at the sexual health clinics.

In Ghana, the most available contraceptive methods include: the contraceptive injections (Depo-Provera, Sayana Press and Norigynon), the contraceptive pills (both POP (Microlut) and microgynon (COC), ECP (Postinor 2), implants (Jadelle and Implanon), IUD (10–12 years), vasectomy and female sterilization and condoms, cycle beads and the natural methods.

Recent studies recorded the methods used by women who are married are different from that of unmarried women. The use of modern contraceptives for men is limited to vasectomy and condoms. The prevalence of modern contraceptives among married Women of Reproductive Age as of 2019 is 57.1% [10].

8. The impact of contraceptive use

Every nation sees the advancement in sexual and reproductive health as a core value for its development. Sexual and reproductive health is the bedrock of the standard development goals [36]. This is a means of controlling the fertility rate of women of reproductive age, to pave way for economic growth and development. It has been evident in the development of nations with improved contraception services and healthcare among women to enjoy a better standard of living in the area of economic growth, investment, education and empowerment as well as decreased rate of maternal morbidity and mortality and infant deaths (Ibid).

When contraceptive care for young women is of greater quality, the decision to accept its usage will be manifested. Globally, maternal mortality has declined by

420,000 within 25 years [37, 38]. That's why it is important to identify those setbacks that discourage young from accepting contraception.

The need to reduce the incidence of maternal and infant deaths associated with pregnancy and childbirth complications in every nation is of paramount importance. Contraceptive use in women is an essential human right to prevent complications from pregnancies and childbirths [21].

The impact of contraceptives according to the UNFPA annual reports states that over 14 million unintended pregnancies and 3.9 million induced abortions have been prevented by the use of contraceptive devices [18]. Consequently, over the past years in the LMICs, consistent use of modern contraceptives among women has led to a drastic reduction in maternal deaths, which records 40% [39].

9. Sexual health service and the type to use

Several clients are considered to be having special needs for contraception, especially those that may have some conditions that may prevent them from accessing sexual and reproductive health services. Sometimes these groups of individuals may be at risk of unplanned pregnancy and STIs. Young people form 41% of 'new adult infections' globally [40]. They may include adolescents, young people, post-abortion clients as well as people with disability. Although they are biologically or emotionally tortured, they all have equal rights to information and services on contraception [41]. It is highly important to provide sexual and reproductive health service information to these groups of people as well as help them to make decisions that can lead to positive sexual health outcomes. This call for the provision of sexual health services (SHS), a system that provides increased attention to SRH information to young people. The intention is to target young individuals with increased risk and provide them with information on sexual and reproductive health care to prevent them from unplanned pregnancy, maternal deaths and STIs (Ibid). This is because they have the right to decide on which contraception to use, obtain and where to get them. On that account, it is essential to make service delivery sites more comfortable and friendlier. The intention of this inauguration is to decrease maternal and infant mortality and encourage the promotion of reproductive health so as to increase the prevalence of contraceptive uptake.

Sexual health service is described as systems that make provision of preventive health services to youth on-site or in their community or within the health facility [42]. These are healthcare services provided by healthcare providers and school health nurses. So, increasing access to these services will help improve adolescents' and young women's immediate and lifelong health significantly, where other health issues would be detected early and services provided on time.

10. Strategies to enhance contraceptive uptake (CU) decisions

In order to build up the decision on contraceptive use, it is essential to periodically intensify the education on sexual and reproductive health care services on contraception by moving to the doorsteps of individuals and some household levels. Furthermore, much attention should be given to mass education in the communities, especially the remote villages to strengthen young women's sense of well-being during decision making in contraception [43].

11. Conclusions

This work clearly explains the views of young women's decisions on contraceptive usage within the context of Ghana. This manuscript is basically giving an account on decision making and its associated factors in contraceptive use. Information gathered from reviewed articles reiterates that perceptions on contraception, limited knowledge on methods of contraception, lack of support in contraceptive decision making and influence from environmental characteristics affect decisions on the use of contraception. However, there has been limited information explaining the positions of women when it comes to decision making in contraceptive usage. Therefore, it is expedient to understand women's points of view with regard to contraceptive decision making. Findings from the study seem to be equally the same as other studies that are in the context of the research area. One area in the study, which seems significant and mostly considered problematic is the issue of partner's support or cooperation as women have been denied household decision making [44, 45]. However, there should be possible mechanisms to promote the use of contraception. The medium of communication in the education of contraceptive services should be sensitized to include women in decision-making process and not undermine the rights of women in decisions concerning their health.

Definition of terms

Decision-making	it is a course of action used to arrive at the best option or a solution for a given issue or problem
Young women	a female between aged 10 and 24 years
Contraception	methods or devices used to delay or space or limit childbirth
Contraceptives	these are drugs or agents or devices that inhibit conception
Sexual and reproductive health	it is the right to good healthcare and to a safe lifestyle

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Chapter 3

Scaling up Contraception through Social and Behavior Change Intervention in Low and Middle-Income Countries

Apiyanteide Franco

Abstract

Despite its benefit and aged long practice, contraceptive use continues to be a problem in low and middle-income countries like Nigeria with one of the highest maternal and child mortality across the globe. This chapter aims to discuss social and behavior change interventions needed to scale up contraceptive use in low and middle-income countries. A review of literature in addition to field experiences in promoting contraceptives was made. Evidence reveals that a well plan and carefully implemented social and behavior change intervention based on formative research is key to improved contraceptive use needed for improved maternal and child health outcomes in low and middle-income countries. Contraception is the right of every woman and a recommended practice for the health and development of any nation.

Keywords: contraception, low and middle-income country, maternal and child health, social and behavior change, intervention

1. Introduction

The use of contraception is an aged long practice and historically, humans have used their imaginations [1] such as coitus interruptus to prevent pregnancy. Evidence revealed that birth control practices are well documented in ancient Egypt and Mesopotamia [2]. The Ebers papyrus from 1550 BC and the Kahun Gynecological papyrus from 1850Bc have some of the earliest methods of birth control. It documented the use of honey acacia leaves and placement of lint on the vagina of women to block spermatozoa penetration into the female genital tract [2].

One of the most effective antifertility herbs in ancient times that was most famous for birth control was the use of silphium plant, which is a native of Cyrene in modern-day Libya, North Africa. This plant was used as a contraception in ancient Greece and Rome and became extinct as a result of over-cultivation of the plant for contraception [3]. In ancient Greece, several plants are used as contraception, including Asatoetidua, a close relative of the extinct silphium plant. Recent evidence shows that the surviving relatives of the silphium plants exhibit anti-fertility potency in rats [3].

In India, Queen Anne's lace (Daucus carota) which is a native to Asia, Europe, and North Africa, is commonly used for birth control up to date [3].

Based on the toxic nature of most ancient contraceptives, there was a need to develop more effective and safe forms of contraception. This resulted in a series of inventions such as the male condom in 1564, which was originally developed to address sexually transmitted infections such as syphilis in Europe [4] and the first modern female condom was released in 1993. Hormonal pills as means of contraceptive in the form of Enovid were first approved by the FDA in May 1960 [5].

Despite the safety effectiveness and benefits of these methods of contraceptive, the use in most low and middle countries continue to be low despite the availability of these contraceptive methods.

2. Contraception

2.1 Definition

Contraception can be defined as the intentional means of preventing conception through the use of various devices, sexual practices, chemicals, drugs, or surgical procedures [6]. It is often referred to as birth control and involves the deliberate prevention of conception through various methods, medicine or devices used to prevent pregnancy.

2.2 Types of contraceptives

Contraceptive methods are available for individuals and couples for birth control in various forms. The most appropriate method depends on various factors such as safety, effectiveness, acceptability, availability, affordable and accessible. The number of sex partner, age of the individual, health status of the users desires to have children in the future, and frequency of sexual activities. Generally, the methods of the contraceptive can be group into natural and artificial methods. Natural methods tend to be less effective when compared to artificial methods of contraception.

2.2.1 Natural methods of contraception

This is based on the use of the body physiological changes and symptoms in the identification of the fertile and infertile phases of the menstrual cycle to make decisions on when to be involved in coitus activities that can result in conception. These methods are also referred to as fertility-based awareness methods and they consist of periodic abstinence, coitus interruptus, lactational amenorrhea, and post-coital douche.

2.2.2 Artificial methods of contraception

Five types of artificial contraceptives have been described. These include

i. Barrier method

ii. Hormonal method

iii. Emergency post-coital contraceptives

iv. Long-acting reversible contraceptives

v. Sterilization

2.2.2.1 Barrier method

In addition to its roles in birth control, barrier methods like male condoms are an effective means of preventing sexually transmitted infections such as HIV/AIDs and other ills. They act by creating a barrier between the male spermatozoa and the female ova and therefore prevent fertilization. During sexual intercourse, barrier methods reduce the exposure of both individuals to sexually transmitted infection [4]. Examples of this method include the male and female condom, cervical caps, and diaphragm.

2.2.2.2 Hormonal methods

Hormonal contraception (HC), also known as "the pill", are currently made up of either estrogen-progestin combinations or progestins alone. Ongoing research to add to this group of contraceptives have focused on the "antiprogestins", more precisely called selective progesterone receptor modulators (SPRM) [7]. This group of contraceptives were originally administered in the form of daily pills, but in recent times, seven different routes of administration have been developed which include: intramuscularly, intranasally, intrauterus, intravaginally, orally, subcutaneously, and transdermally [7]. Common example of this group of contraception are: oral pills, implant, IUD with progestin, injectables like depo-provera, vaginal rings, and skin patch [8].

2.2.2.3 Emergency post-coital contraceptives

This form of contraceptives is not recommended to be the first line of contraceptives for any user. This form of contraception refers to the use of a drug or device to prevent pregnancy after unprotected sexual intercourse. Estimate reveals that the expected risk of pregnancy after unprotected intercourse without emergency contraceptive use is 5.6% [9]. Examples of this form of contraceptives include emergency contraceptive pills (combined and progesterone-only), Copper T380 IUD, Levonorgestrel (Plan B), and ulipristal acetate (Ella).

2.2.2.4 Long-acting reversible contraceptives

Long-acting reversely contraceptives are a group anti-fertility that provide effective contraception that provides extended period without requiring user action. They include injections, intrauterine devices, and subdermal contraceptive implants. They are the most effective reversible methods of contraception because their efficacy is not reliant on patient compliance. Long-acting reversible contraceptives include IUDs and the subdermal implant such as:

- Hormonal intrauterine device is also known as IUC or IUS.
- Nonhormonal intrauterine device with copper.
- Subdermal contraceptive implants such as implanon and jadelle.

2.2.2.5 Permanent method of contraception

Sterilization is considered an elective permanent method of contraception. Although both female and male sterilization procedures can be reversed surgically, the surgery is technically more difficult than the original procedure and the success rate is often low. Vasectomy (male sterilization) and tubectomy (female sterilization) are the two common forms of permanent methods of contraception. Hysterectomy is a form of the permanent method of contraceptive which is not commonly practiced among women.

2.3 Trends in contraceptive use

Trends in contraceptive use have been shown to vary between developed and developing nations, across nations, and within nations. The United Nations (2015) report on trends in contraceptive use showed that contraceptives are used by majority of women of reproductive age group in almost all regions of the world [10]. In 2015, 64% of women of reproductive age worldwide who are either married or in a union were using some form of contraception. However, the report showed that contraceptive use was much lower in the least developed countries with an estimate of 40.0% with the Africa continent having the lowest estimated at 33.0%. Among the other major geographic areas, contraceptive use was much higher, ranging from 59% in Oceania to 75% in Northern America [10]. Furthermore, the report revealed that globally, an estimated 12.0% of married or in-union women have an unmet need for contraceptives [10]. This implies that they wanted to stop or delay childbearing but was not using any method of contraception with the highest figure (22.0%) recorded among the least developed countries [10]. Most of the countries with high unmet needs for contraceptives are in sub-Saharan Africa estimated at 24.0% which doubles the global average in 2015 [10]. In Nigeria, estimates from the National Population Commission revealed that only 14.5% of women use modern contraceptive methods [11]. Paul [12] noted that over 83% of women were not using any form of contraceptives in 2018 with a geographical variation within the country. Yobe State in North East Nigeria has the highest number of women (98.1%) who do not use contraceptives while Lagos State in South West Nigeria had the least number of women (50.6%) who do not use contraceptives [12].

2.4 Benefits of contraception

Contraception is one of the most effective public health interventions of the twenty-first century which is highly needed more than before, especially with the ever-increasing human population and the increase in crime rates. A well-planned pregnancy often enables couples to be able to give the best to their children for them to be productive to the family and the society at large. Thus, contraceptives help in the prevention of unwanted pregnancies among couples and therefore promote planned family size and time of birth for improved reproductive wellbeing of the women. Some contraceptives such as the make condom in addition to prevention of pregnancy are also beneficial in the reduction of sexually transmitted infections such as HIV/AIDs and syphilis. They indirectly reduce the burden of infertility through the prevention of infertility secondary to complications of sexually transmitted infections and abortions conducted with crude instruments in clandestine places by unskilled

personnel. Voluntary family planning practices include the promotion of maternal and child health, human right, population and development, and environmental sustainability and development of a nation. These benefits are clearly exemplified in the developed nations unlike in most low and middle-income countries which are yet to maximize the benefits of contraceptives in their society.

2.5 Factors influencing contraceptive use in low and middle-income countries

Despite efforts and availability of contraceptives in low and middle-income countries, uptake continues to be low as a result of several barriers. These barriers can be grouped into client and health services related.

Akamike et al. [13] in their systematic review of literature observed that client-related include the desire for more children, partner disapproval of contraceptive use, religious and culture bias, educational qualification of women, lack of knowledge on contraceptives, and wealth index [13]. Health service-related factors are poor access to contraceptive services, inability to procure modern contraceptive methods and stockouts of modern contraceptives methods [14].

2.5.1 Client related factors

2.5.1.1 Desire for more children

The desire for large family size is often one of the reasons for refusal of contraceptive use. Couples often ensure continuous procreation and avoid the use of contraceptives until they attain the purported family size they want to actualize [15]. This trend has accounted for high family size of up to 7 above in some regions of low and middle-income countries like Nigeria. This is unlike in regions that prefer a small family size. Despite the need for large family size, couples tend to desire or use contraceptive methods [16].

2.5.1.2 Partner disapproval

Despite the willingness of some women to use contraceptives, partner disapproval and abuse of the right of women continue to negate against the use of contraceptives in low and middle-income countries like Nigeria. Women who desire to delay or limit births often experience strong disapproval and warning from their spouses against the use of contraceptives [17]. They may experience abuse following the discovery of their use of contraceptives without knowledge and approval by their partner.

2.5.1.3 Religious and cultural disapproval

Religious and cultural norms of some groups strongly discourage the use of family planning in low and middle-income countries like Nigeria. Such aversion stems from the fact that these cultures consider contraceptives as means of reducing or controlling their population by the west or an unclean practice. Addressing these fundamental issues through proper education on the benefits of contraceptives in addition to how they work and the need for productive sexual and reproductive health becomes eminent.

2.5.2 Educational qualification of women

Women with a relatively high level of education tend to use contraceptives more than those with little or no form of education. This is because education brings about improve knowledge and rights of women in making decisions that are related to their sexual health and reproductive. This is unlike the women who are less educated and often less empowered to make such decisions and therefore unable to use contraceptives.

2.5.2.1 Contraceptives knowledge

Lack of contraceptive knowledge is one of the barriers to contraceptive use. A high proportion of women of reproductive age group lack adequate knowledge on the benefits of contraceptives. This has adversely affected the use of available forms of contraceptives in low and middle-income countries like Nigeria. Conversely, women with higher knowledge of contraceptives tend to make use of them more for their sexual and reproductive health and wellbeing.

2.5.2.2 Wealth index

Wealth index of women and family often affects contraceptive use due to access to finance and education of the benefits of contraception. The poorer the women, the less likely they will use contraceptives, and those from affluent backgrounds tend to use contraceptives more [18].

2.5.3 Health systems related barriers

2.5.3.1 Access factors

Distance from health facility and source of contraceptive services may hinder contraceptive utilization for most women in rural hard to reach communities of some low and middle-income countries like Nigeria. The absence of functional and effective primary health care systems with modern contraceptive methods may hinder the utilization and result in a higher unmet need for contraceptives within these populations.

2.5.3.2 Cost of family planning methods

A relatively high cost of some modern methods of contraceptives and the inability of some women to purchase these services has negatively affected the utilization of available methods of contraceptives.

2.5.4 Quality of contraceptive services

The quality of contraceptive methods is a prerequisite to its acceptance and utilization. Strobino et al. [19] there are six quality criteria for family planning. Viz: (1) choice of contraceptive methods, (2) information is given to the users, (3) provider competence, (4) client/provider relations, (5) re-contact and follow-up mechanisms, and (6) an appropriate constellation of services [19]. Based on these criteria, high quality in the delivery of contraceptive services is essential for improved utilization of contraceptive methods among couples in low and middle-income countries like Nigeria.

3. Social and behavior change interventions

3.1 Definition of social and behavior change

Several scholars and organizations have defined social and behavior change from various perspectives. Some are defined below.

Mercy Corps [20] defined social and behavior change as a collaborative and transformative process that empowers individuals, households, and communities through improvement in knowledge, shifting norms and perceptions, and modifying structures and policies which facilitate individual and collective behavior change [20].

Prostejov [21] defined social and behavior change as a process that enables individuals, communities, or society to adopt and sustain positive behavior {}. It does so by identifying the various factors that influence people's behavior and addressing these by using those approaches that are most likely to be effective [21].

USAID [22] stated that Social and behavior change (SBC) programming is an approach that applies systematic insights about why people behave the way they do, and how behaviors change, to effect positive outcomes for and by specific groups of people [22].

3.2 Components of social and behavior change

The components of the social and behavior change intervention include:

i. Social and behavior change communication

ii. Community mobilization

iii. Community engagement and

iv. Advocacy

3.2.1 Social and behavior change communication

Social behavior change communication (SBCC) is the systematic application of interactive, theory-based, and research-driven processes and strategies to effect change at the individual, community, and social levels [20]. SBCC examines challenges from multiple sides by analyzing personal, societal, and environmental factors in order to find an effective way to achieve sustainable change. SBCC also employs strategies that influence the physical, socio-economic, and cultural environment to facilitate healthy norms and choices and remove barriers to them.

3.2.2 Community mobilization

A community is a group of people with a common interest who live together in a specific geographical location. Mobilization on the other hand refers to the process of bringing people together to plan, implement and monitor an initiative to obtain an expected goal. Thus, Community mobilization is the process of engaging communities to identify community priorities, resources, needs, and solutions in such a way as to promote representative participation, good governance, accountability, and peaceful change [20].

It is a capacity-building process through which community members, groups, or organizations plan, carry out, and evaluate activities on a participatory and sustained basis with a resultant improvement in their conditions, either on their own initiative or stimulated by others. Community Mobilization is conducted by following some steps known as the Community Action Cycle which is a summary of all the activities needed to be carried out for mobilizing the community in order to ensure success in the implementation of a project. Community members are involved from the beginning and throughout the Community Action Cycle while other individuals and organizations from inside and outside the community provide technical and resource support to the community. The steps for the community mobilization action cycle are preparations for community mobilization, organization of actions for community mobilization, prioritization of needs, activities to be implemented known as the community action plans, monitoring of the plan or projects, and evaluation of the project conducted [22]. Key elements to be ensured during community mobilization include: community participation, setting up a good governance system, ensure accountability and peaceful behavioral change aimed at improving conditions and targets of the project conducted. These are effective in ensuring successful community mobilization and its benefits. For contraceptive use to be optimized there is a need to mobilize community members. Often, respected government officials and traditional/religious leaders who have interest in contraception are mobilized and deployed for supporting the activities. The use of retired and respected health workers within the community is also highly recommended and effective in addressing most of the myths and knowledge gaps that are associated with poor contraceptive use among most communities in low and middle-income countries.

3.2.3 Community engagement

Community engagement is central to any public health intervention, especially in services and products that some cultures show aversion towards. It involves the process of enabling a population at risk to be able to have the right knowledge and skills needed to respond appropriately to a given public health challenge.

