

Contraceptive Technology and Human Development

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Abstract- This paper discusses the impact of Contraceptive Technology on human development. It starts with establishing contraceptives as technology and then evolution of the technology and role of various actors and institutional policies is discussed. The role of market force driven diffusion and various social and technical barriers that affected the diffusion are also discussed. This paper establishes that public sector incubation becomes necessary in the development of health related technologies that impact a wide socio-economic strata and offer minimal financial returns in the early stages. It also discusses the role of firms and social marketing in large scale dissemination of technology. It also brings out that gender oriented development and policy shaping becomes important in case of contraceptive technology. Also, lessons from Arnulf Grubler's concepts of technological life cycle have been drawn to analyse the present stage of development of the Contraceptive Technology.

Index Terms- contraceptive, human development, diffusion, STDs.

I. CONTRACEPTIVE AS TECHNOLOGY

Contraceptive is a device or drug that prevent pregnancy by interfering in the natural process of ovulation, fertilisation and implantation. Until recently scientific contraception methods were based on the realisation that pregnancy can be controlled by preventing the amalgamation of male and female reproductive fluids. Contraception emerged as technology when scientists turned their attention to ovulatory cycle of females and hormonal control of reproduction of both sexes.^[2]

II. HISTORICAL PERSPECTIVE

To truly talk about the history of contraception, we need to understand the context of its usage which is the basis of human reproduction and dates back to the era when humans started to live in a social environment but official records can be traced back to 1550 BCE during Mesopotamia and ancient Egypt when people used honey, acacia leaves, lint and other plants with contraceptive properties to be placed in vagina to block sperm by covering the mouth of the womb.^[3] For centuries, mankind has tried to prevent pregnancy by the simple and direct procedure of withdrawing penis from vagina.

A major breakthrough in contraceptive technology came when birth control became an issue during the 19th century and people started realizing the necessity of controlling population growth. Before 1960, men and women had only a few options like sterilization, reversible methods such as condom and withdrawal for men and periodic abstinence for women that had a high probability of failure which led scientists to turn their attention to

the modern scientific understanding of reproduction process to develop effective and safer contraceptive techniques.

III. 1950s TO PRESENT: EVOLVING TECHNOLOGY

A. First Contraceptive Revolution (1950-1970)

Contraceptive revolution began with patent filing for norethindrone by Carl Djerassi in 1951^[4]. The revolution led to the invention of oral contraceptives and intrauterine devices, which separated reversible contraception from the act of coitus and the market was centralised to US. Watkins in her book *On the Pill: A Social History of Contraceptives, 1950-1970* points out "the climate of the 1950s favoured scientific and technological solutions to social problems."^[5] It was a part of post-world war II 'pharmaceutical revolution' enthusiasm.

US government and other governments started funding contraceptive research to bring improvement in the delivery of hormonal contraception and development of implants and injectable in order to enhance the quality and range of contraceptive options available to men and women. In 1950's many feminists like Margaret Sanger and Katherine McCormick fought hard for the development of oral contraceptives. McCormick which is presently one of the Fortune top 100 companies contributed millions of dollars for research and development of the pills.

Many large pharmaceutical companies especially US firms started sponsoring contraceptive research and development. Even though the field was culturally sensitive and did not offer corporate security, the market demand and technological potential motivated the developers to engage in the development and production of new oral contraceptives. R&D time was shorter and patent life was longer because the regulatory requirements were fairly lenient and clinical studies were less sophisticated.

The family planning programmes and policies of 1960's shaped the revolution. In May 1960 Food and Drug Administration (FDA) approved Enovid as birth control pill^[6]. The popular press or media played a central role in the spreading awareness about the technology, in early 1960's it acted as source of enthusiasm and in later toward 1970s also brought health concern to public attention.

The main role of the first contraceptive revolution was to initiate the research in contraception technology and to incorporate family planning in population control public policies.

B. Changing Technology Dynamics (1970-1990)

Oral contraceptive side effects and negative medical reports led to the 2nd stage of contraceptive research and development. Public perception of the pill and IUD had become quite negative.

R&D time got extended from 10 to 17 years because of more stringent regulatory requirements resulting in greater R&D costs and reduction in effective patent life^[7]. Liability insurance also had become essentially unavailable in the United States resulting in many firms leaving the market.

