

FemTech : Challenges and Opportunities

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Abstract- Technology has continually helped humans to maintain their wellness and health. It has the prospective to address key biological and social differences between males and female through digital health technology and may therefore help to recover women's health and well-being. The technology that assists women in sustaining their health issues is termed as FemTECH. While this word was initially invented to convey a positive technological development for females, the market is now saturated with devices for personal use aimed at tracking and improving female's biological processes, including fertility, breastfeeding, and their sexual preferences. From fertility tracking apps to technology in tampons, the opportunities for improvement are limitless. It is a multi-billion-dollar industry and growing at fast pace. Investors once believed FemTech was not a good market, but now state-of-the-art funders have realized that companies and products that oblige the needs of women in an innovative way are long overdue.

Index Terms : Femtech, Fertility, PHTT, Apps, IVF

INTRODUCTION

Femtech (is short form for "female technology") refers to the umbrella term focused on digital health technologies, to address women's health concerns like fertility solutions, products, services, and softwares. The term "FemTech" was first created in 2016 by entrepreneur Ida Tin. Femtech include periods and fertility mobile tracking apps, fertility monitoring devices, pregnancy and nursing issues, reproductive health issues, self-help apps designed to address the pressures and anxieties associated with general wellness, proactive approaches to menopause and women centric solutions.

BACKGROUND

Men and women have been dissimilar physiologically and anatomically. Women tend to be shorter than men and have thinner skin, both these factors can lower the level of toxins's exposure. They have different

immune levels and hormones systems, which can play a very important role in the absorption of substances inside the body. This lower tolerance threshold is compounded by women's higher percentage of body fat, in which some chemicals can remain in the body for a variable time.

There is plenty of data showing that women have, on average, smaller hands, and yet the designing of various tools/equipment revolve around the average male hand as if one-size-fits-men is the same as one-size-fits-all. For example, the average smartphone size is presently 5.5 inches which can be properly used by one-handed by men, but the average woman's hand is not much bigger than the handset itself and hence women are not going to use such phones.

In the tech world, the inherent assumption is that men and women are alike, and studies are based on men as the default human user. No consideration is taken care of that women are different. Criado –Perez emphasizes, when Apple inaugurated SIRI- its health-monitoring system with much elaboration in 2014, it exaggerated it as a "comprehensive" health tracker. This could track blood pressure, heartbeat, footsteps taken, blood alcohol level, trace metals present in body. But it was not women centric as this did not include menstrual cycle feature. Apple's personal assistant for iOS, mac OS, tv OS and watch OS devices that uses voice recognition and is powered by artificial intelligence (AI) has no solution for abortion solutions for a raped female victim.

From smartwatches that are too big for women's wrists, to map apps that fail to account for women who may want to know the safest and fastest routes to fulfill their sexual desires by the apps called "iThrust" and "iBang." While there are an increasing number of female-led tech firms that do cater to women's needs, they are seen as a "niche" concern and often struggle to get funding.

Female anthropometric data has never been taken into consideration [1]. Cars have been manufactured using car crash-test dummies based on 'average' male size. Only in 2011 female crash-test dummies in the US sent cars were introduced and star ratings was seen dropping. EuroNCAP acknowledged that occasionally they scaled-down male dummies only. But women are not scaled-down men, their body is dissimilar. The females have different muscle mass distribution, lower bone density, differences in vertebrae spacing, female body sway in a different manner. These differences are fundamental when it comes to injury rates in car crashes.

The situation is even worse for pregnant women. Although a pregnant crash-test dummy was created back in 1996, testing with it is still not government-mandated either in the US or in the EU. In fact, even though car crashes are the number one cause of foetal death related to maternal trauma, a seatbelt haven't yet been developed that works for pregnant women. Research from 2004 suggests that pregnant women should use the standard seatbelt, but 62% of third-trimester pregnant women don't fit that design.

Linder [2] has been working on what she says will be the first crash-test dummy to accurately represent female bodies. Currently, it's just a prototype, but she is calling on the EU to make testing on such dummies a legal requirement. In fact, Linder argues that this already is a legal requirement, technically speaking. Article 8 of the Treaty of the Functioning of the European Union reads, "In all its activities, the Union shall aim to eliminate inequalities, and to promote equality, between men and women." Clearly, women being 47% more likely to be seriously injured in a car crash is one hell of an inequality to overlook.

Designers may believe they are making products for everyone, but in reality, they are mainly making them for men. It's time to start designing women specific products to cater her needs.