Cavaye [23], defined community engagement as a mutual communication and deliberation that occurs between government/partners and its citizens that enables a mutual formulation of policy related to the provision of specific services [23]. This involves the participation of a community rather than an individual in decision-making process and implantation of various activities that are beneficial to the community taking into consideration the diversity and dynamic nature of its population. Community engagement is the process of working collaboratively with and through groups of people affiliated by geographic proximity, special interest, or similar public health challenge that needs to be addressed in order to improve the population's wellbeing [24]. It is a continuum, ranging from low-level engagement strategies such as consultation to high-level strategies such as empowerment [23, 24]. Engaging communities is therefore important to address the gaps in family planning activities. This can be actualized through women groups, civil society organizations, and community-based organizations that are conversant with contraceptives and the means for promoting their use within the community.

3.2.4 Advocacy

Advocacy operates at the political, social, and individual levels and works to mobilize resources and political and social commitment for social change and/or policy change. Resources can include political will and leadership as well as money to fund

the implementation of policies or programs. Advocacy aims to create an enabling environment at the community and society level with a focus on encouraging the use of a service by policymakers and those highly respected in society. For contraceptive use, strong advocacy at the government, institutional, and community level will make the needed difference.

3.3 Formative research and social and behavior change

Formative research is a systematic approach of inquiry and activities conducted before the commencement of a Social Behavior Change intervention. This research seeks to obtain insight into the health issue and specific behavior that a program aims to address. Formative research also seeks to identify relevant characteristics of primary and secondary audiences, the communication access available for the target population, existing habits and preferences of the people, and the various factors that hinder and/or drive behaviors within the community.

It is very important to conduct quantitative and qualitative research before the implementation of a Social and Behavior Change Communication program because without such research, it will be difficult to identify your intended audience, their current level of knowledge, the various health beliefs and attitudes, the channels through which they receive and act on information and the barriers to adopting new healthy behaviors needed for improving health and wellbeing of the population.

Formative research helps program planners to address the first three decisions in designing a Behavior Change Framework. This includes:

- Identification of feasible and effective behaviors to promote, prioritizing a few key behaviors (two or three), rather than many at the same time.

- Prioritization of the group(s) to be influenced for the behavior change. This involves the understanding of the priority group behavior and systematically developing a technique for influencing the behavior.

- Understanding the determinants of the behaviors including knowledge on the existing behaviors, knowledge on the benefits of purported behavior, the barriers towards the new behavior, and the socio-cultural context of priority groups. Researchers must decide what questions must be answered, who can provide the necessary information, how the information will be collected, and how the data will be analyzed and used to address the behavior of concern. A mixed approach involving first consulting quantitative research and then in-depth qualitative research with key informant interviews and focused group discussion is often recommended for obtaining detailed and comprehensive information on the barriers to contraceptive methods within the community.

3.4 Rationale for social and behavior change in contraception

Experience and several reports have shown that social and behavior change intervention is an effective means of scaling up contraceptive use. One of the studies that have demonstrated the implementation of this intervention is the landscape analysis demonstrated which clearly showed that social and behavior change is an essential component in achieving global development goals. The Social and Behavior Change in Family Planning Programming: Global Influence Strategy notes that "Increasing the

quality and quantity of SBC investments in FP programming will be critical for the Family Planning sector to reach its high-level goals of ensuring that 120 million additional individuals use contraceptive by 2020 and the third Sustainable Development Goal of ensuring universal access to sexual and reproductive health services and rights by 2030. Studies have shown that complementing investments in commodities and supplies with strong SBC campaigns yield higher usage." [25]. The Business Case for investing in SBC for FP shows that SBC increases the use of FP, provides a strong return on investment, and costs less than $200 per disability-adjusted life years averted [26]. This is very important in public health as it is economic and effective in actualizing the global goal of improved access for the sexual and reproductive health of women which is also key to their improved wellbeing across the globe.

3.5 Implementing the social and behavior change intervention

Social and behavior change intervention is a critical component of program design for positive impacts. USAID stated that improving the quality or coverage of health-care products and services alone is insufficient to improve the health and wellbeing of individuals, families, and society [22]. This is because the health-seeking behaviors of individuals and communities as well as their culture are known to influence the uptake of good services and products despite their availability, accessibility, and affordability.

Changing behavior to promote a positive attitude towards health becomes very important in programs like family planning where cultural factors have limited its utilization in low and middle-income countries. Hence the need for interventions that seek to change behaviors by addressing factors such as knowledge, attitudes, and norms, known collectively as social and behavior change interventions. These interventions often complement and enhance the role played by services such as health promotion and education for health care services like family planning, antenatal care, delivery in a skilled birth attendant, and postnatal care. Social and behavior change interventions are critical to ensure that populations that are most in need can access available services and products. This is often achievable through a well-planned and systematically implemented social and behavior change intervention that is based on formative research. Through social and behavior change interventions, various organizations have been able to raise awareness, reduce misinformation, and address barriers to various life-saving and health promoting interventions among individuals, families and communities. It is an important component of successful program implementation that often ensures a positive behavior change needed to influence a specific habit for great health outcomes.

An SBC approach is a strategic, interactive process that aims to change not only individual behaviors but also social conditions. It requires understanding the situation, designing a focused strategy, developing interventions and materials, implementing, monitoring, evaluating, and adjusting. The process allows program staff, communities, and other key stakeholders to approach a problem from various angles to define key determinants (both positive and negative) of behaviors and to plan and implement a well-planned, comprehensive set of interventions that focuses on these determinants at multiple levels to achieve a health objective.

Thus, for promoting contraceptive use through social and behavior change, a well plan strategic plan that is based on formative research which identified the barriers, mode of communication to the population, and tailored messages to address specific behaviors is the means for scaling contraceptive use among women in low and

middle-income countries like Nigeria where religious and cultural norms, as well as gaps in knowledge, continue to negate against the use of contraception among these populations. Addressing inequalities and promoting the right of women through advocacy, community engagement, community mobilization, and a social and behavior change communication approach that addresses barriers at the three levels of influence which include individual level, group, and societal level will be critical to achieving improved utilization of family planning methods despite existing oppositions from some quarters of the community.

At the individual and group levels, community health influencers and promoters can be used for a one on one and group sessions of educating individuals and families on the benefits of contraceptives and the methods available. Group sessions based on women to women support group with 5-15 members can be design to promote contraceptive use. This can be done during antenatal and post-natal care. It can also be done using a peer to peer meeting approach where contraceptives use and their importance is discussed and women are encouraged to use contraceptive methods of their choice that best suits their needs.

Advocacy visits to government, religious, traditional leaders and other key stakeholders in the community as well as the use of mass media to promote contraceptive use among women of reproductive age can go a long way in scaling up contraceptive use in low and middle income countries like Nigeria.

4. Conclusion

Contraception or birth control methods are an important component of the reproductive health and wellbeing of women across the globe that despite its benefits, utilization in most low and middle-income countries remain low. The implementation of a social and behavior change intervention based on formative research has been successful in most programs that promote contraceptive use among populations. This approach involves a well-planned social and behavior change communication with specific key messages that target the barrier to the utilization of the contraceptive method, community mobilization, community engagement, and advocacy made to obtain political support for the program. This comprehensive approach is highly recommended to actualize the benefits of contraception across all populations, countries, and continents in the globe.

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Chapter 4

The Knowledge and Use of Intra-Uterine Device by Women Attending Ante-Natal Clinic at Enugu State Teaching Hospital, Parklane

Chukwuasokam Caleb Aniechi and Uloma Cynthia Ezuma

Abstract

Intrauterine contraception has been recognized globally as one of the modern long-term reversible contraceptive methods suitable for women of all reproductive ages. It represents the most cost-effective method for preventing unwanted pregnancies, scientifically proven for its safety, efficacy and cost-effectiveness and is known to last longer in preventing pregnancy than other methods. This study assessed the knowledge of mothers attending ESUT teaching hospital, Parklane on intrauterine contraceptive device, the use as well as the common side effects experienced by the users. A descriptive survey research design was used to sample 175 mothers. A structured researcher developed questionnaire was used for data collection. The findings revealed that more than half of the respondents have good knowledge of intrauterine device but only 23 (14%) respondents make use of it. The commonly experienced side effects identified were irregular bleeding (75%) and vaginal discharge (62.5%). Although, the respondents had good knowledge of intrauterine device, their uptake of the method was poor. Therefore, there is a need to improve contraceptive counseling to ensure that women understand the relative effectiveness of IUDS. The study also recommended the need for better education for both clients and providers to improve the accessibility and acceptability of intrauterine device.

Keywords: knowledge, use, contraception, intrauterine device, women

1. Introduction

Approximately, two-thirds of the women worldwide use some form of contraception. The use of contraception is more prevalent in developed countries (72.4% of women) than in less developed countries (61.2% of women). Globally, 14.3% of women aged 15–49 years who are married or in a relationship use intrauterine contraception as the primary form of birth control [1].

It has been reported that globally, the intrauterine contraceptive device (IUD) has been recognized as one of the modern long-term reversible contraceptive methods

suitable for women of all reproductive ages. It represents the most cost-effective method for preventing unwanted pregnancies. Scientifically proven for its safety, efficacy and cost-effectiveness, the copper T380A and Levonorgestrel releasing IUD is known to be more effective and longer lasting in preventing pregnancy than pills, patches and contraceptive rings. It is the most widely used method of contraception with approximately 160 million users worldwide [2, 3]. Advantages of the IUCD include reversibility, long-term efficacy and confidentiality. It is also considered safe and effective for use in selected HIV-infected patients [4].

In areas of Northern Africa and Eastern and Central Asia, IUDs are inexpensive to manufacture and are widely used. In Australia and the US, the uptake is significantly lower. In these countries misunderstandings about the risks of IUC linger because an earlier device, the Dalkon Shield, was found to promote infection, and has tainted the perceptions of healthcare providers and the public about the safety of this method in general [5].

The underuse of the IUD largely results from the lack of knowledge and misconceptions of both health care providers and the public regarding the IUD. Several reasons why health care providers are reluctant to use the IUD have been cited, such as the fear of complications, namely pelvic inflammatory disease, ectopic pregnancy, infertility, sepsis, and death, all of which may lead to legal ramification [6].

Intrauterine contraception is convenient, safe and highly efficacious, and is recommended as a first-line option for all women, including adolescent and nulliparous women. Despite this recommendation, uptake is relatively low; only 5.6% of all contraceptive users and 3% of adolescents were using an intrauterine device (IUD) in a 2010 survey. Two reasons for this discrepancy have been proposed. First, many young women are unaware of the availability of IUDs; two studies found that fewer than 50% of adolescents and young women had knowledge of them. Second, despite evidence-based guidelines promoting their use and studies demonstrating their safety in nulliparous and adolescent women, many providers are still reluctant to recommend IUDs [7].

Several studies have shown that several factors account for the poor IUD use among women. These factors relate to healthcare provider characteristics, health system and individual or user factors. While these may be enough, sociocultural norms, beliefs and practices may serve to regulate IUD use even among high risk women or sub-groups particularly in Africa where there are entrenched sociocultural norms, beliefs and practices on childbirth [2].

Mbuthia et al. [8] noted that increasing IUD use is particularly important in sub-Saharan Africa, where family planning uptake is often motivated by women's desire to limit the number of births. Evidence from this region suggests that there is a large discrepancy between the proportion of women who want to limit the number of births and the proportion using long-acting and permanent methods such as the IUD, implying a large unmet need. Furthermore, the contraceptive provision in many sub-Saharan African countries has so far relied predominantly on short-term methods, such as oral pills, condoms and injectables.

IUDs are a highly effective form of contraception due to several mechanisms. The non-contraceptive benefits of hormonal IUDs include their use in heavy menstrual bleeding, dysmenorrheal, adenomyosis, endometriosis, endometrial hyperplasia and end stages of endometrial cancer in young patients.

Most of the side effects associated with IUDs are minor, which include abnormal uterine bleeding and pain. Complications with the placement of intrauterine devices include uterine perforation, expulsion, malposition in the uterus and migration of IUD into the abdominal cavity and viscera.

Although intrauterine devices pose some side effects and risks, IUDs are fairly easy to place making the intrauterine device an excellent form of long-acting reversible contraception [1].

1.1 Statement of problem

IUCD has established itself as an effective, reliable, and safe method of contraception with minimal complications. However, its acceptance remains low [9].

Gbagbo and Kayi [2] observed that IUCD is used by less than 2% of Ghanaian women in their reproductive age. Ghana's Demographic and Health Surveys (GDHS) have all shown very low IUD usage among both married and unmarried women.

Mbuthia et al. [8] also pointed out that the IUD represents only 0.7% of modern method contraceptive use in sub-Saharan Africa, revealing the under-use of this method of contraception in the region, despite it being such an important choice for women elsewhere.

Following the findings made by different researchers, it can be said that the utilization of IUD is very low in other African countries. However, there is insufficient information regarding its knowledge and use among women in Nigeria, therefore, the researchers wish to find out the knowledge and use of intrauterine device among women attending antenatal clinics in ESUT Teaching Hospital Parklane, Enugu.

2. Research methodology

This chapter deals with the methods and techniques used for this research work.

2.1 Research design

A descriptive survey research design was selected for this study.

2.2 Area of the study

The area of the study is the Enugu State University Teaching Hospital, Parklane, Enugu. It is located in the Government Reserved Area (G.R.A). The hospital was established in 1952, became a specialist hospital in 2005 and a teaching hospital in May 2006. It is the only tertiary hospital owned by the state government. Geographically, on the North, it is bounded by the polo park shopping mall (shoprite), bounded by Christ the King Catholic Church on the South, bounded by solid FM radio station on the West and on the East by New Market.

2.3 Population of the study

The target populations for this study are women attending the antenatal clinic of Enugu state university of science and technology Parklane.

2.4 Sample size

The sample size was statistically determined using the Taro Yamane formula. On monthly basis, an average of 1194 women visit the clinic, 312 women visit weekly and

an average of 49 women visit daily. A sample size of 175 was derived using this formula. (Source: Antenatal Unit Daily Attendance Records from March to April; 2020)

$$n = \frac{n}{1 + N(d)} \tag{1}$$

where n = sample size, N = the population size, d = the level of precision (assumed to be 0.05 at 95% confidence level).

where N is 312

$$n = \frac{312}{1 + 312(0.05)^2} \tag{2}$$

$$n = \frac{312}{1 + 312(0.0025)} \tag{3}$$

$$= \frac{312}{1 + 0.78} \tag{4}$$

$$= \frac{312}{1.78} \tag{5}$$

$$n = 175.3 \tag{6}$$

$$n = 175 \text{ women}$$

2.5 Sampling technique

Convenience sampling technique was used for this study.

2.6 Instrument of data collection

The instrument for data collection was a well-structured researcher developed questionnaire. The questionnaire was developed based on the research objectives and was divided into four sections. **Section A** contained questions on demographic data, **Section B** contained questions on knowledge of intrauterine device. **Section C** contained questions on the use of intrauterine device and **Section D** contained a question on the common side effects of the use of intrauterine device.

2.7 Validity and reliability of instrument: Face and content validity

A pilot test was conducted using 10% was carried out at Polyclinic and Uwani cottage hospital. The reliability of the study was determined using Pearson's formula and a reliability of 0.8 was gotten.

2.8 Ethical considerations

The following ethical issues were considered while carrying out the research work. A letter of introduction was obtained by the researcher from the Head, department of nursing sciences UNEC; a letter of ethical clearance was obtained from the Chief Medical Director of ESUTTH Parklane permitting the researcher to share the questionnaire among the women attending the antenatal clinic. The nursing service department was notified about the ongoing research. The researcher explained the

research process to the respondents and obtained verbal consent before giving out the questionnaires to them. Respondent's personal information was kept confidential and anonymous. The principle of voluntary participation was applied to recruit participants for the research. All the authors whose works were used for this study were cited and referenced properly.

2.9 Method of data analysis

Questionnaires were collected and counted to ensure they are complete. Data collected were analyzed using descriptive statistical methods like tables, frequencies and percentages.

3. Presentation of data

This chapter deals with the presentation of results derived from the responses to the questionnaire administered. Data analysis was done based on the objectives of the study. A total of 175 copies of questionnaire were administered and 164 of the total questionnaire were properly filled and returned making a return rate of 93.7%.

3.1 Demographic data

Table 1 shows that the age distribution of the respondents was slightly varied with a mean age of 37.06 ± 7.34 and respondents aged between 35 and 44 years were comparatively higher (53.0%). Findings under educational qualification revealed that majority 91 (55.5%) had attained tertiary level of education, 48 (29.3%) had secondary education and 25 (15.2%) had primary education. 66 (40.2%) of the respondents were public workers, 52 (31.7%) were self-employed, 28 (17.1%) were unemployed, and 18 (11.0%) were private formal workers. Majority of the respondents, 161 (98.2%) were Christians while minority 3(1.8%) were Islams. Based on ethnicity, 143 (87.2) belonged to Igbo tribe, 14 (8.5%) were from other tribes, 5 (3.1%) were Yorubas while 2 (1.2%) were Hausas. Lastly, 90 (54.9%) have 3 and above living children, 48 (29.3%) had 2 living children, 17 (10.3%) had one living child while 9 (5.5%) had no child.

3.2 The knowledge of intrauterine device (IUD) among women attending antenatal clinic in ESUT teaching hospital, Parklane

Table 2 shows that 121 (73.8%) of the respondents have heard about intrauterine contraceptive device. They identified their sources of information to include Friends 45 (37.2%), Doctor 34 (28.1%), Nurse 29 (24.0%) and Media/book 13 (10.7%). In addition, 84 (69.4%) of the study participants are aware that the facility offers intrauterine device services.

3.3 The use of intrauterine device (IUD) among women attending antenatal clinic in ESUT teaching hospital, Parklane

The most common family planning method used by 40.2% of the respondents was male condom. Less commonly, other methods identified include: intra uterine device (14.0%), natural method (12.2%). Oral pills (9.8%), injectable (6.7%), implant (4.3%) and female condoms (1.8%). However, 11% of the respondents used no method of

Category	Options	Frequency	Percentage (%)	Mean ± SD
Age	15–24	7	4.3	37.06 ± 7.34
	25–34	48	29.3	
	35–44	87	53.0	
	45 and above	22	13.4	
Educational qualification	Primary	25	15.2	
	Secondary	48	29.3	
	Tertiary	91	55.5	
Occupation	Unemployed	28	17.1	
	Self-employed	52	31.7	
	Public worker	66	40.2	
	Private formal worker	18	11.0	
Religion	Christian	161	98.2	
	Islam	3	1.8	
	Pagan	-	-	
Tribe	Igbo	143	87.2	
	Hausa	2	1.2	
	Yoruba	5	3.1	
	Others	14	8.5	
Number of live births	0	9	5.5	
	1	17	10.3	
	2	48	29.3	
	3 and above	90	54.9	

Table 1.
Socio-demographic characteristics of the participants, n = 164.

Variable	Options	Frequency	Percentage (%)
Have you ever heard about intrauterine contraceptive device?	Yes	121	73.8
	No	43	26.2
What is the source of your knowledge?	Doctor	34	28.1
	Nurse	29	24.0
	Friends/relatives	45	37.2
	Media/book	13	10.7
Are you aware that the facility offers intrauterine device services?	Yes	84	69.4
	No	37	30.6

Table 2.
The knowledge of intrauterine device (IUD) among women attending antenatal clinic in ESUT Teaching Hospital, Parklane, n = 164.

family planning. The majority (55.5%) of the respondents have used their identified method for 6 months to 1 year. The reasons for using identified by the majority of the respondents include: quick reversal on removal (52.2%) and long lasting (60.9%). Other reasons were effectiveness (39.1%), does not interfere with intercourse (26.1%), recommendation by a clinician (21.7%), does not interfere with breastfeeding (17.4%), does not contain hormone (13.0%), spousal support (13.0%) and non-detectible by spouse (4.3%). Furthermore, over an average number (56.5%) of the respondents would recommend intrauterine device to other women.

3.4 The common side effects faced by women who use IUD

The opinions of the respondents on the side effects of IUD they face showed that 65.2% did not experience any side effects associated with the use of IUD while 34.8% found side effects associated with its use. The commonly experienced side effects identified were irregular bleeding (75.0%) and vaginal discharge (62.5%). Others include heavy menstrual bleeding (25.0%), abdominal cramps (25.0%) and pelvic pain (12.5%).

4. Discussion of findings

The study examined the knowledge and use of intra uterine device by women attending antenatal clinic of Enugu State Teaching Hospital, Parklane, Enugu.