However, something of a substitution effect and growing interest in family planning in developing countries drew the US agency for International development (USAID) into the field motivating research activity in universities and non-profit organizations. The Centre for Population Research at the National Institute of Child Health and Human Development (NICHD) became major source of contraceptive research because of raising sexual health concerns in US. In 1972, the World Health Organization's (WHO) special program of Research, Development and Research Training in Human Reproduction was established. Manufacturing facilities were set up in over 20 developing countries on recognizing the long-term profit potential in such markets. Also, research indicated that IUD risks had been overestimated which motivated the Europeans to return to the method. By the end of 1980, most of the innovation in contraceptive research resided in Europe^[8].

In the early 1990s, withdrawal of large companies from contraceptive production propelled many small companies to enter into the research, development, production and distribution of contraceptives. Increased collaboration between public and private organizations resulted into a new pattern of funding agencies, basic research facilities, university based scientists and clinical trial organizations. Generally the funds moved from the government funding agencies and private foundations to university research centres, non-profit research organizations and small research firms.

This period mainly saw the rise of public funding and non-profit organisations involvement, stringent medical regulation and exodus of large firms from the sector. Reputation of oral contraceptives revived with reduction in side effects using mini pills, lower dose and multi phasic oral contraceptives and appreciation of secondary health benefits.

C. Women Centric Agenda and Sexual Health

Concept of gender and sexual health safety is quintessential in policies deriving development of contraceptive technology. Women's health advocates got concerned about the unresponsiveness of developers to the voices of women themselves, their needs and priorities. It was realized that women were under represented in scientific bodies. So talented young women scientists were motivated and encouraged to enter into the field of reproductive research. Community advisory groups constituting the representatives of the affected groups became very important in research and technology introduction and development. Most pharmaceutical bodies working in this sector started including both women and men in decision-making positions about the development of contraceptive products.

"In 1994, the International Women's Health Coalition prepared a Women's Declaration on Population Policies, which highlighted the ethical principles, minimum programme requirements, and necessary conditions for their implementation (IWHC 1993)"^[8] and 180 countries which participated in the International Conference on Population Development in Cairo in

1994 agreed on the declaration. The Cairo Program of Action laid out a 20-year plan, nations have agree to increase their collective financial commitment to improve the reproductive health care and meeting the unmet need for contraception; maternal mortality reduction; HIV/AIDS prevention; and promotion of education and literacy. The total costs adds up to \$22 billion by 2015, with developing countries meeting two-thirds of the cost themselves.^[9]

In 1998, US Food and Drug Administration (FDA) created an office of Women's Health whose main function was to ensure that FDA was appropriately approving pharmaceutical products. FDA was respected as a stringent drug regulatory authority as it filed products with whose means companies were able to sell their products to the world's largest market.

US National Institute of Health produces guidelines for basic and clinical research in USA such as proper analysis of different potential effects of drugs on women and men. Institutional Review Boards have increased vigilance on studies related to reproductive-health products. World Health organization with support of major international development organizations such as USAID, DFID and others regularly bodies update and publish the standards and guidelines for family planning products and services which are recognized as basis for national planning in the field of family planning around the world thus creating global standards for sexual and reproductive health products and services.

D. Withdrawal and Return of Large Firms

Legislative bodies and civil courts in countries laid strict rules for organizations to place safety and fundamental human rights at the top of their priority list and the consequences of ignoring professional ethics and best practices would have financial costs for them. Thus, largely legal and organizational laws shaped the field of contraceptive development. Funding for reproductive health services shifted from international donors to national governments as the technology progressed.

But many pharmaceutical companies started leaving the area of discovery and development of contraceptive technology because of uncertainty in financial returns and the threat of lawsuits in developed countries. They also faced religious opposition and litigation worldwide. In particular, IUDs faced most of the rebellion, while oral contraceptives managed to survive in the market. As such, the climate for diffusion looked bleak. However in the late 1990s, AIDS epidemic brought back their attention to reproductive health services.