In chemical, food, pharmaceutical industry and salons the entire female employees are open to a large range of chemicals on routine basis and are found in various products polishes, removers, gels, shellacs, disinfectants and adhesives that are essential part of their work. If these females after returning from their job repeat the same cleaning work and other routine work at their home, they will be exposed to higher concentration of chemicals that are omnipresent in common products. Exposure of these chemical

through inhalation, contact and skin lead to respiratory disease, cancer, miscarriages, and hormonal imbalance. Over the past 50 years, breast cancer rates in the industrialized world have risen considerably. A failure to research on female bodies, occupations and environments means that the data for exactly what is behind this rise in dust diseases is totally missing.

The formula to determine standard office temperature was developed in the 1960s around the metabolic resting rate of the average man. But a recent Dutch study found that the metabolic rate of young adult females performing light office work is significantly lower than the standard values for men doing the same activity. In fact, the formula may overestimate female metabolic rate by as much as 35%, meaning that current offices are on average five degrees too cold for women. This leads to the odd sight of female office workers wrapped in blankets in the summer, while their male colleagues wander around in shorts.

In both developing and developed countries, awareness of the importance of a gender analysis in health is growing, with respect to both infectious and chronic diseases. Gender analysis in health has been undertaken mainly by social scientists who observed that biological differences alone cannot adequately explain health behaviour. Health outcomes also depend upon social and economic factors that, in turn, are influenced by cultural and political conditions in society. To understand health and illness, both sex and gender must be taken into account.

Gender differences in medicine include sex-specific illnesses or conditions which occur only in people of one particular gender due to underlying biological factors. The prostate cancer is observed in males and uterine, breast cancer in females. Historically, medical research has primarily been conducted using the male body as the basis for clinical studies. The findings of these studies have often been applied across the sexes, and healthcare providers have traditionally assumed a uniform approach in treating both male and female patients. More recently, medical research has started to understand the importance of taking sex into account as evidence increases that the symptoms and responses to medical treatment may be very different between sexes. Personalized male medicine cannot be a substitute for female medicine.

The taboos surrounding periods, infertility, and feminine hygiene are gradually being broken as more and more women find a safe space to talk freely about

their issues due to the emerging number of companies that are committed to providing the necessary aid and support to women seeking viable solutions.

Innovative products that help women combat any kind of hygiene issue they may encounter like toilet seat covers, toilet seat sanitizers, disposable funnels, UTI care kits, and even intimate care products like underwear liners, body grooming products or menstrual cramp relief patches, have built the stage for femtech companies to gain speed and popularity.

From the politicization and criminalization of women's reproductive decisions to prompt 'optimum' decision making during pregnancy, to stigmas surrounding (in)fertility and menstruation, to inclusion in clinical trials, women today face multi-layered, institutionalized assaults on their autonomy when it comes to their health and well-being. Yet we also live in a world where women drive the majority of consumer spending, and the market for products aimed at women is booming. The femtech market is expected to be worth nearly \$50 billion by 2025.[3] Those in the field of technology, of which there are now over 200 startups worldwide, claim that femtech can dually assist individual women in knowing and understanding their bodies, and through the data collected enhance scientific knowledge of women's health. The personal health tracking technologies (PHTT) market is now replete with apps (that sometimes come paired with devices) that monitor, track, process, and advice based on data relating to women's fertility, breastfeeding, and sexual pleasure.

IMPORTANCE OF FEMTECH

There are several reasons femtech has become important in present life.

- Progress in medical awareness and delivery systems: The facility of more suitable, patient-friendly way to access healthcare like virtual clinics, direct online consumer-prescription over phone using video and audio services and innovative physical clinics give women a better option to take care of themselves saving lots of time.
- Promotion for self-care: The availability of free and subscribed healthcare trackers/apps, at-home diagnostics, wearable and affordable electronic chips help women get their personal body parameters and understand the changes in the

body to take charge of that particular situation at an early stage.

- Communication/presentation/awareness and advertisements of stigmatized topics: The female menses and the use of disposable sanitary pads and products, pregnancy testing kits, diagnostics tests etc., have been shown through advertisements by the companies at prime time to commercialize these products and target the female audience. This will create awareness and are delivered to women directly online and offline shopping.
- Delivers culturally sensitive and tailored care: The designing of the products and services to marginalized groups, including african and asian women, women in underdeveloped/developed countries, and LGBTQ populations by Femtech companies.
- Better suited to understanding the needs of women: The femtech companies are mainly recognized and supervised by women, hence they can better understand women's needs and problems.
- Moderates the gender discrimination in technology management: This enhances job opportunity for educated women in various field and eliminate gender discrimination.