73.8% of the respondents have heard about IUD. The highest number of the study participants identified friends/relatives (37.2%) as their source of information and 69.4% are aware that the facility offers intrauterine device services. This can conclusively be interpreted as a good level of knowledge on the part of the respondents. The tertiary level of education attained by the majority of the respondents may have been contributory to their level of knowledge. This goes in line with the results of the work by Eastman [10] which showed that only 12% of participants did not know what an IUD is. Contrary to the present study, 50% of the respondents learned about IUDs from professionals (including physicians, nurses and teachers) according to Eastman [10]. However, this finding disagrees with the work Sharma and Pal [11], whose results showed that regarding knowledge on different aspects of IUD, less than half of the study population (44.8%) had good knowledge regarding IUD. Also in disagreement is the findings by Westhuizen and Hanekom [4] which revealed that only 49.2% reported having heard about IUD.

Their good level of knowledge did not translate into a good usage as their level of usage was poor. Among all family planning methods enlisted, IUD was used by only 14.0% of the respondents. Of this proportion, 56.5% would recommend IUD to other women. These findings can be comparable with that of Mbuthia et al. [8] which noted that knowledge of IUD did not affect its uptake by participants as only 30 women were using IUD as a contraceptive method. These results were also found to be in concordance with that of Igwe [12] where the uptake rate of IUD was 13.2%. The major reasons for use identified were long lasting (60.9%) and quick reversal on removal (52.2%). These findings conform to the submissions of Bryant et al. [13], where almost all women mentioned multiple benefits of the IUD which included being long lasting, reversible and convenient. Similarities in the result were noted by Gbagbo and Kayi [2] where the respondents said their reason for IUD was their desire for long-acting family planning method (24%). Gomez and Freihart [14], in their

study also identified that the study participants who chose IUD gave their reasons to be: ease of use, lack of requisite maintenance, effectiveness, long lasting, reduces cramps and makes period lighter and easily reversible.

Only 34.8% found some side effects associated with its use. The commonly experienced side effects identified were irregular bleeding (75.0%) and vaginal discharge (62.5%). The findings of this present study support that of Olamijulo et al. [15] whose results revealed that 32.6% of the IUCD users experienced some form of undesirable effects in association with its use. The most common undesirable effects reported by the clients were abnormal vaginal discharge (40.8%) while the least was dyspareunia (0.7%). Also slightly comparable is the findings of Igwe [12] which also showed that 7.8% of the clients had side effects that include abdominal pain (44.4%), menorrhagia (22.2%).

5. Implication for nursing

Practicing nurses/midwives are ideally placed to take a prominent role in advising clients and providing them with their chosen method of contraception. They cannot be expected to deliver a service if they are not adequately skilled and familiar with the most up-to-date clinical guidelines and national standards on IUD use and sexual health. To this end, education and training must be viewed as a fundamental aspect of effective and sustainable health service planning and delivery, ensuring that patients continue to receive the highest standards of care.

6. Limitations

Limitations to the study included the following: the high cost of printing questionnaires, reluctance of some respondents to fill the questionnaire as well as the physical stress associated with going to the hospital for data collection. In addition, the study focused on the urban population who are more affluent and better-educated women have the means and, based upon this study, are more likely to be knowledgeable about IUDs than the general population and cannot be generalized for the rural women.

7. Summary

This study was carried out to assess the knowledge and use of intra uterine device among women attending antenatal clinic in ESUT Teaching Hospital Parklane, Enugu. The objectives of this study were set and research questions formulated from them and both were according to the purpose of the study. Literature were reviewed ranging from conceptual and theoretical framework to empirical studies based on the research questions that were drawn. A descriptive survey method was adopted for the study and data was collected using a structured questionnaire. The data generated were statistically analyzed based on the research objectives and presented in **Tables 1**–**4**. Several findings were subsequently made. The knowledge of the respondents on IUD was good as more than an average number of the respondents have ever heard about intrauterine contraceptive device with friends and doctors being their main source of information. The results further showed that of all family planning methods, only 14% of the respondents used IUD and the major reasons identified were

Variable	Options	Frequency	Percentage (%)
What family planning method do you use currently?	None	18	11.0
	Intrauterine device	23	14.0
	Implant	7	4.3
	Oral pills	16	9.8
	Injectable	11	6.7
	Male condoms	66	40.2
	Female condoms	3	1.8
	Natural method	20	12.2
	Tubal ligation	–	–
	Vasectomy	–	–
How long have you used this family planning method?	Less than 6 months	14	8.5
	6 months to 1 year	91	55.5
	2 years to 5 years	47	28.7
	Above 6 years	12	7.3
What are your reasons for using intrauterine device? (multiple responses)	Does not contain hormone	3	13.0
	I consider it to be very effective	9	39.1
	It is relatively inexpensive	5	21.7
	Quickly reversible on removal	12	52.2
	Does not interfere with breastfeeding	4	17.4
	The clinician recommended it	5	21.7
	My spouse supported it	3	13.0
	I want a method that cannot be detected by	1	4.3
	My spouse		
	Lasts for a very long time	14	60.9
	Does not interfere with intercourse	6	26.1
Would you recommend Intrauterine device for other women?	Yes	13	56.5
	No	10	43.5

Table 3.
The use of intrauterine device (IUD) among women attending antenatal clinic in ESUT Teaching Hospital, Parklane, n = 164.

long lasting and quick reversal on removal. More than half of the respondents agreed that they would recommend IUDs to other women. The opinions of the respondents on the side effects of IUD showed that only 34.8% had side effects with its use. The

Variable	Options	Frequency	Percentage (%)
*Did you notice any side effects from using intrauterine device?	Yes	8	34.8
	No	15	65.2
If yes to*, What are the common side effects from using intrauterine device? (multiple responses)	Heavy menstrual bleeding	2	25.0
	Pelvic pain	1	12.5
	Dysmenorrhea	–	–
	Dyspareunia	–	–
	Vaginal discharge	5	62.5
	Abdominal cramps	2	25.0
	Irregular bleeding	6	75.0

Table 4.
The common side effects faced by women who use IUD, n = 23.

commonly experienced side effects identified were irregular bleeding and vaginal discharge.

Based on the findings, a conclusion was drawn, recommendations, suggestion for further studies were proffered as well as the implication of the study to Nursing.

8. Conclusions

IUD is a safe, effective form of contraception whose widespread use could decrease the high rate of unintended pregnancies across the globe. However, it remains one of the least utilized family planning services. Even though, the majority of the respondents had good knowledge of IUDs, their uptake of IUDs was poor. This study has exposed a need to improve on contraceptive counseling to ensure that women understand the relative effectiveness of IUDs. Hence, when discussing contraception with women, health care practitioners should discuss the risks and benefits of IUD with women of reproductive age and recommend them as a first-line method.

9. Recommendations

Though their knowledge of IUD was good, there still lies a need for improvement in its use among women by healthcare professionals and policy makers. The researcher, therefore, recommends that:

1. Better education of both clients and providers is essential to improve accessibility and acceptability of the IUD. The IUD needs to be promoted and clients must be made aware of the availability of this option, while providers need to explore the opportunities to update their knowledge and skills to deliver an effective service.

2. The dispersion of accurate information addressing women's beliefs & concerns is crucial to the continued use and growing acceptance of this beneficial method.

3. Increased training and on-the-job support for providers would increase women's willingness to recommend the method, thus stimulating demand.

4. All levels of government and concerned organizations should carry out aggressive campaigns using print and electronic media, outreach programs, and rallies to achieve better awareness and use of IUD.

10. Suggestion for further studies

The researcher hereby suggests that a similar study should be carried out in other health care institutions in the state and within the south-eastern zone to compare results. Also, studies should be conducted to assess the barriers to/factors influencing the use of IUD among women of child bearing ages presenting in health care facilities.

A. QUESTIONNAIRE

Instruction: please tick √ in the appropriate box
Section A: Demographic data

1. Age:

    a. 15–24 [ ]

    b. 25–34 [ ]

    c. 35–44 [ ]

    d. 45 – above [ ]

2. Highest educational level:

    a. Primary [ ]

    b. Secondary [ ]

    c. Tertiary [ ]

    d. Others specify_____

3. Occupation:

    a. Unemployed [ ]

    b. Self-employed [ ]

    c. Public worker [ ]

    d. Private formal worker [ ]

4. Religion:

    a. Christianity [ ]

    b. Islam [ ]

    c. Pagan [ ]

    d. Others Specify_____

5. Tribe:

    a. Igbo [ ]

    b. Hausa [ ]

    c. Yoruba [ ]

    d. Others Specify_____

6. Number of live births:

    a. 0 [ ]

    b. 1 [ ]

    c. 2 [ ]

    d. ≥ 3 [ ]

Section B: Knowledge of intrauterine device

7. Have you ever heard about intrauterine contraceptive device?

    a. Yes [ ]

    b. No [ ]

8. What is the source of your knowledge?

    a. Doctor [ ]

    b. Nurse [ ]

    c. Friend/relatives [ ]

    d. Media/book [ ]

    e. Others Specify_____

9. Are you aware that the facility offers intrauterine device services?

    a. Yes [ ]

    b. No [ ]

Section C: Use of intrauterine device

10. What family planning method do you use currently?

    a. None [ ]

    b. Intra uterine device [ ]

    c. Implant [ ]

    d. Oral pills [ ]

    e. Injectables [ ]

    f. Male condoms [ ]

    g. Female condoms [ ]

    h. Natural method [ ]

    i. Tubal ligation [ ]

    j. Valsectomy [ ]

11. How long have you used current family planning method?

    a. Less than 6 months [ ]

    b. 6 months to 1 year [ ]

    c. 2 years to 5 years [ ]

    d. Above 6 years [ ]

If your answer to number 10 is intrauterine device continue question **12**

12. What are your reasons for using intrauterine device? **NB:** Tick as many that apply.

    a. Does not contain hormone [ ]

    b. I consider it to be very effective [ ]

    c. It is relatively inexpensive [ ]

d. Quickly reversible on removal [ ]

e. Does not interfere with breastfeeding [ ]

f. The clinician recommended it [ ]

g. My spouse supported it [ ]

h. I want a method that cannot be detected by my spouse [ ]

i. Lasts for a very long time [ ]

j. Does not interfere with intercourse [ ]

13. Would you recommend intrauterine device for other women?

a. Yes [ ]

b. No [ ]

Section D: Common side effects of intrauterine device

14. Did you notice any side effects from using intrauterine device

a. Yes [ ]

b. No [ ]

15. What are the common side effects from using intrauterine device? **NB:** Tick as many that apply

a. Heavy menstrual bleeding [ ]

b. Pelvic pain [ ]

c. Dysmenorrhea [ ]

d. Dyspareunia [ ]

e. Vaginal discharge [ ]

f. Abdominal cramps [ ]

g. Irregular bleeding [ ]

h. Infection [ ]

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Section 3

Contraception

Chapter 5

Contraceptive Implants

Paul Hassan Ilegbusi

Abstract

Contraceptive implants or implantable contraceptive are five subdermal implants, rods the size of pencil lead that are embedded just under the skin on the inside of the upper arm. The rods contain etonogestrel, the metabolite of desogestrel, an equivalent progestin. Implants are often used during breastfeeding without an impact on milk production. It was identified that age does not affect the use of contraceptive implants but educational status is significant to its usage; there is an association between the age at first birth and the use of contraceptive implants; the number of liveborn children has a significant impact or influence on the use of implants; etc. This chapter focuses on types of contraceptive implants and its mechanism of action; global statistics on contraceptive implants; side effects; health benefits and positive characteristics of contraceptive implants; those who can and cannot use contraceptive implants; reasons women are not interested in contraceptive implants and factors influencing its usage.

Keywords: amenorrhoea, desogestrel, dysmenorrhoea, etenorgetrel, implanon, jadelle, levonorgestrel, norplant, progestin, sinoplant-II

1. Introduction

Contraception is the act of preventing pregnancy by interrupting the chains of events that lead to conception. It is very paramount in reducing the risk of unintended pregnancies and their attendant complications. It has been estimated that of the 210 million pregnancies that occur annually worldwide, about 80 million (38%) are unplanned, and 46 million (22%) end in abortion. Unintended unprotected intercourse is the primary cause of unwanted pregnancies, and many women with unwanted pregnancies decide to end them by abortion, which is most unsafe. Wider uptake of long-acting reversible contraceptive (LARC) methods is predicted to scale back the high rate of unintended pregnancy [1].

LARCs are defined within the UK National Institute for Health and Care Excellence guideline as contraceptive methods that need administration but once per cycle or month. Included within the category of LARCs are progestin-only contraceptive implants and other methods. Contraceptive implants are progesterone-only contraception that is inserted subdermally or within the skin. They are readily reversible with a return to fertility within days of removal. Moreover, these contraceptive devices are often safely placed within the immediate postpartum period, ensuring good contraceptive coverage [2].

In the same vein, contraceptive implants are subdermal contraception involving the delivering of a steroid progestin from polymer capsules or rods which are

inserted under the skin. The hormone diffuses gradually and slowly at a stable rate, providing effective contraception within five (5) years. The safe period depends upon the precise progestin and therefore, the sort of polymer. The advantages of these implants includes the long term contraceptive action, low dose of highly effective contraception, and quick reversal to fertility after the removal of implants [3].

Furthermore, it is recorded that contraceptive implants are safe, highly effective, and long-term methods of contraception that are widely applicable to any reproductive-aged woman. Implanon is currently approved for three (3) years of use, provides excellent efficacy throughout its use, and is straightforward to insert and remove. Implants require minimal user compliance and are cost-effective. Implanon has been shown to be safe to use during lactation, may improve dysmenorrhoea (painful menstruation), and does not significantly affect bone mineral density, lipid profile, or liver enzymes. The progestin-only implants are safe options for various women including adolescents, postpartum (after birth), breastfeeding, those that are medically complicated, or those that have contraindications to or intolerance of oestrogen-containing contraceptives.

In addition, contraceptive prevalence rate is the percentage of women (15–49 years) who are in union using any type of contraception either traditional or modern. The unmet need for family planning is the ratio of women (15–49 years) not using any contraceptive methods but are either married or in a union, and who are sexually active and able to give birth to children, but do not want children again, or would really prefer to space the birth of another baby for at least two years [4, 5].

This chapter focuses on types of contraceptive implants and its mechanism of action; the side effects of contraceptive implants; health benefits and positive characteristics of contraceptive implants; those who can and cannot use contraceptive implants; reasons women are not interested in implants and factors influencing its usage.

1.1 Types of contraceptive implants and outline

The historical background of the contraceptive implants shows that Norplant was the earliest implant and it had been first produced in Finland in 1983 with a 5-year lifespan. It contained six rods, each containing levonorgestrel (LNG). Continuing research centered on reducing the amount of units to facilitate easier insertion and removal led to its successor, Norplant-2 or Jadelle (two-rod implant), which was approved within the U.S. in 1996 but its production was discontinued globally in 2008. Implanon was launched in 1999 as one rod of etonorgestrel, with contraceptive efficacy of three (3) years. Its successor, Implanon NXT (Nexplanon), with a redesigned applicator to ease its insertion, was introduced in 2010. It is replacing Implanon in many countries. Other implants like NesteroneTM and CapronorTM, consisting of various progestins, biodegradable rods, pellets, and microcapsules remain in development. Advancement during this area has also produced male contraceptive implants MENT acetate that contains 7α-methyl-19-nortestosterone, although still undergoing approval processes [1].

In view of the above records, the following are the identified kinds of implantable contraceptives [1, 6]:

i. **Norplant:** The Norplant contraceptive implant consists of six silastic capsules, each contains 36 mg of LNG (levonorgestrel), and when inserted under the

skin, provides endless release of LNG at the rate of 30 mcg/day. It provides protection against pregnancy for 5–7 years. The associated pregnancy rate varies between 0.2 and 1.3 per 100 women-years. Its use and acceptability was hampered by the six rods with associated difficult insertion and removal, which led to its abandonment in many countries. This was discontinued in 2008 and is not any longer available for insertion.

ii. **Norplant-2 (Jadelle/Sinoplant-II):** This method comprises two-rod silastic implants each measuring 43 mm long and a couple of 2.5 mm in diameter. Each rod contains 75 mg of LNG levonorgestre) with a calculated mean daily in vivo release rate of about 100 μg/day at the first month, followed by a gradual decline to about 40 μg/day at 12 months, and to about 30 μg/day at 24 months, with stabilisation thereafter at about 30 μg/day. Jadelle was initially licenced for 3 years; this has been extended to five years in most countries. Levoplant (Sino-implant ll) is licenced for 4 years. Jadelle has been extensively evaluated, along side its predecessor Norplant, and had been found to be safe and highly effective.

iii. **Nexplanon (Implanon NXT):** These are single-rod contraceptive implants with special applicator for easier and safe insertion. Each rod measured 40 mm × 2 mm, it is embedded with 68 mg of etonorgestrel (formerly called 3-ketodesogestrel) and covered by a 0.6 mm rate-controlling ethylene-vinyl acetate membrane. Nexplanon also contains 15 mg barium sulphate, making the rod radiopaque and this aids easy removal. It is as effective as Implanon. This has replaced the Implanon in most developed countries. It is labelled for up to three (3) years of use (a recent study shows it is going to be highly effective for five years). Implanon NXT are often seen on X-ray and has an improved insertion device.

iv. **Implanon:** It is recorded that implanon may be a subdermal contraceptive that is effective for three (3) years. The single-rod implant, which is inserted on the inner side of the woman's upper arm, contains etonogestrel (ENG), a progestin. Implanon may be a non-biodegradable implant, which contains 68 mg of etonogestrel. The rod features a length of 40 mm and a diameter of 2 mm. A daily release rate of roughly 30 μ getonogestrel inhibited ovulation within the majority of women of childbearing age and within eight hour (8 hr) of insertion, etonogestrel levels are sufficient to supply contraceptive protection. Endless release of etonogestrel is maintained for three (3) years. Within one (1) week after removal, etonogestrel is not any longer detectable in human serum. Implanon is easier to insert and remove than the initial or former six-capsule levonorgestrel implant (Norplant). Implanon functions to prevent or delay pregnancy by suppressing and/or interrupting ovulation and thickening of the cervical mucus which hinders sperm penetration. Etonogestrel is processed by the liver though hepatic-enzyme inducers and some anti-epileptic substances may interfere with the effectiveness of contraceptives. The side effects included bleeding irregularities frequently occur during the beginning of several months after insertion; amenorrhoea becomes more common with increasing duration of use. Other symptoms include emotional lability, weight increase, headache, depression, dysmenorrhoea and acne. The effectiveness rates approach is 100% [1, 7].

This contraceptive is acceptable for women (14–49 years) who desire long-acting reversible contraception (LARC). It must be removed and replaced every three (3) or five (5) years. Ovulation returns within three (3) to six (6) weeks after the removal of Implanon. Implantable contraceptives provides no protection against Sexually Transmitted Infections (STIs) or Human Immunodeficiency Virus (HIV) [7].

v. **Capronor:** This is a biodegradable polymer system for the sustained subdermal delivery of contraceptive steroids. Capronor is a 4-cm rod made from a polycaprolactone capsule containing 21.6 mg of LNG (levonorgestrel). It provides 1-year contraception, but it is not currently in routine use.

vi. **Nestrone:** This is a single-rod implant containing 93 mg of nestrone (16-methylene-17-acetoxy-19 norprogesterone), which releases about 40 μg of nestrone per day. Duration of effectiveness is 2 years.

vii. **MENT (Subdermal Implants for Men):** Male contraceptive methods under development at the population council believe MENT acetate (7α-methyl-19-nortestosterone), a year implant that is placed under the skin of the upper arm of the intending male user. MENT is made from an artificial steroid that resembles testosterone. If approved by regulatory authorities, MENT would be the leading long-acting reversible male contraceptive [1, 7].

1.2 The mechanism of action of contraceptive implants

The progestin-containing implantable contraceptives inhibit ovulation and restrict sperm penetration through sticky cervical mucus. This is done as a result of the antiestrogenic actions of the progestins, which affect the cervical mucus by making it sticky or glutinous, scanty, and impassable to sperm therefore preventing or hindering fertilisation of the ovum. High doses of progestins also prevent gonadotropin secretion, thereby halting the maturation of the follicles and ovulation. This double effect allows the efficacy and effectiveness of implantable contraceptives to be maintained though ovulation is not consistently altered in etonorgestrel implantable contraceptive users towards the end of the 3-year period of use. Oocytes are not fertilised even if the follicles grow while using progestin implantable contraceptives. Even if the follicle ruptures, the abnormalities of the ovulatory cycle or phases prevent the release of a viable ovum or egg. Although progestin suppresses endometrial activity, this is often not a contraceptively significant effect since the most mechanisms of action prevent fertilisation. There has never been any signs of embryonic development found among contraceptive implant users, showing that progestin implants are not medication or substances that cause pregnancy to terminate prematurely. Implants are simpler, easier and safer to use than other contraceptive methods because they do not require regular action by the user [8].