The consumer base began to change rapidly. The fertility rate continued to decline in developed countries and decreased rapidly in developing countries, whereas the number of women using contraceptives increased with equal speed. This demand fuelled the need for more and better contraceptives. Many corporations devoted themselves to the discovery, development and commercialization of new pharmaceuticals. Increase in the regulation of pharmaceuticals and changing economic environment stressed a global view of pharmaceutical market. With the economic improvement in developing countries and the introduction of market economics, global companies began to take part in this expanding market. The new consumer oriented products with good financial returns incentivised the investments

by large firms in the technology and it accelerated the research and development in the technology.

IV. MARKET EVALUATION

“The global contraceptives market was valued at USD 16.0 billion in 2011 and is expected to grow at a CAGR of 5.5% from 2012 to 2018, to reach an estimated value of USD 23.3 billion in 2018”.^[10] Although it is expected that by 2050 population growth rates will decline to the replacement levels but it is also predicted that total world population will reach to 8.9 billion in that year. More than 26 billion new couples will need contraceptives in the next half century.^[11]

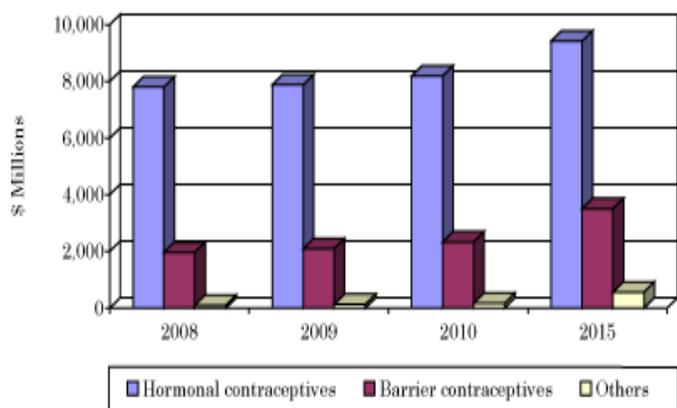


Fig 1. Worldwide revenue of contraceptive market^[12]

The highest demand is for hormonal contraceptives with 78% share in total global contraceptives sale with annual CAGR of 2.8% in 2009. With the research and development of Oral Contraceptive pills, they have become the easiest and reliable method of contraception followed by injectable and topical drugs. The Barrier methods which includes methods that act as barrier between male sperms and female eggs are cheap but lesser effective. But these are better in terms of side effects and also prevent STDs. These barriers are generally male and female condoms. The barrier contraceptives have smaller share but have higher CAGR of 8.5 %. There are some other methods such as spermicides, Trans-dermal package which are new and are not diffused properly. Others also include methods such as terminal sterilisation which include vasectomy and tubectomy, IUCs etc.

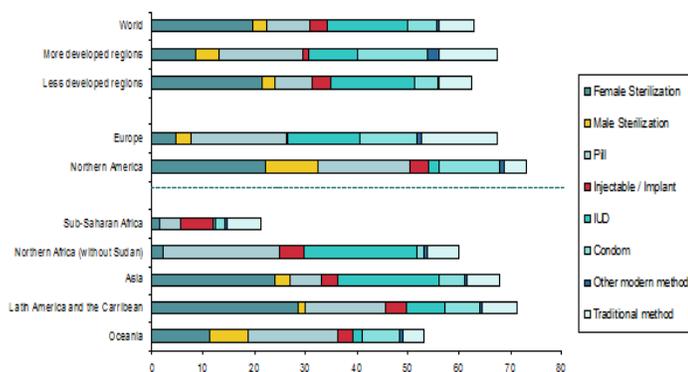


Fig 2. Worldwide Contraceptive Prevalence^[13]

The cultural, regional and social environment plays an important role in defining the volume of the market. Though the global share of hormonal contraceptives is more than 78% but this trend is followed regionally in North American and European markets where the health care standards are the best in the world. In Japan condoms and abortions are common. In China coil is used and oral pill has minimal usage. In sub-Saharan Africa implants and injectable contraceptives account for 38% and oral pill 26%. In central and south Asian countries including India sterilisation account for 64 % and pill adding only 12%. “Among the world’s poorest 69 countries, a study by the Population Reference Bureau showed that sterilisation was most widespread at 17 per cent of women using modern methods, followed by oral contraceptives at 7 per cent, injectables and then intra-uterine devices (IUDs) at just over 5 per cent, with condoms at nearly 4 per cent.”^[10]