FINDING SOLUTIONS

While some types of femtech go beyond the realms of the womb, the majority of it focuses on and around reproduction and fertility-related processes. Within the realms of fertility management, there are numerous apps available for download on smartphones that enable women to track every aspect of their reproductive and sexual lives including menstrual cycles, ovulation, sexual activity, contraceptive use, and any associated symptoms or side-effects of any of the natural processes. Some apps notify women when their period is due, remind women when they are due to take their contraceptive pill, when they are entering their fertile period, and when to change sanitary products.

Some of these apps now have paired biosensing technologies, such as a thermometer, that feed data back to the app (usually via Bluetooth). Internal, or 'insertable' devices are available that detect changes in cervical mucus to predict fertile windows or detect

progesterone levels in saliva. Femtech thus comes in the form of stand-alone apps, or wearable or insertable technology that sends data to a paired smartphone app. App users are often prompted to input personal information from more simple facts like name and age to more complex and private matters like occasions of intimacy. [4]

The life of present-day women has been changed completely due to higher education, high speed internet availability, access to information and female hygiene products available in the market. The awareness about the feminine issues like menstrual health and hygiene has increased and they are looking at solution in the form of products and devices to make them comfortable and safe in society. Various app for early cancer prediction, fertility is now being used by women to focus on female health issue. However, there is lack of awareness among rural women about monthly hygiene.

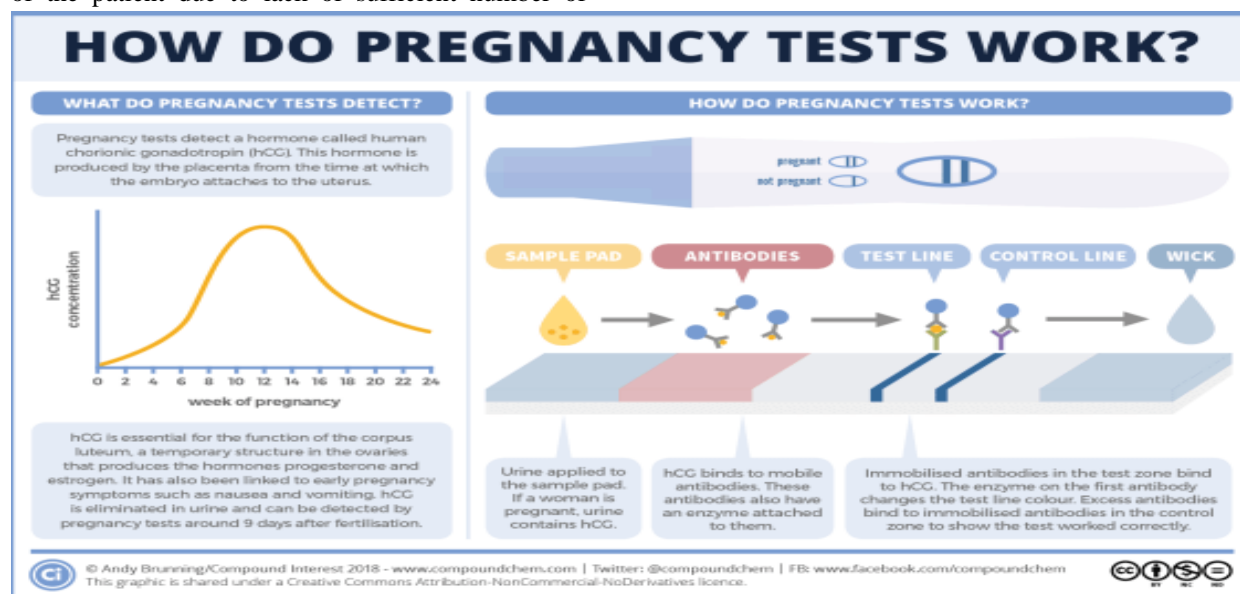
The major drifts in innovative technologies shows that femtech is targeting on monthlies issues, pelvic health, fertility and pregnancy control, sexual wellness and chronic conditions of women. This is helping women to take better care about their health themselves using trackers, apps and wearable devices. The noninvasive detection methods help in the start of early treatment of deadly disease like cancer and can lessen the possibility of complexity of the disease. Femtech cannot be a substitute for the doctor's assessment about the disease and treatment process. This can be used in addition to the ongoing personalized treatment of the patient due to lack of sufficient number of

specialized consultants of the disease. This technology may lessen the hospital burden and time of women for physical appointment/examination with the doctors. The various self-operated automated screening tools are less expensive, are very accurate, has high speed and give results in few seconds.