1.3 Advantages of contraceptive implants

The following advantages of contraceptive implants had been identified [9, 10]:

i. High effectiveness of up to 99 percent within seven days of implant insertion;

ii. Very inexpensive method of longterm contraception, like intrauterine devices;

iii. It is convenient to use or adopt by all women of childbearing age (i.e. from age 14–49 years);

iv. It is very safe for women of childbearing age;

v. It is very efficacious for three years;

vi. It could be easily removed when pregnancy is expected by women;

vii. It provides continous contraception;

viii. The anonymity of use is provided;

ix. It is safe during breastfeeding period for women;

x. It relieves excessive and difficulty menstruation in some women;

xi. Amenorrhoea which is experienced in some women using contraceptive is often perceived to be a benefit;

xii. It reduces the risk of pelvic inflammatory disease in women;

xiii. It is good for conditions which prevent the use of combined hormonal contraceptive;

xiv. There is quick return of fertility after the removal of contraceptive implant;

xv. Some women experience improvement in acne following the use of the implant; and

xvi. Some protection against endometrial cancers.

1.4 Disadvantages of contraceptive implants

The following are the disadvantages of contraceptive implants [9, 10]:

i. There is no protection against sexually transmitted infections (STIs) when using contraceptive implant;

ii. There is a contra-indication with anticonvulsants, some antibiotics, or St. John's wort;

iii. It does not proffer immediate protection when inserted, hence, another type of effective contraceptive must be used for at least seven days following the insertion;

iv. It has some nauseating side effects;

v. It diminishes sexual pleasure in some frigid women; and

vi. It encourages promiscuity in some sexually active women.

1.5 The side effects of contraceptive implants

The side effects of implants include the following: changes in bleeding patterns, including (a) lighter bleeding and fewer days of bleeding; prolonged bleeding; irregular bleeding; infrequent bleeding; and no monthly bleeding (within a year period); (b) lighter bleeding and fewer days of bleeding; irregular bleeding; infrequent bleeding; and no monthly bleeding (after a year period); (c) users of Implanon and Implanon NXT are more likely to experience infrequent bleeding, prolonged bleeding, and/or no monthly bleeding than irregular bleeding; (d) other side effects are: headaches; abdominal pain; acne (can improve or worsen); weight change; breast tenderness; dizziness; mood changes; nausea; and enlarged ovarian follicles. The bleeding changes are normal and are not harmful. It also included skin atrophy at the site of insertion; impalpable implants; neurovascular injury; fractured implants; and abnormal uterine bleeding, as the risks or side effects of contraceptive implants [1, 6].

1.6 Health benefits of contraceptive implants

The benefits of implantable contraceptives are: it helps protect against risks of pregnancy, including ectopic pregnancy; it protects against symptomatic pelvic inflammatory disease; it is going to help protect against iron-deficiency anaemia; and it reduces the risk of ectopic pregnancy. Contraceptive prevents pregnancy; reduces unintended pregnancy and abortion; reduces pregnancy-related morbidity and mortality; improves birth outcomes; helps women and couples time and space their pregnancies; improves maternal health behaviours; reduces cancer risk; improves mental health-related outcomes; and treats menstrual-related symptoms and disorders [6, 11].

Furthermore, it was discovered that the use of contraceptive implants brings harmony between the couples, which invariably promotes their mental health; and contraceptive implants are the most cost-effective method of family planning because it prevents unintended pregnancies and abortion among women of childbearing age [10].

1.7 Positive method characteristics of contraceptive implants

It had been postulated in some studies that contraceptive implants is safe; highly effective; it is convenient; it facilitates harmony between the couples. In the same vein, implants have many positive characteristics that contribute to their rapidly rising popularity [10, 12]:

i. Implants can be quickly, safely, and easily inserted by medical and community health workers.

ii. Whichever contraceptive implant a client chooses, women can be assured with highly effective contraception for up to five (5) years.

iii. Implants have the highest effectiveness of all methods.

iv. Implants do not entail pelvic examination or abdominal surgery (like intrauterine devices (IUDs) and feminine sterilisation).

v. Removal is typically a fast and uncomplicated procedure.

vi. There is prompt return to fertility.

vii. Implants are appropriate for limiting further births.

viii. Implants generally have high client satisfaction, as implied in their high continuation rates.

ix. Implants provision requires less health system infrastructure and less-highly trained staff than other provider-dependent clinical methods.

1.8 Those who can and cannot use contraceptive implants

It has been stated that almost all women of childbearing age can use implantable contraceptives safely and effectively, including women who: (a) have or have not had children; (b) are married or unmarried; (c) are of any age (e.g. adolescents and women over 40 years old); (d) have just undergone an abortion, miscarriage, or ectopic pregnancy; (e) smoke cigarettes; (f) are breastfeeding; (g) have anaemia; (h) have varicositis; (i) and are living with HIV [6].

In furtherance to the above reports, implantable contraceptive should be considered for women who: (a) desire a long-acting and highly effective contraception; (b) experience serious or minor side effects of eostrogen and/or eostrogen-progestin contraception; (c) are interested in a contraceptive method that does not require continous adherence; (d) love a non-coitus-related type of contraceptive; (e) have completed childbearing but not ready for permanent sterilisation; (f) have a history of anaemia with abnormally heavy bleeding at menstruation; and (g) have chronic illnesses which threaten pregnancy [8].

However, contraceptive implants should not be considered for women: known or suspected of pregnancy; having current or past history of thrombosis or thromboembolic disorders; having hepatic tumour or active liver disease; having undiagnosed abnormal genital bleeding; having known or suspected breast cancer or history of breast cancer; and having hypersensitivity to any component of the method [8].

1.9 Factors influencing the acceptance of contraceptive implants

Some studies identified the demographic factors influencing the use of contraceptive as age; parity; marital status and marriage type e.g. polygamy has been associated with lower levels of contraceptive use. A study from Northeast Nigeria reported that women in polygamous unions are less likely to use contraceptives compared with women in monogamous unions. Polygamy, when coupled with youthful age at marriage and with a wide differences in age between spouses, may inhibit husband-wife interactions and perpetuate male dominance within the marriage. This was in line with the study carried out in Ethiopia that showed that woman's age, number of children alive, couple's intention for more children and discussions about contraceptive use among the couple were significantly associated with demand for modern contraceptives among women. Also, it was agreed that religion, education status and age at marriage were significantly associated with contraceptive usage. Furthermore, in a study, it was discovered that age does not affect contraceptive implants use; educational status is significant to the usage of contraceptive implants; there is an association between the age at first birth and the use of contraceptive implants, which indicates that age at first birth influences the use of contraceptive implants;

and the number of liveborn children has a significant impact or influence on the use of implants. A study also indicates that any categories of women of childbearing age could use or utilise contraceptive implants [10, 13–15].

It has been stressed that age of women, the level of education of women, the religion of women, marital status of women, health care visits during antenatal care and childbirth were significantly associated with the use of any contraceptive method [16].

It had been discovered that socio-demographic factors may be alleviated by biological and behavioural factors, such as sexual activity, fecundity and desire for children. African societies as pro-natalist, believe that children are a gift from God and as such are social and economic investments; this has undesirable influence on the use of contraceptives. Studies have found that an inverse relationship exists between the number of living children and use of modern contraceptives. Evidence from variety of nations has pointed towards the partner's disapproval and his desire for more children as key factors for non-use of contraception [13].

Furthermore, it has been stressed that there has been found a strong relationship between women's education, especially completed primary education and entry into secondary level, and fertility reduction. Several studies have reported that women's education has a strong positive impact on contraceptive use). In Nigeria, education has been found to increase contraceptive use. Nigerian women with tertiary level education are one-and-a-half times more likely to have ever used contraception than women with secondary education. Partner's level of education is equally important, because it may operate through many of an equivalent pathways (childbearing preferences) because the woman's own education, as long as education levels of husbands and wives are positively correlated. Results from some studies conducted showed that older female adolescents were quite three (3) times likely to practice contraceptive use than younger female adolescents. The findings also revealed that the level of education, working status, knowledge of ovulatory cycle, visit of the health facility and marital status were the determinants for contraceptive use among female adolescents [13, 17].

The extent of education may be a predictor of socio-economic status, which correlates with contraceptive use. It showed that women of lower socio-economic status have lower uptake rates of contraceptives. Also, exposure to mass media has strong effects on attitudes towards family planning through ideation. However, a study identified the following as reasons for rejecting contraceptive implants among women of childbearing age: fear of side effects; lack of interest; husband's refusal; lack of information; religion influence; contraceptive failure; lack of regular sex; and it diminishes sexual pleasure [10, 13].

1.10 Attitude and practice of women of childbearing age to contraceptive usage

It has been discovered in some studies that some women were afraid of the side effects of contraceptives; some want to conceive; familial pressure; lack of knowledge, are the reasons some women of childbearing age do not accept contraceptives. Also, a research showed that the fear of side effects is the main reason for low contraceptive prevalence among young female students. However, the results of a study carried out indicated that the main reasons for switching to implant contraceptive among women of childbearing age were: convenience, contraceptive failure and experienced side effects with other contraceptive methods.

Furthermore, some studies found out in their studies that women of childbearing age who were not using any form of contraceptive was as a result of lack of knowledge; negative perception of contraceptive side effects; lack of interest; lack of regular sex; husband's refusal; expectant of becoming pregnant; and some could not afford it. A study also showed that any categories of women of childbearing age could use or utilise contraceptive implants, they identified the following reasons women of childbearing age are not interested in contraceptive implants: fear of side effects; it diminishes sexual pleasure; it encourages promiscuity; lack of information about the contraceptive implants; expectant of becoming pregnant; contraceptive failure; husband's refusal; lack of regular sex; lack of interest in the use of contraceptive implants; religion influence; and cultural background [10, 15–16, 18–19].

1.11 Recommendations for the acceptance of contraceptive implants

The following recommendations for the acceptance of contraceptive implants among women of childbearing age [10]:

i. All health workers should intensify efforts by properly informing women of childbearing age concerning contraceptive implants;

ii. During antenatal and postnatal visits, women should be health educated on the benefits, the cost-effectiveness and minimal side effects of contraceptive implants;

iii. There is the need for couples to understand each other and decide on the use of contraceptive implants, which is safe, convenient and highly effective for the family circuit.

iv. There should be more public enlightenment campaigns on the use of contraceptive implants most especially the sexually active teenagers, so as to prevent teenage pregnancies and teenage motherhood.

v. Regular jingles should be on radio and television, so as to improve the knowledge of women of childbearing age towards the acceptance of contraceptive implants.

vi. Husbands should be carried along during counselling before choosing any contraceptive implants for their spouses.

vii. All myths, rumours and misconceptions against contraceptive implants should be dispelled by the government either through regular jingles or through the use of mass media and billboards.

viii. Contraceptive implants and its attendant services should be rendered free to all women of childbearing age.

ix. Any woman with the side effects of contraceptive implants should be treated or managed freely in the health institutions.

2. Conclusion

This chapter has shown that contraceptive implants or implantable contraceptive are five subdermal implants, rods the size of pencil lead that are embedded just under the skin on the inside of the upper arm. The chapter further indicated the types of contraceptive implants which included Norplant, Norplant-2 (Jadelle/Sinoplant-II), Nexplanon (Implanon NXT), Implanon, Capronor, Nestrone, and MENT (subdermal implants for men).

Furthermore, the mechanism of action of contraceptive implants, the advantages and disadvantages of contraceptive implants had been discussed including its side effects. The health benefits of the implantable contraceptive including the positive method characteristics of contraceptive implants have been well stated in the chapter.

This chapter also discussed those who can and cannot use implantable contraceptives as well as the factors influencing the acceptance of contraceptive implants. The attitude and practice of women of childbearing age to contraceptive usage had been discussed, likewise, some recommendations which would promote the use of contraceptive implants among women of childbearing age had been extensively stated in this chapter.

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Conflict of interest

There is no conflict of interest as far as this work is concerned.

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Section 4

Birth Control Methods

Chapter 6

Perspective Chapter: Modern Birth Control Methods

Rahma Al Kindi, Asma Al Salmani, Rahma Al Hadhrami, Sanaa Al Sumri and Hana Al Sumri

Abstract

This chapter focuses on various modern birth control methods, including combined oral contraceptives, progestogen-only pills, progestogen-only injectables, progestogen-only implants, intrauterine devices, barrier contraceptives, and emergency contraceptive pills. Each contraceptive method is covered in detail, including mechanism of action, effectiveness, health benefits, advantages, disadvantages, risks, and side-effects.

Keywords: combined oral contraceptives, progestogen-only pills, progestogen-only injectables, progestogen-only implants, intrauterine devices, barrier contraceptives, emergency contraceptive pills

1. Introduction

In recent years, the desire for smaller families and healthy birth spacing has steadily increased in developed and developing countries alike [1, 2]. The United Nations Millennium Development Goals calls for universal access to contraceptive services so that women and couples are able to have the desired number of births at the desired time [3]. Measuring and documenting levels and trends in contraceptive use and the unmet need for family planning services is crucial to informing the decisions of healthcare providers, program planners, and those in charge of resource allocation, particularly in developing nations [4].

Available information regarding unmet needs for contraception in developing countries allows health promoters, professionals, policymakers, and funding bodies to identify the necessary level of investment required in family planning programs [5]. Women are considered to have an unmet need for contraception if they are sexually active and want to avoid becoming pregnant, but are not using any method of contraception to achieve this goal [6]. When women receive health guidance in preventing unintended pregnancies, this helps reduce unwanted births and unsafe abortions, ultimately improving both maternal and child health [7].

The ideal contraceptive method needs to be highly effective in preventing pregnancy with the minimum number of possible side-effects and risks; in addition, it should be affordable, reversible, widely available, and acceptable to people of various cultures and religions [8]. These characteristics are believed to enable better utilization of modern contraception methods by couples and, more specifically, by women, with research

showing that women transform their knowledge into behavior—in other words, that knowledge of contraceptives reduces fertility [9].

Investing in family planning is one of the most crucial measures to improve human wellbeing, as population dynamics have a fundamental influence on the pillars of sustainable development. Most importantly, the utilization of modern contraceptives is believed to be highly cost-effective in enhancing the socioeconomic status of nations and thus reducing poverty [3, 9]. This chapter gives the reader an overview of the various methods of modern contraception available, as well as their mechanisms of action, health benefits, and potential side-effects and risks, thereby allowing health care practitioners to better support women in making informed decisions about their fertility.

2. Combined hormonal contraception

Combined hormonal contraception (CHC) is a combined formulation of progestin and synthetic estrogen [10]. This type of contraception has been utilized by women worldwide for almost 60 years, with significant changes in dosage and preparation over time [11, 12]. More than a third of women aged 16–44 years in the UK use oral contraception; in addition, oral contraceptive pills are used annually by approximately 10 million U.S. women [11]. Health care practitioners should support women to make informed decisions about choosing specific forms of CHC, ensuring that they are aware of their effectiveness—and how they compare to other contraceptive methods—as well as their potential risks and benefits.

2.1 Content

CHC contains estrogen paired with a progestogen in different formulations.

2.1.1 Estrogen

The majority of combined oral contraceptives (COCs)—as well as the combined transdermal patch and combined vaginal ring—contain between 20 and 35 μg of ethinylestradiol (EE), a synthetic form of estrogen. Current 'low-dose' COCs were developed to reduce the health risks associated with the high estrogen content of COCs used in the 1960s and 1970s [13]. Low-dose COCs (i.e., formulations containing <50 μg of EE) are a safe and reliable contraceptive option for the vast majority of women [14, 15].

2.1.2 Progestogens

Progestogens are synthetic steroids designed to have some of the properties of progesterone. The synthetic progestogen component of CHC allows for convenient dosing intervals, potent suppression of ovulation, and prevents overproliferation of the endometrium in response to estrogen. Newer progestogens were developed to have fewer androgenic and glucocorticoid effects; some are anti-androgenic and have potentially favorable anti-mineralocorticoid effects [16]. However, different progestogens can modify the effect of EE on hepatic clotting factors in different ways; for example, forms of CHC which contain certain newer progestogens in combination with EE appear to be associated with a greater risk of venous thromboembolism (VTE) compared to COCs containing other progestogens [17–21].

The different progestogens included in CHC are sometimes grouped by 'generation' as below, according to the time they were first marketed as constituents of COCs:

- First-generation: norethindrone (NET).
- Second-generation: levonorgestrel (LNG).
- Third-generation: desogestrel (DSG), gestodene, norgestimate.
- Other: drospirenone (DRSP), dienogest, nomegestrol acetate [16, 22].

2.2 Types

There are currently two types of CHC regimens offered: standard hormonal regimens or tailored/combined regimens.

2.2.1 Standard regimens

The majority of COCs are designed to be taken on a 28-day cycle, with 21 consecutive daily active pills followed by a 7-day hormone-free interval prior to starting the next packet of pills. The first 7 pills inhibit ovulation and the remaining 14 pills maintain anovulation.

For combined transdermal patches, 1 patch is applied to the skin and worn for 7 days to suppress ovulation. Thereafter the patch is replaced on a weekly basis for 2 further weeks. The fourth week is patch-free to allow a withdrawal bleed. A new patch is then applied after 7 patch-free days [23].

For combined vaginal rings, 1 ring is inserted into the vagina and left in place continuously for 21 days. After a ring-free interval of 7 days to induce a withdrawal bleed, a new ring is inserted [24].

The majority of COC products are monophasic; that is, all pills in the packet contain the same dose of estrogen and progestogen. Multiphasic (variable dose) COCs are also available in which the dose of either or both steroid hormones varies during the pill cycle. Evidence is inadequate to establish whether multiphasic COCs differ significantly from monophasic COCs in terms of bleeding patterns, side-effects, discontinuation rates, or effectiveness in preventing pregnancy [25–27]. As existing evidence suggests there is no particular advantage to multiphasic preparations, it is recommended that monophasic COCs should be used as a first-line intervention.

2.2.2 Tailored regimens

Tailored CHC regimens include:

- Continuous use of CHC with no free interval.
- Extended use of CHC with a less frequent hormone-free interval in which the timing of the hormone-free interval can be either fixed or flexible.
- CHC regimens in which the hormone-free interval is shortened.

In continuous or extended CHC regimens, the contraception is taken for more than 21 consecutive days without a hormone-free interval. Such regimens have the potential advantage of eliminating or reducing the frequency of withdrawal bleeding and associated symptoms; the bleeding pattern is, however, unpredictable.

Less frequent hormone-free intervals could also reduce the risk of escape ovulation and, potentially, contraceptive failure [28–31]. A shortened hormone-free interval, offering more continuous ovarian suppression, could also reduce the risk of escape ovulation, particularly if contraceptive use is imperfect around the hormone-free interval. A shortened hormone-free interval can be taken either after every 21 days of active CHC use or incorporated into an extended regimen.

2.3 Mechanism of action

The main mechanism of action of COCs is the suppression of ovulation through the inhibition of gonadotropin-releasing hormone from the hypothalamus, as well as inhibition of both luteinizing hormone (LH) and follicle-stimulating hormone (FSH), and disruption of the mid-cycle LH surge. These effects are mediated by both the progestogen and estrogen components of the COC working synergistically; however, it is the estrogen's ability to suppress FSH and thus prevent folliculogenesis that is likely the most important mechanism.

The additional estrogen exposure in continuous-use pills, pills with a shorter pill-free interval, and pills with an additional 10 μg of EE in the placebo week results in more complete suppression of FSH and less folliculogenesis. However, a substantial number of women can still develop follicles while taking low-dose COCs [32, 33]. Additionally, the estrogen component stabilizes sufficient endometrium production to maintain a regular withdrawal bleeding pattern, thereby permitting cycle control.

Additional progestogen-related mechanisms that contribute to the contraceptive effect of COCs include:

- Effects on the endometrium, rendering it less suitable for implantation. Long-term cyclic or daily progestogen exposure leads to endometrial decidualization and eventual atrophy.
- Thickening of the cervical mucus, which becomes less permeable to penetration by sperm.
- Impairment of normal tubal motility and peristalsis.