V. EMERGING MARKETS AND DIFFUSION

As per WHO report there are about 220 million women who want to delay their pregnancy but have unmet contraceptive needs and developing regions such as sub-Saharan Africa south east and central Asian countries top the list.^[37] A report created by the Guttmacher Institute in New York stated that new methods of birth control are out of reach of 148 million women in three regions of Africa and Asia where there are 49 million unintended pregnancies every year resulting in 21 million abortions. The study also states, “sub-Saharan Africa, south central Asia and Southeast Asia are home to 69 percent of women in the developing world who have an unmet need for a modern method, seven in 10 women with unmet need in the three regions cite reasons for non-use that could be rectified with appropriate methods and are emerging markets for contraceptive technology”^[14]

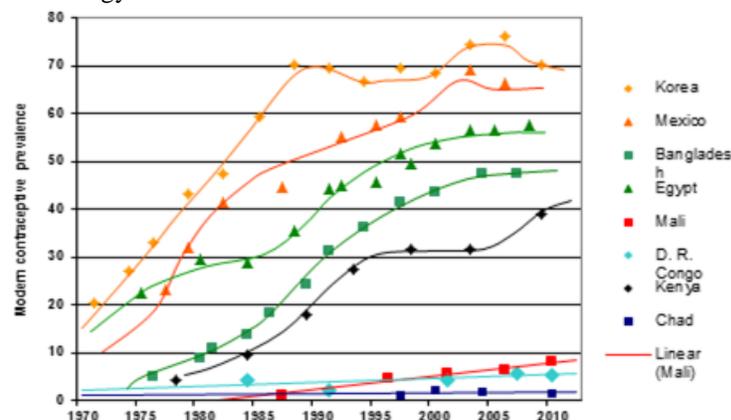


Fig 3. Contraceptive technology diffusion curves^[38]

“The use of modern contraceptive methods, including voluntary sterilization, has generally increased rapidly over the past 30 years, especially in emerging economies with strong family planning programmes. However, progress has stalled in many low-income countries. The use of modern contraceptive methods has changed little in the past decade throughout much of sub-Saharan Africa, and is still low (less than 10 per cent in many countries).”^[15] The process of diffusion for contraception is thus

going through the adolescent phase in low income countries but in emerging countries it has already picked up good speed.

The developing world is the main future market for the contraceptive technology. The return of big firms, increasing prevalence of Sexually Transmitted Diseases and its awareness among potential users through innovative social marketing and advertising, improving sale and distribution systems, changing socio-cultural environment in developing nations and, increasing population and governmental efforts to curb it will drive contraceptive market growth in near future.

By 2025, the customer base for contraception will likely be comprised of 2500 million women^[16]. Contraceptive use is increasing among young women. Increasing young women education and awareness about the need of contraception fuels this demand.

VI. SOCIAL MARKETING AND DIFFUSION

Social dynamics play an important role in the diffusion process of any technology, but more so in the case of contraception. The mechanisms of information flow and demonstration effects are essential for diffusion. Therefore, social marketing measures have been used in developing countries to accelerate diffusion. For instance, in 1968, the Government of India initiated a social marketing programme for contraceptives in the area of family health and welfare, with the launch of “Nirodh” brand of condoms.^[17] By the early nineties, many Social Marketing Organizations (SMOs) such as HLPPT, PSI, Parivar Seva Sanstha, DKT India, PHSI, HLL started springing up with funding from government and other organizations.^[18] The Ministry of Health and Family Welfare (MoHFW) of India now identifies social marketing as a key approach for providing accessible and affordable contraceptive products to low-income families and vulnerable groups. Elsewhere, various social marketing strategies being adopted include behaviour change communication, capacity building, networking, community mobilization, policy advocacy, and mix usage of media. Social Marketing of Contraceptives mainly consists of three factors, “Contraceptive branding, the development of a commodity logistics system and a sustained marketing campaign.”^[19] Market research shows that local implementation and adaptation of brands is very important and multiple brands should be designed so as to appeal and accommodate various cultural mind-sets.