The Procter and Gamble invented the first commercial applicator tampon for female menstrual cycle in the year 1000. First menstrual pads were sold commercially in 1896, invention and manufacture of the first reusable menstrual cup was in 1930. The first period panties were used in 2011 and menstrual disc was invented in 2015. There are various examples of Femtech in present scenario.

PREGNANCY PREDICTION

“My healthy Pregnancy” kit /app detect the presence of changeable risk parameters from preterm to delivery using digital data of patients using algorithms. When any risk is observed app immediately inform the doctor and also sends the sensitive and modifiable schemes to help minimize the risk which might go unaddressed for racially diverse and socioeconomically deprived woman. The pregnancy kits help in early detections and taking extra precaution for women who have tried and failed to conceive (Fig.1). Femtech is a great option for the fertility control with females with PCOS (Polycystic ovary syndrome), Femtech startups snagged over \$1.1B to help women's healthcare preferences in 2014.



(a)



(b)

Fig 1 Pregnancy Test

Earlier the pregnancy symptoms were physically observed in the form of tiredness, a missed period, or even nausea and vomiting. There are, however, some ancient techniques which had a high degree of accuracy, even if at that time people didn't know reason. Ancient Egyptian women used the growth of seed to confirm pregnancy. They urinated on bags of barley and wheat seeds. The quick growth of the sprouts of the seeds indicated pregnancy. This had a surprising success rate of more than 70-85%. Scientists believe this is because estrogen in the urine stimulated the seed growth.

Though home pregnancy tests seem commonplace now, they were only developed in the 1970s. Prior to this, tests were carried out in diagnostic laboratories. These laboratory tests were developed less than 100 years ago and were initially somewhat unusual than today's methods.

The first home pregnancy test was introduced in 1976. Since then, pregnancy kits have become the most common diagnostic kit used at home by women. Pregnancy tests detect human chorionic gonadotropin (hCG) levels using antibodies. It is an ideal indicator of pregnancy using drops of urine since its level rises rapidly and consistently in just a few weeks of pregnancy. Today, more than 15 different types of home pregnancy tests are available to buy over the counter in various countries. Presently the home pregnancy kits can detect pregnancy with an accuracy of 99% and are very reliable. Digital pregnancy tests use a sensor to detect the colour change and determine the different lines for 'pregnant' or 'not pregnant' on their screens Fig1(b).

BREAST PUMPS

Wearable breast pumps are an example of Femtech. This has allowed women to relieve themselves from the pain and milk the baby by extracting milk directly

in baby bottles for later use. There are no proper places in offices to pump the extra milk coming out of the breasts manually or using power. Now with the use of breast pump they can join their work and other activities as per their convenience.

MENSTRUAL HYGIENE PRODUCTS

A menstrual cup (Fig 2) is a menstrual cleanliness device in the form of bell with a shoot which is introduced into the vagina during monthly periods in women. Its function is to accumulate menstrual fluid (blood from the uterine lining mixed with other fluids).. The stem is used to push in and pull out the bell-shaped cup that fits in the vaginal wall just below the cervix and collects menstrual fluid. Every 4 –12 hours (depending on the amount of flow), the cup is detached, fluid removed, rinsed, and reinserted. After each period, the cup requires emptying and cleaning. It is made of flexible medical grade silicone or latex. The advantages are that these are reusable for up to 10 years, making their long-term cost lower than that of disposable tampons or pads, though the initial cost is higher. This is unlike tampons and sanitary pads, which absorb the fluid instead and generate solid waste being disposable in nature. As menstrual cups are refillable, they generate less solid waste than tampons and pads, both from the products themselves and from their packaging. Most menstrual cup brands sell various sizes smaller and a larger size depending on age and flow of fluids. These cups are colorless/colored and translucent, with different firmness depending on the brand of the cup. Menstrual cups typically do not leak if used properly, though incorrect placement or inadequate cup size can cause some women to experience leakage. Softer cups may be more comfortable for some, but firmer cups may have a better seal. Menstrual cups are a safe alternative, ecofriendly with less toxic infections as compared to other menstrual hygiene products.