2.4 Effectiveness

The efficacy, or failure, of COCs can differ considerably based on the type of user. The perfect user never misses taking a pill, takes the pill at the same time each day, and never vomits or has diarrhea. The failure rate for perfect users is <1 pregnancy per 100 women (or 3 per 1000 women). In turn, the typical user's behavior results in the failure rates reported for the general population, which is 5–8 pregnancies per 100 women in the first year [34–38].

It is important to note that the risk of pregnancy is greatest when a woman starts a new pack of pills 3 or more days late or misses 3 or more pills near the beginning or end of a pack.

2.5 Advantages

In addition to their high contraceptive efficacy, COCs have many advantages, including rapid reversibility, regulation of menstrual bleeding, decreased menstrual

blood loss, and dysmenorrhea, as well as population-level reductions in the risk of ovarian and endometrial cancers. Furthermore, CHC use does not interfere with intercourse and can be easily discontinued at any time.

2.5.1 Non-contraceptive uses

COCs are also widely used to treat a variety of other disorders and conditions, including:

- *Menstrual cycle disorders*—COCs are often used in women with menstrual cycle disorders, such as oligomenorrhea due to polycystic ovary syndrome (PCOS), abnormal uterine bleeding (e.g., midcycle spotting or heavy menstrual bleeding), menstrual migraines, and premenstrual syndrome or premenstrual dysphoric disorder, although COCs are not considered a first-line therapy for the latter indications.

- *Pelvic pain disorders*—Women with pelvic pain (e.g., endometriosis-related or chronic pelvic pain) or dysmenorrhea often benefit from the hormonal and endometrial suppression associated with COC use to reduce their symptoms. Continuous or extended-cycle COCs are often more effective in this population compared with cyclic use.

- *Ovarian cysts*—COCs are often prescribed to women with a history of painful ovarian cysts to suppress ovulation and the subsequent formation of new cysts. However, COCs do not appear to aid the regression of existing functional ovarian cysts [39, 40].

- *Hyperandrogenism*—COCs can reduce the dermatologic manifestations of hyperandrogenism, such as acne and hirsutism, which are particularly common in women with PCOS or non-classic congenital adrenal hyperplasia due to 21-hydroxylase deficiency. The relevant mechanisms of action for this effect include the inhibition of gonadotropin secretion, and thereby a decrease in ovarian androgen secretion, and an increase in serum sex hormone-binding globulin concentrations, which results in increased binding of androgens and a decrease in serum-free androgen concentrations [41].

- *Cancer risk reduction*—Women at increased risk of endometrial and ovarian cancer can benefit from COC use to reduce their cancer risk. There is a similar reduction in risk for women with *BRCA1-* or *BRCA2*-associated ovarian cancers. Although a history of COC use has been associated with a reduced risk of colorectal cancer in certain studies, the overall body of evidence is conflicting, and it is as yet unknown if the prophylactic use of COCs reduces colorectal cancer risk [42, 43].

- *Bone health*—Perimenopausal women who use COCs have improved bone mineral density (BMD) compared to nonusers [44]. COCs are also useful for the treatment of hot flashes and abnormal uterine bleeding in this population.

2.6 Disadvantages

There are certain disadvantages to CHC use. The efficacy of this form of hormonal contraception is highly user-dependent as it must be taken every day at the same time;

forgetfulness and missing pills increases the likelihood of failure. Similarly, CHC effectiveness may also be lowered with the simultaneous use of certain medications. Moreover, this method requires periodic resupply and offers no protection against gastrointestinal tract infections or sexually-transmitted infections (STIs), like the hepatitis B virus and HIV/AIDS. Though very infrequent, CHC use may sometimes delay return of fertility for 2–3 months. Finally, CHC may cause minor side-effects and risks, as detailed below.

2.6.1 Side-effects

Patients may experience breast tenderness, nausea, and bloating when starting COCs. These symptoms typically resolve quickly. Other concerns can include unscheduled bleeding, which typically resolves within 3 months, and a possible impact on mood and sexual function. There is no evidence to show that COCs cause weight gain.

2.6.2 Risks

The risks associated with COC use are influenced by the type and dose of estrogen and progestogen contained in the formulation. These risks are as follows:

- VTE—COC use has been associated with an increased risk of VTE. The risk of VTE varies with estrogen dose and patient-specific factors, such as age, obesity, and smoking status. Nevertheless, while the VTE relative risk is increased, the absolute increase in VTE risk is still low for most women and does not outweigh the numerous benefits of this contraceptive method, particularly when compared with the VTE risk during pregnancy and the postpartum period [45].

- Cardiovascular health—COC use has been associated with increased risks of hypertension, myocardial infarction, and stroke in certain populations. However, the absolute risk of myocardial infarction and stroke attributable to COCs is low in women of reproductive age. Rarely, COCs can cause a mild elevation in blood pressure in the range of 3–5 mmHg; however, this is unlikely to be clinically significant in healthy women [46].

- Cancer—COC use does not appear to increase the overall risk of cancer. The impact of COC use on breast cancer risk is a subject of active debate, with conflicting data reported. At least 1 study has reported a differing risk of breast cancer with COC use based on hormone receptor subtype. Women who have taken COCs also appear to have a slightly increased risk of developing cervical cancer. By contrast, COC use is associated with a reduced risk of developing ovarian and endometrial cancers [47].

- STI acquisition—The impact of developing STIs in women using COCs appears to vary by type of infection. Two systematic reviews reported that COC use positively correlated with chlamydia infections, but not with gonorrhea, herpes simplex virus-2, trichomoniasis, syphilis, and human papillomavirus. While COCs may be associated with increased rates of chlamydia, rates of pelvic inflammatory disease (PID) do not appear to be increased. One study reported similarly increased rates of bacterial vaginosis, trichomoniasis, and vaginal candidiasis among women starting either COCs or an LNG-IUS device, which makes

sexual exposure the likely risk factor for these infections and not the contraceptive method. Other studies have reported reduced rates of bacterial vaginosis in women using COCs. Data generally do not support any influence of COC use on the acquisition of HIV. There are currently no restrictions on COC use among women with STIs, PID, or HIV [48–50].

3. Progestogen-only pill

The progestogen-only pill (POP) is a form of hormonal contraception which contains a progestogen. It is often referred to colloquially as the "mini-pill".

3.1 Content

The POP is formulated with a single synthetic hormone, progestin. Unlike CHC, POPs do not contain any estrogen. Moreover, the dose of progestin in POPs is substantially lower than that included in COCs (NET: 0.35–1 mg, DRSP: 3–4 mg).

3.2 Types

There are multiple types of progestins available:

- NET—Commonly available as individual 0.35-mg tablets, NET is dispensed in packs of 28 active pills, which are taken continuously (i.e., without a 7-day hormone-free interval) [51].

- DRSP—DRSP is dispensed in packs of 20 tablets containing 4 mg of DRSP and 4 inert tablets [52]. One tablet is taken daily until the pack is empty and then a new pack is started.

- DSG—In numerous countries, DSG POPs are available in a 75-μg formulation [53]. This formulation has significant differences from NET-POPs.

3.3 Mechanism of action

Depending on their formulation, POPs have several independent modes of action that contribute to their contraceptive effect [51–53]. POPs increase the volume and viscosity of the cervical mucus, preventing sperm penetration into the upper reproductive tract [54]. This change occurs soon after starting a POP, within 2 days of taking the pill. However, the contraceptive effect provided by these mucosal changes is short-lived; it has been estimated that full protection conferred via cervical mucosal changes may last less than 24 h unless maintained by regular pill-taking [53].

In addition, POPs can act to suppress ovulation [54]. However, the extent to which this occurs is variable; for example, up to 60% of cycles in women using LNG pills are anovulatory, whereas ovulation is suppressed in up to 97% of cycles in women using DSG pills [55, 56]. Other modes of action include endometrial changes that hinder implantation and reduction in cilia activity in the fallopian tube that slows the passage of the ovum [54]. The main mechanism of action of DRSP-POPs and DSG-POPs is the suppression of ovulation.

3.4 Effectiveness

The effectiveness of POPs in preventing pregnancy is as high as that of combined estrogen-progestin contraceptive pills; moreover, intake delay of up to 12 h does not affect contraceptive efficacy [57]. Nevertheless, the effectiveness of this method still depends on the user, as higher failure rates occur with poor compliance. For perfect users, the failure rate is <1 pregnancy per 100 women over the first year (3 per 1000 women). However, for typical users, the failure rate is 1 pregnancy per 100 women in the first year for breastfeeding women and 3–10 pregnancies per 100 women in the first year for non-breastfeeding women [58].

3.5 Advantages

The most important advantage of POPs is their rapid effectiveness (<24 h), if taken within the first 7 days of the menstrual cycle. Unlike COCs, intake delay of up to 12 h does not affect contraceptive efficacy [57]. Moreover, the lack of estrogen eliminates the possibility of estrogen-related side-effects and complications. POPs do not interfere with intercourse or affect breastfeeding. Women taking POPs can easily cease taking the pills with an immediate return of fertility. Anecdotally, some women mention that the POP tablets are easier to take compared to COCs because each tablet is the same color.

3.5.1 Non-contraceptive uses

Daily use of progestin protects against the development of endometrial cancer [59]. In addition, NET acetate has demonstrated efficacy in treating dysmenorrhea, abnormal uterine bleeding, and endometriosis-related pain, albeit at higher doses (2.5–15 mg per day) [60]. A single-arm trial of continued DRSP use over 13 cycles in adolescent females reported reduced rates of dysmenorrhea, as well as a corresponding decrease in the use of pain medication to treat the aforementioned dysmenorrhea [61].

Although POPs neither protect from nor increase the risk of acquiring STIs, progestin-induced thickening and increased viscosity of the cervical mucus has been hypothesized to inhibit the ascent of bacteria and thus potentially reduce the risk of PID development. Nevertheless, all women at risk of STI acquisition should be advised to use a condom.

3.6 Disadvantages

As with COCs, there are certain disadvantages to POPs. Although the window of time for contraceptive efficacy when taking POPs is more forgiving compared to COCs, the efficacy of POPs still relies on the user taking the pill every day. Similarly, this method also requires a periodic resupply of pills and offers no protection against STIs. Moreover, POP users may experience certain side-effects and risks, as detailed below.

3.6.1 Side-effects

- Bleeding—Altered bleeding patterns are a common reason given by women for stopping POPs [62–64]. Indeed, almost half of POP users experience prolonged bleeding and up to 70% report breakthrough bleeding or spotting in 1 or more cycles [64]. Bleeding patterns associated with POPs may depend upon the type of

progestogen used, the dose at which it is given, circulating endogenous estradiol concentrations, and ovulation.

- Decreased libido—Decreased libido is a commonly reported adverse reaction (≥1 per 100 women) in clinical trials [64, 65]. However, establishing causation is difficult, given the subjective nature of sexual interest and the multitude of factors that may influence it. Studies looking specifically at the impact of POPs on libido are lacking.

- Weight changes—In women of reproductive age, minor weight fluctuation is common. However, a review of 16 randomized controlled trials (RCTs), one of which examined a POP, reported limited evidence of weight gain (<2 kg over 12 months) among users of progestogen-only contraceptives. Whilst there is a paucity of evidence relating to the POP specifically, the available evidence does not support a causal association between POP use and weight change [66].

- Headaches—Although there are limited data on the effects of progestogen on migraine development, the available evidence does not suggest an increased incidence of migraines associated with the use of POPs [67].

- Depression and mood changes—As with other forms of hormonal contraception, depression and mood changes are possible undesirable effects of POP use [68–70]. However, there is as yet no direct evidence from studies to suggest a causal association.

3.6.2 Risks

- Cardiovascular health—Few studies have been large enough to evaluate VTE risk associated with the use of progestogen-only contraceptives. However, the available evidence does not demonstrate an increased VTE risk with the POP [71–73]. Hypertension is a condition for which there is no restriction on the use of POPs, as there is no evidence that POPs increase blood pressure [54]. Even for women with vascular disease, the advantages of POPs generally outweigh the theoretical or proven risks [74]. POPs are generally appropriate for women with cardiac disease and are useful as a bridging method while specialist advice is being sought [75].

- Breast cancer—The annual risk of breast cancer increases with age, irrespective of hormone use. Due to the small numbers of women using progestogen-only methods in studies that have investigated the association between hormonal contraceptive use and breast cancer, data are limited with regards to determining breast cancer risk associated with POP use [76]. Any attributable risk is likely to be small and, as with COCs, likely to reduce with time after discontinuation of the contraceptive.

- Ectopic pregnancy—The risk of ectopic pregnancy associated with any particular contraceptive method is determined, in the first instance, by the ability of the method to prevent pregnancy and, subsequently, by the proportion of ectopic to intrauterine pregnancies that occur. Other factors may also influence this risk, including age, smoking status, and a previous history of ectopic

pregnancy. The incidence of ectopic pregnancy associated with POPs is difficult to determine due to the small numbers of ectopic pregnancies that occur and the inability to adequately control for other risk factors. Up to 10% of pregnancies that occur in traditional POP users may be ectopic [54]. Methods that suppress ovulation are likely to be associated with a lower overall rate of ectopic pregnancy than those that do not. Women should be informed of possible signs of ectopic pregnancy (e.g., lower abdominal pain or shoulder tip pain). A previous history of ectopic pregnancy does not place any restrictions on the use of POPs [74].

4. Progestogen-only injectables

Progestogen-only injectables (POIs) are one of the most effective contraceptive methods and are reversible, safe, and easy to use [77]. These long-acting contraceptives consist of injections of progestogen which are steadily released into the bloodstream over several weeks. Injections are given every 8–13 weeks, depending on the type of injectable [78, 79].

4.1 Content

Much like POPs, POIs contain progestin, a synthetic hormone that mimics progesterone, the natural hormone present in a woman's body.

4.2 Types

There are three types of POIs currently available:

- 150 mg of depot medroxyprogesterone acetate (DMPA) given intramuscularly every 3 months (DMPA-IM).
- 104 mg of DMPA given subcutaneously every 3 months (DMPA-SC).
- 200 mg of NET enanthate given intramuscularly every 2 months [78, 80].

In 1992, the U.S. Food and Drug Administration (FDA) approved the marketing of DMPA as a contraceptive agent [81]. Of the three options outlined above, DMPA-IM is the most commonly used and extensively researched injectable progestin [79]. It should be administered deep into the muscles, as the preparation is released slowly into the blood stream from the site of injection [82]. For DMPA-SC, the BD Uniject™ system (Becton, Dickinson & Co., Franklin Lakes, NJ) is a useful option for community-based programs or home delivery as it can be self-administered using the system's prefilled, single-dose, disposable hypodermic syringes [83]. The efficacy of DMPA-SC is likely maintained when administered in the upper arm, abdomen, or thigh, which may be preferrable for some women [84].

4.3 Mechanism of action

There are three primary mechanisms of action that contribute to the efficacy of injectable DMPA in preventing pregnancy:

- Inhibition of ovulation through suppression of the hypothalamus, the main mechanism of action [85].

- Mucosal changes in which the cervical mucus becomes more viscous, thick, and scanty, thereby inhibiting sperm from reaching the oviduct (fallopian tubes) and preventing egg fertilization [81, 82].

- Thinning and atrophy of the endometrium through decreased estradiol concentrations [86].

4.4 Effectiveness

POIs containing DMPA are one of the most effective methods of contraception. Contraceptive efficacy is achieved rapidly (<24 h) and, because there is a grace period of 4 weeks, is non-user-dependent. Nevertheless, it is important that the injections are given consistently and correctly. Pregnancy protection rates reach 99% with perfect use and 96% with typical use, assuming occasional non-use and/or incorrect use for the latter [80, 87]. The risk of pregnancy is higher when a woman misses an injection. The failure rate is up to 6 pregnancies per 100 women in the first year of use [88]. Age, income, desire to prevent or delay pregnancy, and culture affect the consistent and correct usage of any method of contraception [80].

4.5 Advantages

In general, POIs are a good choice for women who want a reliable, long-lasting, reversible method of contraception without the need for daily action on their part, such as pill-taking. This type of contraceptive can be used by women of any age and parity status and is easily discontinued. Client satisfaction is high, as injections are often considered more convenient compared to other forms of contraception and follow-up injections can be easily given by a nurse. There is no need for a pelvic examination prior to the use of POIs. Furthermore, the injections do not affect breastfeeding or interfere with intercourse. Overall, POIs have a good safety profile and few specific health risks. They have minimal drug interactions.

4.5.1 Non-contraceptive uses

Since its introduction into the market in the 1960s, DMPA has been used for a variety of gynecological conditions, including endometriosis and abnormal menstrual bleeding [81]. Because it decreases menstrual blood loss by 50% at 1 year of use and by 70% after 2 years of use, DMPA improves iron deficiency anemia and amenorrhea [83]. The mechanism of action of progestin with regards to endometrial thinning and atrophy contributes to its use in the treatment of endometriosis, plus its direct effect on endometrial lesions [86]. DMPA can also be used in the treatment of abnormal uterine bleeding associated with uterine fibroids, adenomyosis, or coagulopathies [39]. In addition, it protects against endometrial cancer and symptomatic PID.

DMPA also improves cyclical menstrual symptoms, such as pain, mood changes, headaches, and breast tenderness, and decreases the incidence of benign breast disease, ovarian cysts, and ectopic pregnancy. Furthermore, women with sickle cell disease will have fewer sickle cell crises, while those with epilepsy will have fewer *grand mal* seizures [79, 81, 82].

4.6 Disadvantages

There are several limitations to the use of DMPA. The main disadvantage of this type of contraception is its ability to engender changes in the bleeding pattern of a woman's menstrual cycle, potentially limiting its uptake. Indeed, discontinuation of DMPA is reported to be 25–50% in the first year of use [89, 90]. Moreover, POIs do not provide protection against STIs such as chlamydia, gonorrhea, and HIV. The client has to return to the clinic for follow-up injections and, once given, their contraceptive action cannot be stopped until the time of the next injection. Furthermore, there is some delay in return of fertility which takes approximately 7–10 months from the date of the last injection [79, 82].

Counseling is highly recommended to ensure that the possible side-effects and risks of POIs, described below, are explained to clients, particularly the reasons behind any menstrual changes.

4.6.1 Side-effects

- Bleeding—Unpredictable, irregular, frequent, or heavy bleeding usually occurs with the first 3 months of POI use; subsequently, by 1 year of use, the majority of women have achieved amenorrhea [82].

- Weight changes—There is some evidence to show that the use of progestogen-only contraceptives up to 12 months may cause weight gain (mean of <2 kg/4.4 lb). In addition, progestogen-only contraceptive users showed greater increases in body fat and decreases in lean mass compared to users of non-hormonal contraceptive methods [66]. Another prospective study with a longer follow-up over 36 months found that DMPA users gained an average of 5.1 kg/11.2 lb, whereas women who used COCs did not gain any weight [91, 92]. Weight gain with the first injection may be predictive of weight gain over time and women who are overweight and obese may be at higher risk [81].

- Hormonal side-effects—Like other hormonal contraceptives, DMPA has other related side-effects, including breast tenderness, headaches, nausea, acne, abdominal bloating and discomfort, and hypo-estrogenic effects such as hot flashes, reduced libido, and vaginal dryness. While DMPA may cause mood changes, depression is not a contraindication to its use [93].

- Bone health—In suppressing gonadotropin production and ovulation, DMPA also suppresses ovarian production of estradiol and hypoestrogenemia causes a decline in BMD in current DMPA users [94]. The rate of loss is greatest during the first 1–2 years of use (by 0.5–3.5% at first and 5.7–7.5% subsequently) [95]. This reduction in BMD normalizes after discontinuation of DMPA use for up to 5 years [96–98]. There is no reported increase in fracture risk among DMPA users [99].

- Allergic reactions—Allergic reactions are a serious side-effect of DMPA [81].

4.6.2 Risks

- Cardiovascular health—DMPA use is not associated with an increased risk of cardiovascular events in healthy women, including VTE, myocardial infarction, or

stroke. Although circulating lipids are affected by DMPA use, it does not increase production of coagulation factors and has no adverse effect on blood pressure. No adverse clinical effects on cardiovascular disease have been observed [83].

- Depression—prospective studies do not support a causal relationship between DMPA use and depression.

5. Implantable contraception

Implants are small, flexible, impermeable plastic rods about the size of a matchstick that are placed just under the skin of the upper arm [100, 101]. Over the past 35 years, various types of contraceptive implants have been approved in more than 60 countries; today, this method of contraception is used by millions of women worldwide [102]. Implants are a good choice for women of reproductive age who are sexually active and desire continuous, long-term contraception.