VII. DISTRIBUTION SYSTEMS

Distribution systems differ from country to country depending on fertility preferences of the women with unmet need for contraceptive technology. Today, non-clinical delivery systems have developed more because of the inability to expand clinical-based system since clinical based distribution systems heavily rely upon existing health facilities and require the help of private physicians. Non-clinical delivery systems have different modes of operations such as commercial distribution, community based, village based, contraceptive retail sail programs, and household distribution.

A. Commercial Distribution Systems

In commercial distribution system, the contraceptives are given to the distribution network like pharmacies, local boutiques and village centers at low subsidized price or no cost so that they can further sell it to the consumer at a low price. Little money that is generated from sales is returned back to the program to lessen program costs. NGOs such as Rockefeller and Bill & Melinda Gates Foundation have contributed millions of dollars for supply of contraceptives in developing countries.^[20]

B. Community Based Distribution Systems

In community based distribution system, canvassers are identified, contacted, trained, and supplied with contraceptives so that they can sell it to the local people who want them. These canvassers may be village elders, midwives, merchants or volunteers willing to take responsibility for tasks such as contraceptive storage and transmittal of family planning education and information. Various households are visited to identify the clients.

To improve the distribution systems, innovative advertising methods have been developed which make discussion and purchasing of contraception more comfortable among people. The public policy domain is also crucial sale or distribution. The policies keep changing over the time in order to make contraceptive technology more readily accessible to people. Some examples of changes are integrating family planning services into the existing health services, elimination of requirements for prescriptions of pills and incorporation of paramedical personnel into the family planning delivery system in order to overcome scarcity of medical doctors and pharmacies in rural areas.

VIII. FEEDBACK AND LEARNING

Feedback from the user is an important criterion that affects further innovation and diffusion because ultimately it is the user who chooses an appropriate contraceptive technology with which he/she is most comfortable culturally and ethically and also about which he/she is well informed regarding its safety and side effects. Hence, opinions are sought from the contraceptive users on the type of product they wish to see in the market. Program managers and service providers have informed that affordable products that are highly effective, reversible, easy to use, have secondary health benefits and are controllable are desired by users. With prevalence and awareness of STDs and present inefficacy of contraceptives to provide both protection and efficiency, there is a demand for dual contraceptive technology. Also, it has been observed that people readily accept vaccinations and injections because of their past experience with small pox vaccinations and injections but no such vaccination exists as of now that can provide protection against pregnancy. Such feedbacks are taken into account for further innovation in contraceptive technology for better human development.

IX. PRODUCT INNOVATION

As a result of feedback obtained, several new products have been launched into the market during the last few years like implants, medicated intrauterine systems (IUS), and transdermal patches with longer duration of action, new oral contraceptive pills and contraceptive vaginal rings. The new oral contraceptive pills are based on newer progestin synthesized in the last decade. They have higher anti-ovulatory action and are more accepted and tolerated by the users. They also provide additional health benefits such as prevention of salt and water retention that reduces symptoms of bloating, weight gain and increase in blood pressure. The contraceptive vaginal ring has the advantage that it gives women a prescription for a full one-year of supplies thus reducing the return visits for resupplies. Also it does not need any specific clinical training of health providers since women can themselves use it. The current contraceptive methods have additional benefits like improvement in menstrual bleeding patterns, alleviation of acne, premenstrual syndrome and protective effect against endometrial cancer. New technologies like Jadelle, Norplant, Evra and Copper-T 380 IUD have been recently developed.^[21] Some contraceptive technologies that are presently under development include transdermal gels or sprays. Also, Contraceptive Technology that can provide protection against unwanted pregnancy as well as sexually transmitted diseases is advancing.^[22]

X. BARRIERS AND CONTROVERSIES

A. Religious and Cultural Barriers

Family planning methods of couples are deeply influenced by cultural and religious beliefs. These factors become more important in the developing countries. An analysis done by National Family Health Survey in India for Muslims and Non-Muslims brought out the result that Muslim women have greater opposition to family planning. They prefer to use temporary methods of contraception while the National Family Planning Program promotes sterilization. Further, they prefer to utilize private-sector services while the program relies on public sector services for family planning.^[23] Many people especially some Hindu families believe that having large families provide status and security. Women are believed to be unclean during their menstrual period because they bleed. This leads to the non-acceptability of contraceptive methods, especially the ones that cause bleeding like IUD.

In Latin American countries, church prevented the adoption of contraception methods.^[1] In such countries, it was the physicians who spread awareness regarding the contraception technologies because of large number of women coming to them with health issues after poorly performed abortions. In South central Asia, Southeast Asia and Sub Saharan Africa, religious prohibition, cultural and social beliefs account for 16% of unmet need of women for modern contraceptives.^[24]

There have been a lot of controversies over the coverage of women's contraception methods by health insurance companies in developed countries too because of conflicts between religious motives and the rights, beliefs and health care needs of people that further act as a barrier for contraceptive usage. Traditional attitudes and laws governing sales and use of contraceptives can

create political difficulties in the advertisement of contraceptives while taking approval from the government. Also, the "Clinicians who develop a heightened sensitivity towards their patient's cultural orientation can enhance the opportunity for a successful outcome and ensure that the care delivered is congruent with that patient's values and beliefs".^[25]

B. Barriers in Developing World

Apart from Regional and Cultural barriers, the major barrier to contraceptive technology in the developing world is limited choices available which are not able to meet everyone's needs. People are poor due to which they are not able to afford suitable latest contraceptive technology. Unavailability of trained health care officials is another barrier. Because of lack of awareness regarding the systematic usage and side effects of the contraceptive, people fear using them. There is a lack of knowledge among people regarding family planning services.

C. Barriers in Developed World

Significant unmet need for contraception is a problem in developed countries as well. Apart from that, barriers are mainly due to requirement of prescription for the use of contraceptive technology although researchers suggest that there is little need for a routine physician's involvement. Sometimes poor quality of available services and labeling on the product based on outdated data miss informs both the public and health care providers thus preventing many users from using contraceptive technology. Media influences, fear and misconceptions about contraceptives also add to the barriers.

D. Gender Based Barriers

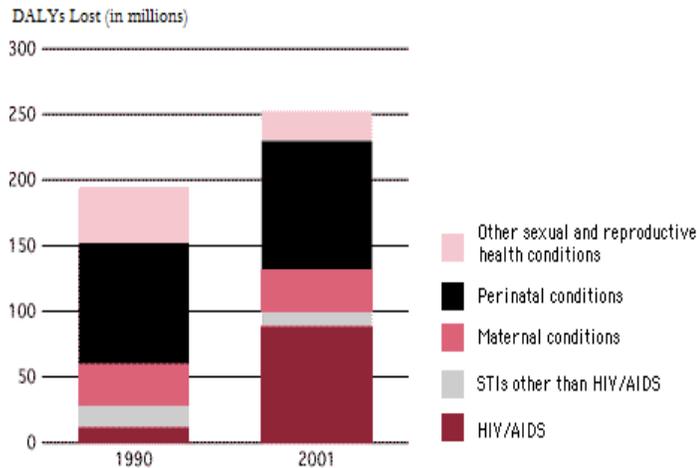
Earlier there was a huge difference in the attitude of men and women towards contraception. It was seen that women were usually concerned about the side effects and the psychological changes that contraception might bring while men were concerned about how contraception would affect the sexuality and sexual intercourse. In male dominated societies, males usually disapproved the use of contraception probably because they feared that their partners would become sexually unfaithful once they started using contraception and they might lose control over their wives' sexuality.

However in recent years, Social scientists have observed a shift in men's attitude about the impact of their role in their partner's sexual health and benefit. Men and women think that they should share the responsibilities mutually for contraceptive use. They have started to consider male contraception as well, as another option. The idea of male pill, which can suppress sperm production, is being floated around.