5.1 Content

Contraceptive implants include a progestin which is released in a low, steady dose into the bloodstream. The most common forms of progestin used in implants are LNG and etonogestrel.

5.2 Types

There are several types of contraceptive implants on the market:

- Jadelle® (Bayer, Leverkusen, Germany), which consists of 2 rods each containing 75 mg of LNG, labeled for up to 5 years of use [103].

- Implanon NXT®/Nexplanon® (Organon, Jersey City, NJ), which consists of 1 rod containing 68 mg of etonogestrel, labeled for up to 3 years of use. The Nexplanon® has replaced the Implanon NXT® which is now discontinued [104].

- Levoplant®/Sino-Implant (II) (Shanghai Dahua Pharmaceutical Co. Ltd., China), which consists of 2 rods each containing 75 mg of LNG, labeled for up to 4 years of use. Levoplant® is also sometimes referred to as Sino-Implant (II) [105].

- Norplant® (Wyeth Pharmaceuticals, Madison, NJ), which consisted of 6 capsules each containing 36 mg of LNG and was effective for 5–7 years. This device was discontinued in 2008 and is no longer available for insertion.

Of the various types of contraceptive implants available, the Implanon NXT®/Nexplanon® is the most commonly used and is registered in approximately 80 countries worldwide [106]. It is radio-opaque (visible on X-ray) and has an improved insertion device.

5.3 Mechanism of action

Contraceptive implants have two primary mechanisms of action: inhibition of ovulation and restriction of sperm penetration [107]. The anti-estrogenic effect of

the progestin causes the cervical mucus to become more viscous and scanty, thereby stopping sperm penetration and egg fertilization [108]. Furthermore, high doses of progestin diminishes gonadotropin secretion, inhibiting follicular maturation and ovulation. While progestin also suppresses endometrial activity by causing the endometrial thinning and atrophy, thereby impeding implantation, these two actions remain the major mechanisms of action in preventing fertilization [109]. There is no evidence of embryonic development among implant users, indicating that progestin implants have no abortifacient properties [81].

5.4 Effectiveness

The etonogestrel implant (Implanon NXT®/Nexplanon®) is among the most effective and long-lasting contraceptives available and is as good as or better than sterilization procedures, with pregnancy protection rates of >99% for both typical and perfect users [88, 110]. If inserted within the first 5 days of the menstrual cycle, the implant is effective immediately after insertion, with peak serum levels occurring within 4 days [111]. The failure rate is negligible at <1 pregnancy per 100 women in the first year (or 1 per 1000 women). Beyond the first year of use, a small risk of pregnancy remains and continues as long as the client is relying on the implant as the only form of contraception.

The efficacy of implants is based on correct sub-dermal insertion and removal of the device. All healthcare providers should receive instructions and training prior to the insertion or removal of the implant. Women taking efavirenz for HIV should be advised to use condoms along with implants, as this medication may reduce the effectiveness of contraceptive implants.

5.5 Advantages

Contraceptive implants are a highly effective, long-acting form of user-independent, non-coitus-related contraception that provides protection against pregnancy without the need for repeated adherence. Moreover, they have few side-effects and are rapidly reversible [100, 101]. Implants are a good option for adolescents, as they do not require the user to do anything after insertion and there is no need for routine follow-up visits, as well as for adult women who desire highly efficient, easy-to-use, long-term protection. Implants can be inserted without the need for a pelvic examination, breast examination, blood tests, or any other laboratory tests, barring another indication for doing so. Moreover, implants do not interfere with intercourse and clients are ensured of a complete return of fertility after removal.

5.5.1 Non-contraceptive uses

Implants do not disturb lactation and reduce the risk of ectopic pregnancy and symptomatic PID, probably as a result of the effects of progestin on the cervical mucus; moreover, they may protect against iron-deficiency anemia. Furthermore, implants do not increase the risk of STIs [78, 81]. Implants have been shown to be beneficial in women with dysmenorrhea as they decrease abdominal cramps by up to 80% [112]. Unlike DMPA, etonogestrel implants have not been found to induce bone loss [78, 110].

5.6 Disadvantages

A woman cannot start or stop using implants on her own as insertion and removal of the device constitutes a minor surgical procedure which must be performed by a well-trained provider. Furthermore, implants are a relatively expensive method of contraception and do not protect against STIs.

5.6.1 Side-effects

Contraceptive implants may cause changes in menstrual bleeding in the first several months to 1 year of use, including lighter bleeding, fewer days of bleeding, prolonged bleeding, irregular bleeding, and even no bleeding. After about 1 year of use, the pattern of bleeding becomes more regular. Changes in bleeding patterns as a result of implants are not harmful but are a common drawback of this contraceptive method. Amenorrhea occurs in approximately 20% of women in the first year of use, although this rates declines with duration of use to 13% by year 3 [113].

Unscheduled bleeding was reported as the reason for discontinuation of this method among 14.8% of users in the U.S. and Europe and 3.7% in Southeast Asia, Chile, and Russia [114]. About 90% of women who discontinued the implant experienced frequent or prolonged bleeding/spotting versus 22% of those who continued using the device [115].

Like other progestogen-only forms of contraception, other possible-side effects of contraceptive implants include headaches, abdominal pain, mood changes, nausea, breast tenderness, dizziness, acne (either improvement or exacerbation), weight change, and possibly enlarged ovarian follicles [78, 110].

5.6.2 Risks

Complications are reported in 0.3–1% of implant insertions and 0.2–1.7% of removals [116]. Uncommon insertion/removal complications include infection, hematoma formation, and local irritation and rashes at the insertion site; these occur mostly within the first 2 months of insertion. Clinician training and experience, and the use of a stringent, aseptic technique reduces the incidence of such complications.

In addition, rare complications can occur, including expulsion of the implant (occurring within the first 4 months of insertion) and migration of the implants over time a short distance (<2 cm) from the site of insertion [78, 117]. Nerve injuries have also been reported with implants, including injury to the branches of the medial antebrachial cutaneous nerve during placement and the medial antebrachial cutaneous nerve [118, 119].

6. Intrauterine contraception devices

Intrauterine contraception devices (IUCDs) are small, flexible devices inserted in the uterine cavity to provide effective, long-acting, reversible contraception. The IUCD is a safe, easy-to-use, and highly cost-effective means of contraception, with significantly low failure rates [120, 121]. It provides a nonsurgical option for pregnancy prevention that is as effective as surgical sterilization. The IUCD is one of the most commonly used methods of long-acting, reversible contraception worldwide, with an average utilization

rate of approximately 23% among female contraceptive users, although there is wide variation between countries, ranging from <2% to >40% [122, 123].

6.1 Content

There are different types and shapes of IUCD available globally. Most IUCDs have a plastic frame and release either copper or a progestin to prevent pregnancy.

6.2 Types

Generally, most frequently used IUCDs are divided into two main categories: hormonal and non-hormonal. Various terms are used to describe IUCDs, including intrauterine device and intrauterine contraception; hormonal IUCDs or progestin-containing devices are also referred to as an IUS.

Copper IUCDs (Cu-IUCDs) are non-hormonal and vary in size and shape. They consist of a piece of plastic and copper, with some types containing silver or other metals. Theoretically, this may increase the longevity of the device; however, no evidence has been identified to confirm any clinical benefit of mixed-metal IUCDs over IUCDs that only contain copper. In addition to their use as long-acting, reversible forms of contraception, Cu-IUCDs can also be used as a method of emergency contraception [124, 125].

In turn, the LNG-IUS is a T-shaped device with an elastomer core containing LNG. There are different LNG-IUSs available which release a varying amount of LNG. In addition to its use for contraception, the LNG-IUS can be used in the management of heavy menstrual bleeding and as endometrial protection during estrogen replacement therapy [126].

6.3 Mechanism of action

The IUCD has multiple mechanisms of action that contributes to its contraceptive properties. The device causes chemical changes that damage the sperm and ova before they can meet, thus preventing fertilization [127]. Moreover, copper ions released by Cu-IUCDs reduce sperm motility and viability and inhibit sperm penetration and migration by affecting the uterotubal fluid, thus decreasing the number of sperm reaching the oviduct and their capacity to fertilize the ova. Copper also induces changes in the endometrium, causing a cytotoxic inflammatory response increasing levels of white blood cells, enzymes, and prostaglandins in the uterine fluid, thereby impairing sperm function and preventing implantation. Additionally, Cu-IUCDs inhibit ova development [114, 128, 129].

The LNG-IUS inhibits fertilization by thickening the cervical mucus which acts as a barrier to the upper genital tract, as well as causing changes in the uterotubal fluid that impair sperm migration. Inhibition of implantation via endometrial changes is the secondary mechanism of action of the LNG-IUS. A foreign body effect may also be a contributing factor, as has been observed with other intrauterine methods [128, 130, 131]. While the LNG-IUS also has a minor effect on the hypothalamic pituitary ovarian axis, serum estradiol concentrations are not reduced, and the majority of women (>75%) continue to ovulate [132–135].

Progestogenic effects of the LNG-IUS on cervical mucus have been demonstrated, but it is not fully understood how quickly such changes are established [136–138]. Prevention of implantation occurs via a progestogenic effect on the endometrium [139–141]. Within

1 month of insertion, high intrauterine concentrations of LNG induce endometrial atrophy [130, 131, 142–144]. The LNG-IUS also causes changes in the endometrium that may also contribute to its contraceptive effect, particularly by altering the intercellular junctions between the epithelial and stromal cells and increasing the number of phagocytic cells [140, 143, 145].

All of the anti-fertility actions of IUCDs occur prior to implantation [114, 128, 129, 146]. The common belief that the mechanism of action of IUCDs is the destruction of an implanted embryo is not supported by evidence. Studies of IUCD users were unable to find embryos or detect human chorionic gonadotropin, indicating that transient, or chemical, pregnancies had not occurred [128, 147, 148]. In summary, there is no evidence to suggest that IUCDs disrupt an implanted pregnancy [149].

6.4 Effectiveness

Failure rates within the first year of IUCD insertion are 0.6–0.8% for women with a Cu-IUCD and 0.2–0.9% for women with an LNG-IUS. The cumulative failure rate over 10 years of use of the Cu-IUCD is 2.1–2.8%, while that of the LNG-IUS over 5–7 years of use is 0.7–1.1% [150]. Unlike most other forms of reversible contraception, the IUCD does not rely on patient participation or adherence for correct usage; thus, failure rates for typical and perfect users are similar.

6.5 Advantages

The IUCD is one of the most cost-effective methods of long-acting, reversible contraception available; even though the cost of the device and insertion can be high initially, the overall cost with long-term use decreases with time because no additional expenditure is required [151]. Moreover, this method is highly effective, acts immediately, and is not dependent on user compliance as it does not require regular adherence to maintain its effectiveness. It requires only a monthly self-checking for strings, and yearly follow-up visits. In addition, the IUCD does not interfere with intercourse or breastfeeding and can be inserted 6 weeks after giving birth. Clients are assured of a rapid return of fertility upon removal. Depending on the type of IUCD inserted, women can avoid the use of either exogenous estrogen (both IUCD types) or hormones in general (Cu-IUCDs only).

6.5.1 Non-contraceptive uses

The IUCD offers a reduced risk of cervical, endometrial, and ovarian cancers [152–155]. Moreover, the LNG-IUS can be used in the treatment of menorrhagia, endometriosis, and pelvic pain [155–157].

6.6 Disadvantages

There are several disadvantages to the utilization of IUCDs. This type of contraceptive device requires the client to undergo a minor procedure for insertion and removal; as such, the client cannot discontinue use of this method on her own. Moreover, the client will need to check strings after each menstrual period. Pelvic examination and genital tract infection screening is mandatory before initiation of use, as per the Centers for Disease Control and Prevention guidelines. In addition, because she may experience heavier monthly bleeding, the device may contribute

to anemia if the women has low iron stores prior to insertion [158, 159]. Finally, IUCDs do not protect against STIs.

6.6.1 Side-effects

- Pain and menstrual bleeding changes—The IUCD can result in abdominal cramps, pain, and changes in monthly bleeding patterns, especially in the first 3–6 months of use, including prolonged and heavy monthly bleeding, irregular bleeding, and no bleeding [158–160]. Users of the LNG-IUS are more likely to terminate use due to amenorrhea, while Cu-IUCD users are more likely to terminate the method because of pain and other menstrual events [160].

- Hormonal side-effects—Discontinuation because of hormonal side-effects is also more common among LNG-IUS users [158]. These side-effects include acne and weight changes, both of which are rare.

6.6.2 Risks

- Expulsion of the device—The incidence of expulsion is 3–10% for the Cu-IUCD and 3–6% for the LNG-IUS in the first year of use [146, 147, 161]. A trial reports that the expulsion of the Cu-IUCD occurs less frequently than with the LNG-IUS (8.4 versus 11.7 cases per 100 users). Another study reveals that the expulsion rate is equal between Cu-IUCD and LNG-IUS as well as reported pain.

- PID—The IUCD may increase the risk of PID in women who have chlamydia or gonorrhea at the time of insertion, although this is rare [162]. Rates of PID among users of IUCDs are fairly similar regardless of type of device (3.6 cases per 100 women).

7. Barrier methods

Barrier contraception is a safe, effective, and reversible form of contraception acceptable to many couples. These methods can be used either alone as the primary method of contraception, or in combination with other contraceptive methods. In terms of the latter, barrier methods may be used as a short-term combination therapy, for example when CHC is initiated, or in the long term to provide additional protection against pregnancy. Barrier methods are also the only method of contraception which can be used to prevent the transmission of STIs.

7.1 Content

Depending on the type of method utilized, barrier devices may be made of rubber, plastic, or organic components such as lambskin [12, 163].

7.2 Types

There are several types of barrier methods available, including:

- Male condoms (including latex, non-latex, and deproteinized latex varieties).

- Female condoms (latex, polyurethane, or nitrile).
- Diaphragms (latex or silicone).
- Cervical caps (silicone).
- Spermicides (foams, gels, and films with sperm-killing or blocking properties) [12, 163].

Male condoms are sheaths or coverings that fit on an erect penis. Female condoms are sheaths, or linings, that fit loosely inside a woman's vagina, made of a thin, transparent, soft film. Female condoms have flexible rings at both ends; one ring at the closed end helps to insert the condom, while the ring at the open end holds part of the condom outside the vagina [78].

Diaphragms and cervical caps consist of plastic or silicone domes which are inserted inside the vagina to cover the cervix, primarily used in conjunction with a spermicidal agent. A recent survey found that <1% of women reported using diaphragms and caps [12].

7.3 Mechanism of action

Barrier methods provide a physical barrier to prevent the migration of sperm from the vagina to the upper reproductive tract where fertilization occurs, thereby preventing pregnancy. Male and female condoms work by keeping sperm out of the vagina and forming a barrier to ejaculate, pre-ejaculate, and vaginocervical secretions [78]. In turn, diaphragms and caps keep sperm from reaching the cervix. However, as only the cervix is covered by the latter two methods, they do not prevent exposure of the vaginal mucosa to semen or exposure of the penis to vaginocervical secretions.

7.4 Effectiveness

Data from the U.S. suggest that there is a 5% failure rate with the female condom and a 2% failure rate with the male condom with perfect use (i.e., correct and consistent use). With typical use (which includes incorrect and inconsistent use), failure rates are 21% and 18%, respectively [88]. Nevertheless, many factors other than user error may influence the efficacy of condoms in the prevention of pregnancy, including background fertility, coital frequency, or the use of emergency contraception. A study assessing semen exposure following condom failure suggested that even when condoms break or slip, the risk of pregnancy may be reduced in comparison to when using no method of contraception at all [164]. Although condom studies often report clinical breakage and slippage rates, these are not considered valid surrogate endpoints of pregnancy [165].

Data have suggested that, with perfect use, 4.3–8.4% of women using a diaphragm with a spermicidal cream or jelly experience an unintended pregnancy within the first year of use. With typical use, the percentage increases to 12% [88]. In a comparative study, the only contraceptive cap available in the UK was found to be less effective at preventing pregnancy than the diaphragm to which it was compared. The unadjusted typical-use probability of pregnancy at 6 months of use was 13.5% for contraceptive cap users and 7.9% for diaphragms users, with the adjusted risk of pregnancy being 1.96 times higher in the former group [166, 167].

7.5 Advantages

The advantages of male and female condoms include their rapid effectiveness, low cost, and the fact they are simple to use with no required medical supervision. As a non-hormonal method of contraception, they are free from the side-effects and risks associated with exposure to exogenous estrogen or hormones in general.

7.5.1 Non-contraceptive uses

Condoms are the only contraceptive method that provides protection against STIs and, by extension, help in the protection against conditions caused by STIs (e.g., PID and cervical cancer). Laboratory studies have shown that both male latex condoms and male and female non-latex condoms protect against many STIs, including hepatitis B and HIV/AIDS [168–173]. Data from other studies suggest that female condoms may be as effective as male condoms in the prevention of STIs arising due to vaginal intercourse, including *Chlamydia trachomatis*, *Neisseria gonorrhoeae*, *Trichomonas vaginalis*, and genital ulcer disease [173, 174].

7.6 Disadvantages

The disadvantages of condoms are that they are entirely user-dependent, requiring continuous user motivation. Moreover, risk of failure is always present due to the possibility of condom slippage or breakage; as such, barrier methods are not suitable for high-risk pregnancy clients. In addition, they should be used at every act of sex, for which re-supply must be readily available. Condoms may interfere with sexual pleasure in some clients. They require appropriate storage and proper disposal. Allergic reactions to latex is the only known side-effect of barrier methods made of latex [78].

8. Emergency contraception

Emergency contraception, sometimes referred to as the "morning after" pill or postcoital contraceptives, is designed to prevent or delay ovulation after an act of unprotected sexual intercourse (UPSI).

8.1 Content

Current methods of emergency contraception include either the insertion of a Cu-IUCD or the administration of contraceptive pills with hormonal components, including either estrogen and progestin in combination, progestin only, or selective progesterone receptor modulators [175].

8.2 Types

There are various types of emergency contraceptive pills (ECPs), including:

- Pills containing LNG or ulipristal acetate (UPA) alone.
- POPs containing LNG or norgestrel (LNG-ECPs).
- COCs containing both estrogen and a progestin (i.e., LNG, norgestrel, or NET).

In Europe, UPA-ECPs have been available since 2009; subsequently, they received approval in the U.S. from the FDA in 2010 for use as an emergency contraceptive. They are now available in more than 50 countries [78].

8.3 Mechanism of action

The risk of pregnancy after an episode of UPSI is difficult to estimate because it depends on a number of factors, including the fertility of both partners, the timing and number of acts of UPSI, cycle length and variability, and whether contraception has been used incorrectly or not at all. Pregnancy is extremely unlikely to occur as a result of UPSI in the first 3 days of a woman's natural menstrual cycle [141]. However, pregnancy is theoretically possible after UPSI on most days of the cycle. A woman's fertile period is considered to be the 6 consecutive days ending with, and including, the day of ovulation.

Sperm are viable in the female genital tract for about 5 days after UPSI [141]. If ovulation occurs within those 5 days, fertilization could take place and the woman is at risk of pregnancy. A judicial review concluded that pregnancy begins at implantation [176]. It is therefore currently accepted that any emergency contraception intervention must act either to prevent fertilization or to prevent implantation, rather than to disrupt established implantation. According to available data, the shortest time from ovulation to implantation is 6 days, although over 80% of pregnancies implant 8–10 days after ovulation [177].

LNG-ECPs inhibit ovulation, delaying or preventing follicular rupture and causing luteal dysfunction. If taken prior to the start of the LH surge, LNG inhibits ovulation for the next 5 days, until sperm from the UPSI for which it was taken are no longer viable [178]. In the late follicular phase, however, LNG-ECPs become ineffective [179]. Although post-ovulation effects of LNG-ECP have been suggested, subsequent studies have not shown a significant effect when administered after ovulation [180]. *In vitro*, LNG-ECPs have not been found to impair endometrial receptivity or the attachment of human embryos [181].

UPA is a selective progesterone receptor modulator that acts by delaying ovulation for at least 5 days, until sperm from the UPSI are no longer viable. Unlike LNG-ECPs, UPA-ECPs delay ovulation even after the start of the LH surge [179]. However, UPA-ECPs cannot inhibit ovulation at or after the LH peak. Moreover, UPA-ECPs have not been demonstrated to be as effective as other ECPs when administered after ovulation. Li et al. found a significant difference between observed and expected pregnancy rates for women who received UPA-ECPs prior to ovulation, but not for women who received UPA-ECPs after ovulation [182].