XI. IMPACT ON HUMAN DEVELOPMENT

"Human development is a process of enlarging people's choices. The most critical ones are to lead a long and healthy life, to be educated and to enjoy a decent standard of living."^[26]
"Worldwide, pregnancy-related conditions and STIs account for one-third of the global burden of disease among women of

reproductive age (15-44) and one-fifth among the total population.”^[9] The contraceptive technology plays an instrumental role in family planning, population control, prevention from sexually transmitted diseases, improving sexual and reproductive health, empowerment which directly or indirectly expands choices and contributes significantly in improving well-being of human beings. “The international community has agreed that reproductive choice is a basic [human right](#).”^[12]



Note: DALYs = disability-adjusted life years. Fig 4^[9]

A. Tackling Sexually Transmitted Diseases

The Sexually Transmitted Infections and Venereal diseases are transmitted by sexual intercourse with infected person or through any other medium through which bodily fluids are exchanged such as using infected needles. STDs/STI are basically of two types bacterial and curable such as chlamydia, gonorrhea, and syphilis and viral, which can't be cured, only their symptoms can be treated such as HIV/AIDS, HPV. “Globally, 35.3 million [32.2–38.8 million] people were living with HIV at the end of 2012. An estimated 0.8% of adults aged 15–49 years worldwide are living with HIV”^[27]. HIV is primarily transmitted through unprotected sexual contacts. The protected/safe sex refers to the use of contraception by individuals involved in sexual activity. Barrier methods of contraception has major potential of reducing the spread of STDs. Hormonal contraceptives don't provide protection against the risk of STDs but most of the married couples rely mainly on Oral Contraceptives and are highly prone

to STDs. Dual protection by using both hormonal contraceptives (implants, pills) and barrier methods (condoms) offer the best protection. The relevance of the contraception and STDs is also a driver for the development of the technology as STDs and specifically AIDS is a major health issue and significantly affect human development which bring public funding by governmental and non-profit organizations for the development of the contraceptive technology.

B. Contraceptives and Family Planning

“For every \$1 spent on family planning, \$4 are saved on education, public health and water and sanitation.”^[28] Family planning services are defined as "educational, comprehensive medical or social activities which enable individuals, including minors, to determine freely the number and spacing of their children and to select the means by which this may be achieved.”^[29] It is achieved mainly by using contraceptive technologies along with sexuality education, pre conception counselling etc. Promotion of Family planning practices and availability of contraceptive methods is essential for well-being of women health and a couple can make informed and planned choice about their sexual life and parenthood responsibilities. It also helps in development of communities and better allocation of public funds. “The total medical cost for a pregnancy, delivery and care of a new born in the United States is on average \$21,000 for a vaginal delivery and \$31,000 for a [Caesarean section](#) as of 2012. In most other countries the cost is less than half. For a child born in 2011, an average US family will spend \$235,000 over 17 years to raise them.”^{[30][31]}

C. Prevention Of Pregnancy Related Risks In Women

Family planning allows a women or couple to decide the gap between two births and also helps in controlling the number of births. The child birth has direct effect on a women's health. It also helps in decreasing the abortion rates which adversely affects the women's health and also helps in avoiding early child bearing. “Globally, the total number of maternal deaths decreased by from 543 000 in 1990 to 287 000 in 2010. Likewise, global MMR declined from 400 maternal deaths per 100 000 live births in 1990 to 210 in 2010. The latter represents an average annual decline of 3.1%.”^[32]The report points out that family planning, better contraception and improved health care facilities are the main reasons for the decline.

D. Reduced Infant Mortality Rate

The main reason for infant mortality is ill timed and closely spaced pregnancies, and family planning helps in preventing this. It also helps in reducing the adolescence pregnancies which lead to birth of preterm or low weight babies which have higher rates of neonatal mortality. The contraception or family planning also reduces the births to older age women which also leads to high infant mortality rate. The development levels are also indicative of Infant mortality rate. "On average, 61 babies die for every 1,000 live births in developing countries, compared with eight deaths per 1,000 in developed countries; in some developing countries, the rates are much higher than the average."^[33]