Despite this, various theoretical mechanisms of action have been suggested for a post-ovulation effect of UPA, including delayed endometrial maturation; however, the clinical relevance of this in terms of its contribution to preventing pregnancy is unclear [183]. *In vitro*, UPA-ECPs have not been found to inhibit endometrial receptivity, prevent human embryo attachment to the endometrium, or affect sperm function [184, 185].

8.4 Effectiveness

The overall effectiveness of ECPs is difficult to ascertain. Most studies report the pregnancy rate after use of various types of ECPs as a percentage of the number of women who used ECPs; however, a significant number of these women would not

have become pregnant in any case. Studies assessing the effectiveness of ECPs in preventing pregnancy depend, therefore, on an estimation of the number of pregnancies that would have occurred without the emergency contraception intervention.

UPA-ECPs have been demonstrated to be effective when taken up to 120 h after an episode of UPSI, with no significant reduction in effectiveness observed with increasing time until this point [186, 187]. The overall pregnancy rate after taking UPA-ECPs has been reported to be 1–2% [186, 187].

Studies have reported the overall pregnancy rate among women taking LNG-ECPs within 72 h of an episode of UPSI to be 0.6–2.6% [186, 188]. However, in several of these studies, the LNG-ECPs were taken at any time of the cycle; thus, UPSI may or may not have occurred when the women were at risk of pregnancy. Two large RCTs comparing LNG-ECPs to other ECP regimens estimated the number of pregnancies that would have occurred without the intervention and compared this with the actual number of pregnancies observed [188]. The percentage of pregnancies prevented by LNG-ECPs, when taken within 72 h of a single episode of UPSI, was estimated to be about 85%.

8.5 Advantages

Overall, ECPs can be used by women of any age, including adolescents and women with HIV. They do not cause abortion and do not prevent or affect implantation. In addition, they do not cause birth defects if pregnancy occurs. ECPs are considered safe for women's health and do not cause infertility. Oral ECPs can be used more than once in a women's cycle and a woman can take ECPs when needed without first seeing a health care provider. No procedures or tests are needed before taking ECPs, apart from a pregnancy test if indicated [78].

8.6 Disadvantages

Women may have cultural or religious reasons for avoiding a method of emergency contraception that could have its effect after fertilization [189]. It is therefore important that a client who raises concerns about the mechanism of action of any emergency contraception intervention is given sufficient information about what is known and what is uncertain.

8.6.1 Side-effects

Nausea, abdominal pain, fatigue, headaches, breast tenderness, dizziness, and vomiting are commonly reported side-effects of ECPs. Some users also report changes in bleeding patterns after ECP administration, including slight irregular bleeding for 1–2 days or monthly bleeding that starts earlier or later than expected in the first several days after taking ECPs. However, irregular bleeding due to ECPs will typically stop without additional treatment [78].

8.6.2 Risks

A Cochrane review identified only 5 cases of ectopic pregnancy among over 55,000 oral ECP users [190]. Frequent repeated use of ECPs may be harmful for women with cardiovascular diseases, migraine, or severe liver disease [78].

Conflict of interest

The authors declare no conflicts of interest.

Abbreviations

CHC	combined hormonal contraception
COC	combined oral contraceptive
EE	ethinylestradiol
VTE	venous thromboembolism
NET	norethindrone
LNG	levonorgestrel
DSG	desogestrel
DRSP	drospirenone
LH	luteinizing hormone
FSH	follicle-stimulating hormone
IUS	intrauterine system
WHO	World Health Organization
PCOS	polycystic ovary syndrome
BMD	bone mineral density
STI	sexually-transmitted infection
PID	pelvic inflammatory disease
POP	progestogen-only pill
RCT	randomized controlled trial
POI	progestogen-only injectable
DMPA	depot medroxyprogesterone acetate
DMPA-IM	intramuscular DMPA
DMPA-SC	subcutaneous DMPA
FDA	Food and Drug Administration
IUCD	intrauterine contraception device
Cu-IUCD	copper-IUCD
UPSI	unprotected sexual intercourse
ECP	emergency contraceptive pill
UPA	ulipristal acetate

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Section 5

Insights in Human Reproductive Medicine

Chapter 7

The Quantum Theory of Reproduction – How Unique is an Individual?

Zouhair O. Amarin

Abstract

Our understanding of nature's way is founded on quantum mechanics. In its existence of over 80 years, quantum theory has been describing the physical world. The attraction of studying quantum mechanics is the perception of the conceptual structure of nature. This is aided by the mathematical structure that exposes the internal logic of the subject by inventing a notation that embeds the philosophy of the question. To describe how unique each individual is. A calculation method was applied. The uniqueness of an individual is one in two nonillion, octillion, septillion, sextillion, quintillion, quadrillion, trillion, billion, million and thousand. Individuals are indefinitely unique.

Keywords: quantum theory, reproduction, uniqueness, individualism

1. Introduction

The development of a human being begins with fertilization, a process by which two highly specialized cells, the spermatozoon from the male and the oocyte from the female, unite to give rise to a new organism, the zygote.

1.1 Oogenesis

In humans, the ovaries begin to form during embryonic formation in the first few weeks of the first trimester of pregnancy. It starts at the yolk sac, where the primordial germ cells originate, followed by migration along the hindgut to the gonadal ridge around the fifth and sixth week of the embryonic development [1, 2].

At around the sixth-week post-conception, the ovary contains around 26,000 oogonia. The number of oogonia increases by invasion and local proliferation, whereby the ninth week the number of oogonia would be around 250,000 in each ovary [3].

At around this stage of development, the first oogonia of the ovary enter meiosis, although most oogonia continue the mitotic cycle up to the time of the initiation of meiosis [4]. At the start of meiosis, the oogonia lose their ability to divide mitotically and will be described as oocytes [5]. The mitotic division of the oogonia finishes around the 20th week of gestation, where the formation of new oocytes ends [6].

The early development of the ovary and the relation between oogonia and somatic cells is a delicate process. Interfering with ovarian formation during this critical period may have consequences on the number of oocytes a girl is born with and thus on her fertility later on in life [7–9].

1.2 Spermatogenesis

From puberty to old age, male germ cells originate at the seminiferous tubules from a self-renewing stem cell pool. This spermatogenic process is a cascade of developmental stages that provide the mechanism of successful spermatogenesis [10].

There are intratesticular and extratesticular hormonal regulatory mechanisms for successful spermatogenesis in the testicular Leydig cells and the intertubular space, where thin septula divide the parenchyma into about 370 conical lobules. These lobules contain the seminiferous tubules, Leydig cells, and other cellular elements [10, 11].

The seminiferous tubules are coiled loops with two ends that open in the rete testis [11], where their secreted fluid is delivered to the epididymis. The seminiferous tubules consist of germinal epithelium and the peritubular tissue that include different developmental stages of germ cells, namely spermatogonia, primary and secondary spermatocytes, and spermatids that are located in the Sertoli cells [12].

The Sertoli cells have a specialized germinal epithelium in a basal and an adluminal zones, called "tight junctions" that form the blood-testis barrier of the testis. The germ cells pass through this barrier to the adluminal compartment, thus avoiding the possibly diffused nextraneous substances. With the advancement in age, Sertoli cells exhibit increasing amounts of lipid droplets as an indicator of the testicular "biological clock" [13].

Other functions that are attributed to Sertoli cells include nutrition of the germ cell, delivery of spermatids to the tubular lumen; a process that is described as spermiation; production of endocrine and paracrine factors that play a role in spermatogenesis, and secretion of androgen-binding protein to help maintain the duct system [14].

The process of germ cell development during spermatogenesis passes through various stages that include spermatogoniogenesis, meiosis, maturation of spermatocytes, spermiogenesis, and spermiation [15–19].

Spermatocytes go through meiosis with its associated change in chromatin configuration after spermatogonial division. These cells go through two divisions during meiosis and are called primary spermatocytes before the first division and secondary spermatocytes before the second division [20].

Spermiogenesis begins after spermatocytes complete two quick successive meiotic reductive divisions to produce haploid round spermatids. During cytodifferentiation of spermatids, there is condensation of the nuclear chromatin, formation of the acrosome cap, and the development of flagellum, to enable them to leave the germinal epithelium as the process of spermiation takes place [19–20].

Leydig cells surround the testicular capillaries and secrete androgens, including testosterone. Testosterone activates the hypophyseal-testicular axis, masculinizes the brain, initiates and maintains spermatogenesis, and commands the differentiation of the male genital organs and secondary sexual characteristics [21].

Furthermore, Leydig cells have neuroendocrine activities added to their endocrine role as they express serotonin, catecholamine-synthesizing enzymes, neurohormones, cell adhesion molecules, components of the renin-angiotensin system, growth factors, and their receptors [19, 22].

In addition, Leydig cells are involved in autocrine and paracrine regulation mechanisms of the testes and are considered a part of the general neuroendocrine cell system, and their main regulator is the luteinizing hormone of the pituitary gland [22, 23].

The kinetics of spermatogenesis that exists throughout the reproductive life of man is due to the large reservoir of stem cell in the seminiferous tubules. The continuous process of spermatogenesis features cell differentiation and migration from the basal to the adlumin of the germinal epithelium [24–26].

In all parts of the germinal epithelium, there is a 16-day cycle of standard differentiation processes. This "space of time" is called "cycle of the seminiferous epithelium." The production of an A type spermatogonium to become a mature spermatid requires 74 days. Mature spermatids leave the germinal epithelium as spermatozoa and pass through the epididymis. This additional transport takes another 12 days. Thus, the complete spermatogenetic cycle from spermatogonium to mature spermatozoa takes around 86 days [27–28].

Spermatozoa, the products of spermatogenesis are unique in their shape and function making them capable of progression through the female genital tract to meet the oocyte at the lateral end of the Fallopian tubes. At this point, the acrosome reaction takes place. This enables the spermatozoon to pass through the zona pellucida of the female gamete and to get into the cytoplasm and merge with the pronucleus of the zygote [28].

The efficiency of spermatogenesis is questionable. Germ cell loss (oligozoospermia), percentage of malformed spermatozoa (teratozoospermia), and motility problems (asthenozoospermia) in the ejaculate can be extremely high. A high percentage of the developed germ cells are lost by apoptosis and degeneration. Only a fraction of the male germ cells reaches the ejaculation including a high percentage of malformed gametes. Thus, only around 10% of the spermatogenetic potential might serve the reproductive process [28].

The fecundability of the human race is compared poorly with laboratory animals. The mean elongate spermatid-Sertoli cell ratio is 3–4 for the human germinal epithelium versus 12 in rats [28]. The daily rate of spermatozoa production in humans is around 3–4 million per gram of testicular tissue. Accordingly, a higher number of ejaculate spermatozoa are expected in relation to the 20 million spermatozoa per ml as considered a normal value by the WHO [29].

Recent observations report a recent decline of sperm counts in the ejaculates of healthy individuals. This might be due to detrimental prenatal factors including hormones and their metabolites in the drinking water that may adversely affect the different internal and external processes of spermatogenesis in the seminiferous tubules [30].

The intrinsic factors include testosterone, neuroendocrine substances, and growth factors (IGF1, TGFβ, NGF) that represent an independent intratesticular regulation of spermatogenesis. The extrinsic influence is provided by the pulsatile secretion of gonadotropin-releasing hormone by the hypothalamus and the gonadotrophins of the pituitary gland. Other factors include nutrive substances, drugs, different toxic substances, and radiation that may adversely affect testicular function [30–34].

2. How unique is an individual?

Each human individual is unique to an extreme. Each zygote is the result of a certain probability. At around the fifth month of development, the ovaries of the fetus

contain around 12 million oogonia [6]. A single man's ejaculation contains around 422 million spermatozoa [35], only one of which may fertilize an ovum.

The probability of a certain spermatozoon fertilizing a certain oocyte follows the rule of statistically independent events. For example, if a coin and a dice are tossed at the same time, the probability of getting a head with the coin and a six with the dice are quite independent of each other. The probability of a head and a six at the same time = p (H) x p [6], that is:

P (H) x P (6) = 1/2 x 1/6 = 1/12.
Listing an array of possible results can check this:
H1, H2, H3, H4, H5, H6.
T1, T2, T3, T4, T5, T6.
P (H + 6) = 1/12.

This is known as the multiplication law of probability.

To extend this to the probability of a given spermatozoon fertilizing a given oocyte and resulting in the birth of a baby to a certain couple is as follows:

$$P(\text{embryo}) = P(\text{oocyte}) \times P(\text{spermatozoon}).$$

$$= \frac{1}{12 \times 10^6} \times \frac{1}{422 \times 10^6 \times 1.93 \times 52 \times 62}$$

$$= \frac{1}{3.17 \times 10^{20}}$$

$$= 3.17 \times 10^{-20}$$

where 12 x 106: average number of oogonia [6], 422 x 106: average number of spermatozoa per ejaculate [35], 1.93: average frequency of sexual intercourse per week [36], 52: number of weeks per year, 62: mean male reproductive life span = average life span [37]—the average age of adolescence [38].

On one hand, the figure of (3.17×10^{-20}) is only each individual's chance of being the descendant of a given couple in our present time. On the other hand, each individual could have been born in a different period that may date back to a time that might be easily defined. The true figure for this notation should cover all possible combinations since human life started and between all men and women that have ever existed.

To evaluate this, it is necessary to estimate the total number of people who ever lived. The magnitude of present-day population is impressive. Yet, the inhabitants of the world today are only a certain percentage of the populations of earlier periods. It is necessary, therefore, to include the evolutionary and growth rate factors in the notation.

As to the evolutionary factor, in the past four decades, the phylogeny of the *Hominidae* has increasingly become the focus of investigation. On the Geologic Time Scale, early and modern humans existed in the late Pliocene Epoch of the Tertiary Period and in the Pleistocene and Recent Epoch of the Quaternary Period of Cenozoic Era (Age of Mammals).

Although the fossil record of the last 200,000 years presents an unmistakable well-defined picture of the evolution of our modern species, *Homo sapiens*, the final stages leading to contemporary humans present several unresolved problems. The grade of sapiens contains at least two contrastingly different anatomical types; the bulkily built and heavily muscled Neanderthals and the slim-bodied Cro-Magnons.

Moreover, the traditional steps from the *Homo erectus* level of humans to the *H. sapiens* grade have yet to be disentangled [39].

The first undeniable hominid—*Australopithecus*—existed about 4 million years ago. The australopithecines shaded imperceptibly into *Homo habilis*, who integrated slowly into *Homo erectus*, with the latter ultimately transforming into modern *H. sapiens*. However, spirited debate exists over which of the australopithecines occupy a prominent place in the direct ancestry of humans.

It has been suggested that vegetarian *Australopithecus robustus* perished without leaving any descendants and that *Australopithecus africanus* was the forebear of a more advanced hominid. The discovery in 1972 of the "1470" skull and in 1975 of the fossil jaws and teeth that have been classified as the remains of *Homo habilis* and dating back between 1.8 and 3.8 million years, supposing that an older australopithecine gave rise to *Homo habilis*.

The candidate for such an ancestor appears to be the fossil hominid uncovered in 1973 that has been called "Lucy," delineated as the new species *Australopithecus aferensis*. At present, it is safe to state that the *A. aferensis* remains, dating between 3 and 4 million years ago, constitute the earliest definitive members of the family hominidae [39].

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As to the growth factor, the human population has undergone three phases of exponential growth. In the first phase of human history, from our species' origin to about 10,000 years ago, the population grew slowly as people existed as hunter gatherers. Cultivation of plants and animal husbandry may have allowed our agricultural revolution and the second phase of exponential growth, from about 8000 $_{\text{B.C.}}$ to about 1750 $_{\text{A.D.}}$

The industrial revolution, which occurred about 1850 $_{\text{A.D.}}$, promoted the third phase of exponential growth that continues today [40]. Generally, the human population growth since prehistoric times displays a classic J-shaped exponential curve. This curve suggests that the total number of people alive today is approximately equal to the total number who have ever lived and died before us. As the present global population totals 6.3 people, the total number of people who ever lived is over 12.6 billion [41].

To extend this to the probability of a given spermatozoon fertilizing a given oocyte and resulting in the birth of any baby that has ever lived is as follows:

$$= \frac{1}{3.17\,x\,10^{20}}\,x\,\frac{1}{6.3\,x\,10^{9}}$$

where 6.3×10^9: total number of males/females who ever lived [41].

$$= \frac{1}{5.04\ x\ 10^{30}}$$

$$= 5.04\ x\ 10^{-30}$$

Approximately $= 5\ x\ 10^{-30}$

Or 1 in 200,000,000,000,000,000,000,000,000,000

A two nonillion, octillion, septillion, sextillion, quintillion, quadrillion, trillion, billion, million, and thousand is an indefinitely large statistic! Mathematics used this way is irreplaceable in the pursuit of meaning in which fascination lies. But meaning does not reside in the mathematical symbols. It resides in the cloud of thought enveloping these symbols. The most important dictum in quantum mechanics is that what you can measure is what you can know [42]. To perceive the aforementioned question as inherently meaningless is what quantum mechanics teaches us.

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Chapter 8

Smoking and Its Consequences on Male and Female Reproductive Health

Amor Houda, Jankowski Peter Michael, Micu Romeo and Hammadeh Mohamad Eid

Abstract

Smoking contributes to the death of around one in 10 adults worldwide. Specifically, cigarettes are known to contain around 4000 toxins and chemicals that are hazardous in nature. The negative effects of smoking on human health and interest in smoking-related diseases have a long history. Among these concerns are the harmful effects of smoking on reproductive health. Thirteen percent of female infertility is due to smoking. Female smoking can lead to gamete mutagenesis, early loss of reproductive function, and thus advance the time to menopause. It has been also associated with ectopic pregnancy and spontaneous abortion. Even when it comes to assisted reproductive technologies cycles, smokers require more cycles, almost double the number of cycles needed to conceive as non-smokers. Male smoking is shown to be correlated with poorer semen parameters and sperm DNA fragmentation. Not only active smokers but also passive smokers, when excessively exposed to smoking, can have reproductive problems comparable to those seen in smokers. In this book chapter, we will approach the effect of tobacco, especially tobacco smoking, on male and female reproductive health. This aims to take a preventive approach to infertility by discouraging smoking and helping to eliminate exposure to tobacco smoke in both women and men.

Keywords: tobacco, reproductive health, infertility, cessation therapies

1. Introduction

The higher predominance of smoking is seen among youthful men during their fertility period. It is estimated that almost half of smokers, in the world, are aged between 20 and 39 years old [1, 2].

Infertility is a complicated condition in which contribute environmental lifestyle, genetic, and epigenetic factors [3, 4].

Different studies showed that semen parameters may be affected by various lifestyles, advancement in technologies, environmental pollution [5], alcohol intake [6], smoking [7–9].

Smoking and chewing tobacco are the harmful addictions [10] that include a variety of toxic, mutagenic, and carcinogens substances, together with nicotine reported for adversely affecting semen quality and consequently male infertility [11, 12].

1.1 Hormone regulation disruption

The most toxic compound in tobacco products is nicotine. It is a psychoactive drug and an oxidizing substance, which is addictive. The nicotine in any tobacco product readily absorbs into the blood when a person uses it. Nicotine may change the hypothalamic–pituitary axis (HPG) by enhancing the release of cortisol, growth hormone, oxytocin, and vasopressin, which in turn inhibit the prolactin and the luteinizing hormone (LH) [13].

Heavy smokers are the most facing fertility problems than nonsmokers [14]. Studies showed that in smokers, the mean levels of prolactin (PRL), follicle-stimulating hormone (FSH), mean levels of LH were lower, and the mean estradiol (E2) levels were higher in comparison to nonsmokers [15]. The same is observed in another study where testosterone, E2, LH, and FSH levels are lower in smokers [16].

In contradiction, no differences in serum total testosterone, LH, and FSH levels were demonstrated among fertile male patients divided into heavy, moderate, and mild smokers [17].

Moreover, substances in tobacco smoke affect pituitary, thyroid, adrenal, and testicular functions and consequently alter semen quality of both infertile and fertile men [18], leading to a change in testosterone, E2, PRL, LH, and FSH levels, which may cause Leydig and Sertoli cell failure in smokers [19–22].

1.2 Erectile dysfunction

Smoking have been demonstrated to be a hazard factor for erectile dysfunction, a condition in which man is incapable to induce or keep an erection firm sufficient for satisfactory sexual intercourse [23].

In Korea, after a survey among 600 men aged between 40 and 80, they found that ejaculatory and erectile functions malfunction was associated with previous and current smoking habit [24].

In Australia, a second study found that ED was associated with cigarette smoking, and even this association became stronger in heavier smokers [25].

Shiri and colleagues demonstrated that the risk for ED from smoking was generally little, and the smokers had decreased chances of recuperating from ED compared with nonsmokers [26].

A group of researchers showed an association between smoking more than 20 cigarettes daily and nearly 50% high risk of erectile dysfunction [27].

He et al. concluded a relationship between nearly 12 million cases of ED in Chinese men and smoking and reported a significant dose–response association between smoking and the risk of ED [28].

Cao et al. confirmed a significant association between smoking and the high risk of ED. Besides, quitting smoking significantly improved both physiological and sexual wellbeing in male smokers, notwithstanding the level of erectile dysfunction [29].

1.3 Smoking and oxidative stress

The compounds of a cigarette enhance superoxide generation by both endothelial and smooth muscle cells from NADPH oxidase (NOXs) and uncoupled endothelial

nitric oxide synthase (eNOS) and upregulate proinflammatory cytokines and the Ras homolog gene family, member A (RhoA), and its downstream effector Rho-associated protein kinase (ROCK) (RhoA/ROCK) contractile pathway. This process leads to reduction of nitric oxide (NO) bioavailability, endothelial dysfunction, and increase of vasoconstriction [30].

Reactive oxygen species (ROS) also affect hypothalamic–pituitary-thyroid axis and reduce triiodothyronine (T3) and thyroxine (T4) secretion. Low levels of T3 reduce the levels of the protein in Leydig cells and the steroidogenic acute regulatory (StAR) mRNA, along with testosterone production [31]. ROS production interferes oxygen delivery to the testis, which is crucial for spermatogenesis [32, 33].

A possible cause of the harmful effects of nicotine and other compounds of tobacco, on the male genital tract, is the release of mediators of inflammation, such as interleukin-8 and interleukin-6, which may enroll and actuate leucocytes [34, 35].

Successively, activated leukocytes lead to excessive ROS production in semen. Studies reported high levels of oxidative stress markers such as ROS malondialdehyde (MDA) and smoking markers such as cotinine in seminal plasma of smokers [9, 36]. Even expression of antioxidant enzymes and seminal vitamin C was insufficient to provide full protection of spermatozoa [37].

Furthermore, the high levels of ROS and cotinine in seminal plasma were associated with the number of daily cigarettes. The higher consumption means a severe damage in the sperm membrane because of its polyunsaturated fatty acids composition [38].

1.4 Smoking and sperm parameters: Concentration, motility, and morphology

As mentioned before, tobacco and its compounds lead to an excessive production of ROS. The key mechanism responsible for sperm damage is the lipid peroxidation of spermatozoa membrane caused by ROS. As a result, sperm concentration, viability, mobility, and normal morphology decrease [39, 40].

It alters the fertilizing capacity of the sperm [41] and reduces antioxidant activity, which has possible adverse effect on sperm density, motility, and morphology [9, 42].

Calogero et al. demonstrated that Cigarettes Smoke Extract (CSE) in healthy nonsmokers men could suppress sperm motility and alters chromatin condensation. Besides, in a concentration- and time-dependent manner, CSE induces early apoptotic sign and a late apoptotic sign: fragmented sperm DNA [43].

In comparison to mainstream smoke, sidestream smoke contains several toxicants at higher levels including ROS such as superoxide and hydrogen peroxide [34, 40], as well as cadmium [34, 44]. They have also shown to affect semen quality and cause disturbance in sperm acrosome function [39].

Therefore, passive smokers are concerned with this problem. They are 2.5 times more exposed to cancerous substances in tobacco than active smokers [45, 46].

1.5 Smoking and sperm DNA fragmentation in sperm

The most frequent DNA anomaly is DNA fragmentation, which is associated with poor spermatozoa quality, low fertilization rates, and bad embryo quality [47].

Sperm DNA fragmentation is generally induced by oxidative stress and/or apoptosis [48, 49].

Oxidative stress (OS) caused by smoking induces oxidative DNA damage of the spermatozoa [50] and mutagenic adducts [51]. Thus, it leads to alteration of sperm quality and may cause male infertility [52].

Different techniques were used to measure the spermatozoa DNA damage. The latter showed an association with various assisted reproductive technology (ART) outcomes such as fertilization rate, embryo quality, implantation rate, pregnancy, and spontaneous abortion [53]. So, an elevated DNA damage is associated with low implantation and consequently, low pregnancy rate [54].

In men with idiopathic infertility, associated with cigarette smoking, an increase in sperm DNA stainability, sperm DNA fragmentation index, and spermatozoa with round head were noticed [55].

In addition, it has been suggested that DNA damage is the main cause of implantation failure in embryos derived from healthy eggs fertilized by sperm with chromatin defects [56, 57]. These negative effects of smoking on spermatozoa and the damage to the DNA may be due to excessive ROS production [58] and decrease the antioxidant levels in seminal plasma [42].

Dai et al. also reported that tobacco smoking negatively affects sperm parameters, such as volume, concentration, motility, morphology, and viability, leading to male infertility [59].

Moreover, an excessive production of ROS leads to oxidative stress; in turn it affects not only sperm nuclear DNA but also sperm mitochondrial respiratory activity [60] and the endocrine function resulting in several pathologies of the male reproductive system and may be leading to male infertility [61, 62].

1.6 Smoking and molecular alteration: epigenetics, miRNA/noncoding RNA of spermatozoa

Different lifestyles and environmental factors alter epigenetic profiles: chromatin modifications, DNA methylation, and noncoding RNAs, thereby altering chromatin structure and changing gene expression [63].

The protamines are fundamental in the sperm chromatin condensation and the protection of the paternal genomic DNA from alterations [56, 64, 65]. It has also been proposed that the deficiency in protamine may lead to the accumulation of lesions at the level of the spermatic DNA [66], morphological abnormalities, and the triggering of apoptotic pathways, the inactivation of mitochondria, and consequently, the decrease in the sperm motility [67].

The alterations of protamine ratio (P1/P2) at the level of the interval (0.8–1.2) in the semen have been clearly associated with the male infertility [68].

Hammadeh et al. also investigated the association between smoking and protamine deficiency of sperm chromatin and demonstrated that the high P1/P2 ratios in smoker are due to an underrepresentation of P2. This suggests that ROS production in smokers deteriorates chromatin condensation and change protamine 1 to protamine 2 ratio of spermatozoa [9].

Smoking is probably behind the underexpression of protamine ending with high levels of histone to protamines ratios [69]. Overall, the alteration from the normal P1/P2 ratio seems to be important in male fertility, although the precise manner by which this happens can differ from person to person.

Abnormalities during the arrangement of chromatin may also cause infertility [70, 71], affecting embryo development [72, 73].

Epigenetic modifications change the gene expression without altering the DNA sequence and can be transferred to next generation through both meiotic and mitotic cell divisions [74].

Different studies have investigated the relationship between the effects of smoking on epigenetic profiles such as chromatin modifications and DNA methylation and genes transcription [75, 76].

Cigarette smoking adversely affects DNA methylation patterns [77–79]. A previous study from our laboratory showed that smoking may lead to biochemical changes in many regions of the sperm DNA that are related to MAPK8IP and TKR gene. And that has negative effects on semen parameters [80].

Moreover, benzo[a]pyrene and nicotine induce alterations in sperm chromatin during histone-protamine transition, which may alter the methylation pattern of CpG in the promoter regions of DNA in the offspring of heavy smokers [81].

Furthermore, many studies took in considerations the interaction between the gene and the environment. They studied the association between tobacco smoking and genetic polymorphisms, involving DNA repair genes and genes involved in carcinogen metabolism [82, 83].

Over 100 miRNAs were found in spermatozoa. Twenty eight of them were differentially expressed between nonsmokers and smokers. In infertile men, the expression of has-miR-146b-5p, has-miR-509-5p, has-miR-146d, and has-miR-652 was altered [83]. These four miRNAs are involved in different pathways such as cell proliferation, differentiation, and apoptosis in spermatozoa as well as early embryogenesis [83].

Altered spermatozoal mRNA profiles and miRNA changes have been shown in smokers [84, 85].

An increased risk of idiopathic male infertility was reported in male smokers, while nonsmokers did not show an increased risk of infertility. These men carried 462Ile/Val genotype of the CYP1A1 gene [86].

Moreover, a significant relationship was observed between smoking and the GSTM1+/GSTT1 del genotypes and the GST gene GSTP1 105IV/GSTT1 polymorphisms in infertile men. The GSTP1, GSTM1, and GSTT1 genes are engaged in the development of idiopathic male infertility [87].

Amor et al. demonstrated that *H2BFWT*, *TNP1*, *TNP2*, *PRM1*, and *PRM2* genes were differentially expressed ($p < 0.01$), and these genes were downregulated in the spermatozoa of heavy smokers [7].

1.7 Male smoking and assisted reproductive treatment (ART)

Almost 50 million couples worldwide are facing infertility issue [88, 89]. Infertility is described as a disease characterized by a failure to conceive after regular unprotected intercourse of 1 year and is used interchangeably with the term "subfertility" [90].

ART technique was the solution for such couples to solve their infertility issues and to achieve pregnancy. Different lifestyles and environmental factors showed to have an adverse effect on a male and female fertility and consequently conceiving. Tobacco smoking is one of the lifestyle factors that was associated with infertility.

A smoking habit in males also has an adverse effect on pregnancy outcomes among in vitro fertilization (IVF) intracytoplasmic sperm injection (ICSI) patients [8, 91]. An association between cigarette smoking and altered ICSI and IVF outcomes was reported [41]. In a study by Klonoff-Cohen et al., the number of retrieved oocytes decreased by almost 46% in smokers. The males were active smokers, and the females were passive smokers [92]. In addition, a decrease in live birth rates was noticed in 166 couples seeking pregnancy using ART [93].

Although spermatozoa with damaged DNA is still capable of fertilization, but its effect is prominent in the later stages such as apoptosis, poor fertilization rate, high frequency of miscarriage, and morbidity of off springs [94, 95].

Because of the faulty transition histones-protamines, sperm DNA breaks increased, and this may cause poor embryo morphology at early cleavage stages. An abnormal protamine ratio was associated with poor preimplantation [56].

However, other studies have reported that there is no significant relationship between smoking and fertility outcomes in humans [96].

2. Effect of tobacco on female infertility and reproductive health

2.1 Smoking and conception delay

Smoking women experience almost 50% conception delay for over 1 year than nonsmokers women. Besides, active and/or passive tobacco smoking by either partner had adverse effects on conception [97].

Smoking couples, with a conception of over 15 cigarettes daily, demonstrated low fecundity and an increased time to achieve pregnancy [98].

The majority of studies support the negative effects of smoking on fecundity, regardless of other factors [98, 99].

Several reviews have accumulated data on female fecundity and cigarette smoking. All of them concluded that smoking adversely affects female fertility [100].

2.2 Smoking and ovarian function

Compounds of tobacco smoke seem to accelerate the loss of reproductive function and follicular depletion [101].

Women who were exposed to tobacco during the fetal period showed an increase in ovarian dysgenesis [102]. A relation was found between smoking and short menstrual cycle length, that could lead to low fecundity [103]. Moreover, smoking women have their menopause 1–4 years in comparison to nonsmokers women [104].

Women consuming tobacco have high levels of nicotine, which can induce ovarian dysgenesis, resulting in increased infertility [102, 105]. On the other hand, other chemicals in cigarettes can affect the anatomy and function of the uterine tubes [106]. Another study reported that tobacco exposure during pregnancy can cause long-lasting effects in the reproductive system [52].

2.3 Smoking and early pregnancy loss

Tobacco smoke showed an association with bacterial vaginosis, which in turn is associated with second-trimester miscarriage and with preterm labor [107].

A case–control study demonstrated that smoking women (>20 cigarettes/day) had an increased risk of ectopic pregnancy in comparison to nonsmokers women [108]. An increase in spontaneous miscarriage is associated with tobacco smoke in both natural and ART cycles [109].

Moreover, 24% of women with experience of abortion and 19% of women without experience of abortion were passives smokers [110]. Passive smoker women

had low fertility rate and a risk of abortion four times higher in comparison to nonsmokers [111].

A dose–response relationship has been found between miscarriage and smoking. One percent increase in relative risk of miscarriage per cigarette smoked daily. Besides, the risk of miscarriage increased by 11% among pregnant women exposed to secondhand smoke [112].

Pineles et al. demonstrated also that the amount of cigarette smoked by the pregnant woman increases the risks of stillbirth, neonatal death, and perinatal death [112].

In a large cohort study, parental smoking during pregnancy was found to increase the risk of stillbirth, and paternal smoking was an independent risk factor for stillbirth despite maternal passive smoking status [113].

2.4 Female smoking and assisted reproductive treatment (ART)

A smoking woman seems to have reduced fertility and difficulty in conceiving. Different studies showed that tobacco may affect hormone production, which makes it difficult for a woman to become pregnant [114].

Studies have also reported that smoking woman, during fertility treatment, had higher numbers of canceled cycles, lower peak estradiol levels, an elevated gonadotropin injection for ovarian stimulation, increased testosterone, fewer oocytes retrieved, thicker zona pellucida, and more cycles with failed fertilization and implantation compared with nonsmokers [92, 115, 116]. Besides, the success rates of IVF were lower in smoking woman compared with nonsmokers one [117].

Some have also shown that female smoking is associated with reduced numbers of oocytes [118], lower fertilization [115, 119] and pregnancy [119], and higher miscarriages rate [120]. In contrast, other studies have reported that smoking has no adverse effects on fertilization [3] and pregnancy outcomes [121].

Freour demonstrated that active smoking women presented poor ovarian response and lower clinical pregnancy rate [122]. Moreover, an association has been described between current smoking woman, undergoing IVF, and lower concentrations of anti-mullerian hormone (AMH) [122, 123]. In addition, AMH levels were 44% higher in nonsmokers compared with current smokers [124] and declined 21% faster yearly in smokers compared with nonsmokers [125].

Ozbakir and Tulay investigated the association between cigarette smoking and oocyte quality. They concluded that cigarette smoking did not affect the follicles count and the number of oocytes retrieved. However, a significant difference was detected in the morphological assessment of oocyte including cytoplasmic anomalies [126].

3. Effects of tobacco smoking on progeny

The birth defects among the offspring of smoking parents are high [127]. During their pregnancy, smoking woman showed an increased risk of trisomy 21 in the offspring, which results from maternal meiotic nondisjunction [128].

Maternal smoking increased the risk of spontaneous abortion, fetal growth restriction, preterm birth, stillbirth, and low birth weight [129]. A dose–response relationship was found between the risk of low-birth weight and the number of cigarettes smoked daily during pregnancy [129].

Maternal smoking was suggested to have even negative effects on the sperm count of men, whose mothers had smoked more than 10 cigarettes daily, in comparison to men having nonsmoker mothers.

Benzo[a] pyrene and nicotine in cigarette smoke have recently been shown to induce harmful alterations of sperm DNA that can be transmitted through the germ line to future generations [130, 131].

It has also been reported that preconception paternal tobacco smoking increases the chances and risk of multiple forms of morbidities in the fetus and offspring, which could be mediated through epigenetic modifications [132].

Kataoka et al. showed that the high number of daily cigarettes can be the reason behind the low weight at birth. Smoking mothers, who smoked 11–40 cigarettes/day, had infants with 435 g lower weight in comparison with infants born to nonsmoking women. The same was observed for infants whose mothers smoked 6–10 cigarettes/day. Their birth weight was 320 g lower than infants of nonsmoking mothers [133].

Liu et al. concluded also that low number of cigarettes smoked during either the first or second trimester of pregnancy, even as low as 1–2 cigarettes per day, showed an association with a high risk of preterm birth. This proves that during pregnancy, there is no safe level or safe trimester for maternal smoking [134].

4. Smoking cessation

4.1 Nicotine replacement therapies

Nicotine replacement therapies (NRTs) were the first smoking cessation medications the FDA approved for use in smoking cessation therapy. NRT is an effective and safe strategy for quit smoking. They diminished withdrawal sentiments by giving you a low, controlled amount of nicotine but none of the other dangerous compounds found in cigarettes. A low amount of nicotine makes a difference by fulfilling your need for nicotine and diminishes your smoking addiction [135, 136].

There are different varieties of NRTs, which are used in different ways. Each person can choose which variety that suits him. From person to person, the results of NRT are different. Current NRT products include transdermal patch, chewing gum, nasal sprays, lozenges, and inhalers. A combination of short- and long-acting forms of NRT is more effective for smoking cessation in comparison to the use of single forms of NRT [136, 137].

There are non-nicotine medications such as bupropion and varenicline, which are approved from FDA. Their targets are the nicotine receptors in the brain. That helps with withdrawal feelings and blocks the effects of nicotine [135, 136].

4.2 Smoking cessation, reproductive health outcomes, and ART treatment

Santos et al. evaluated sperm quality after a 3-month smoking cessation. They observed a remarkable improvement of different sperm parameters: sperm concentration, sperm vitality, motility, and percentage of spermatozoa recuperated after an enrichment technique [138].

Smoking is associated with oxidative stress. Therefore, antioxidants can be recommended in treatment of infertile smoking women [139]. In addition, patients should adopt lifestyle modifications and quitting smoking [3, 140], losing weight through

different methods, such as diet, education, and exercise [141], and decreasing exposure to harmful toxins, such as phthalate [142].

Fecundity associated with smoking may be improved within 1 year of smoking cessation [143]. The physiological and sexual health in male smokers was improved after they quit smoking, regardless of their baseline level of erectile dysfunction [144].

If behavioral approaches did not work, the use of bupropion and/or varinecline have helped non-pregnant women to quit smoking [145]. Besides, the use of combined NRT was superior to any single NRT in treatment of individuals [146].

5. Conclusion

In the light of the present review, tobacco smoking has deleterious effects on reproductive health including gametes from both parents. Active or passive smoking negatively affects not only the parents but also the offspring. Therefore, the lifestyle factors are very important factors for pregnancy and delivering healthy children. Smoking women and men reproductive age should be strongly encouraged to quit smoking before trying to conceive. Besides, research is still needed to understand how and why smoking causes adverse outcomes in these patients.

Conflict of interest

The authors declare no conflict of interest.

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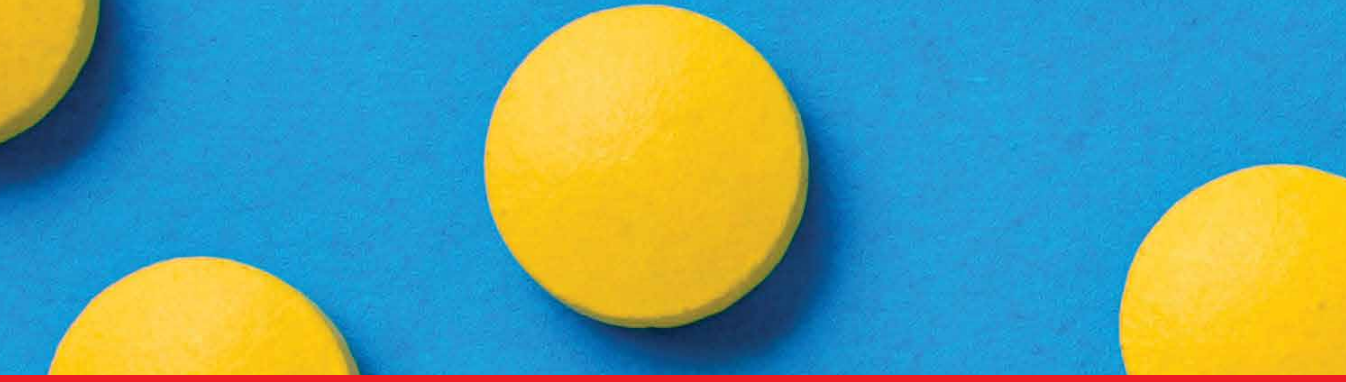

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Globally, there is a shortage of family planning services. This shortage is associated with unacceptably high rates of maternal and perinatal morbidity and mortality that are mostly preventable. The current situation does not comply with the United Nations Millennium Declaration, signed in September 2000. Family planning needs to be widely available and easily accessible. In addition, it is vital that research intensifies to further cover the safety, effectiveness, affordability, and acceptability of family planning methods and accessibility to family planning services. This book is designed as an additional contribution to the family planning spectrum. It covers some aspects of family planning and deals with a number of issues that pertain to reproductive health.

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