opportunities for women and increases their participation in the

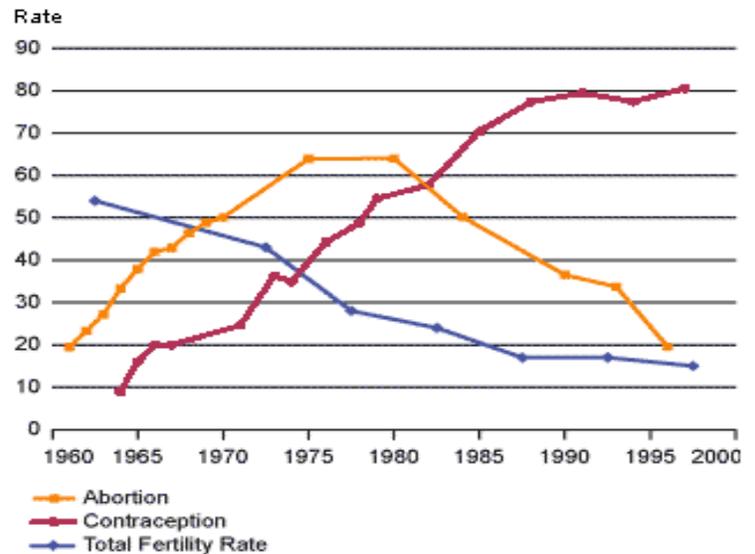
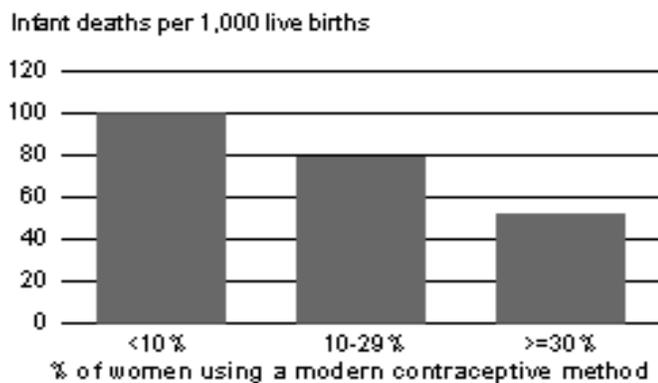


Fig 6. South Korean Experience ^[35]

Note: Abortion rates are expressed per 1,000 women of reproductive age, contraceptive prevalence per 100 married women of reproductive age and TFRs per 10 women.

public life including economy. "Improved maternal health means fewer orphans and more time for and greater ability of mothers to care for and nurture their children."^[9] An educated mother has better information about health, which leads to well being of both mother and child. Also, smaller family enables parents to invest more in one child. "Children with fewer siblings tend to stay in school longer than those with many siblings."^[37]

Contraception's Role As contraceptive use increases, infant mortality declines.



Source: All data are from Demographic and Health Surveys; averages based on 49 countries.

E. Human Population Control

Population Control are the practices of artificially altering the rate of human population growth. Family Planning and Contraceptives become very important in devising policies for the reducing the population growth rate. "Family planning is key to slowing unsustainable population growth and the resulting negative impacts on the economy, environment, and national and regional development efforts."^[37] The figure shows that as the contraceptive prevalence increases the Total Fertility Rate (TFR) decreases and TFR is closely related to the long term population growth rate.^[34]

F. Empowering People and Enhancing Education

Family Planning enables people to make informed choices about their sexual health. It enhances the educational

XII. S CURVE ANALYSIS OF CONTRACEPTIVE TECHNOLOGY

Contraceptives Diffusion curves showed a steady growth in 1970-1990 for which universities and public funding and non-profit organisations were the main actors and regulatory health institutions defined law and policies for the development of technology. The large firms left the market because of strict regulations which explains the decline in contraceptive prevalence in the early 1990s. But the AIDS epidemic and new developing countries' contraceptive needs created the strong market force which brought back large firms to the technology and awareness campaigns and New Millennium Plans also brought public funding in the process. As we saw in the case study that the contraceptive technology is still in the phase of product innovation based on feedbacks, has increasing growth rates, many new firms are still entering the field and the technology development and diffusion is still hugely dependent on the public institutional policies. Also, technology has not achieved global standardisation and cost-effectiveness which are major characteristics of the maturity phase of technology. It's fair to conclude from the above arguments and Arthur Grubler's concepts of technological life cycle ^[36] that Contraceptive Technology is still in the second phase (adolescent phase of diffusion) of its development.

In conclusion, the impact of contraceptive technology has been significant on the human development not only because of its direct effect on improving health and population control but also due to the many indirect ways in which it gave gender parity a new dimension and triggered many lasting social changes. Though the contraceptive technology is still in its development phase, it has effected and improved many human lives and is key for solving major health and population growth problems. It is a technology that will have its utility and usability as long as human race exists on the face of planet earth.

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