Fig 2 Menstrual Cups

INFERTILITY TREATMENT

Infertility is an ailment of the female reproductive system described as the failure to conceive a child after 12 months or more of regular unprotected sexual intercourse[6]. Healthcare providers consider a couple infertile if they try for a baby but fail to get pregnant within one year. The infertility diagnosis shows that the amount of time trying to conceive drops to six months if a woman is older than 35.

There are two types of infertility which include : Primary- A woman who was never pregnant and who can't conceive after one year of not using safe sex devices. Secondary-When a woman has at least one past pregnancy can't get pregnant again.

Infertility affects millions of people of reproductive age worldwide – and has an impact on their families

and communities. Estimates suggest that between 48 million couples and 186 million individuals live with infertility globally. [7- 9]

In the male reproductive system, infertility is most commonly caused by problems in the ejection of semen, absence or low levels of sperm, or abnormal shape (morphology) and movement (motility) of the sperm.

In the female reproductive system, infertility may be caused by a range of abnormalities of the female reproductive organs like ovaries, uterus, fallopian tubes, and the hormonal levels.

Fertility care encompasses the prevention, diagnosis and treatment of infertility. Equal and equitable access to fertility care remains a challenge in most countries, particularly in low and middle-income countries. Fertility care is rarely prioritized in national universal health coverage benefit packages.

Causes of Infertility in female reproductive system:

- Tubal disorders such as blocked fallopian tubes, which are in turn are caused by untreated sexually transmitted infections (STIs) or complications of unsafe abortion, postpartum sepsis or abdominal/pelvic surgery.
- Uterine problems which could be inflammatory in nature (such as such endometriosis), congenital in nature (such as septate uterus), or benign in nature (such as fibroids and polyps)
- Disorders of the ovaries, such as polycystic ovarian syndrome and other follicular disorders
- Disorders of the endocrine system causing imbalances of reproductive hormones. The endocrine system includes hypothalamus and the pituitary glands. Examples of common disorders affecting this system include pituitary cancers and hypopituitarism.
- Abnormality in menstruation
- Celiac and Kidney disease
- Past ectopic (tubal) pregnancy
- Pelvic inflammatory disease
- Polycystic ovary syndrome (PCOS), ovarian cysts and primary ovarian insufficiency.
- Sickle cell anemia.

Home ovulation kit can be used to record signs of ovulation, such as basal body temperature and cervical mucus. Various tests can also help detect and rule out a female fertility problem:

- Pelvic examination comprise of a Pap smear to check for structural problems or signs of disease.
- Blood test: A blood test can check hormone levels, CBC, thyroid profile test.
- Transvaginal ultrasound: The doctor inserts an ultrasound rod into the vagina to look for problems with the reproductive system.
- Hysteroscopy: The doctor inserts a thin, lighted tube hysteroscope into the vagina to examine the uterus.
- Saline sonohysterogram (SIS): A transvaginal ultrasound is performed with filled full uterus with saline (sterilized salt water) to see inside the uterus.
- Hysterosalpingogram (HSG): X-rays capture an injectable dye as it travels through the fallopian tubes. This test is a diagnosis for blockages in the fallopian tubes.
- Laparoscopy: A laparoscope (thin tube with a camera) is inserted into a small abdominal incision. Female pelvic laparoscopy helps identify problems like endometriosis, uterine fibroids and scar tissue.

After diagnosis, the treatments for infertility include:

- Medications: Fertility drugs that can change hormone levels to stimulate ovulation.
- Surgery: Surgery can open blocked fallopian tubes and remove uterine fibroids and polyps. Surgical treatment of endometriosis doubles a woman’s chances of pregnancy.

Some couples require more help conceiving like Intrauterine insemination (IUI) and In vitro fertilization (IVF). To increase pregnancy odds, a woman may first take medications to stimulate ovulation before trying one of these options:

- IUI: A healthcare provider uses a long, thin tube to place sperm directly into the uterus.
- IVF: IVF is a type of assisted reproductive technology (ART). It involves harvesting the eggs at the end of the stimulation and placing sperm and eggs together in a lab dish. The sperm fertilize the eggs. A provider transfers one of the fertilized eggs (embryo) into the uterus.
- Intracytoplasmic sperm injection (ICSI): This procedure is similar to IVF. An embryologist (highly specialized lab technician) directly injects a single sperm into each of the harvested eggs and then a provider transfers an embryo into the uterus.
- Third-party ART: Couples may use donor eggs, donor sperm or donor embryos. Some couples need a gestational carrier or surrogate. This person agrees to carry and give birth to the baby.

FEMTECH PRODUCTS

As the Femtech industry is growing the available products for women are also rising and are summarized in Table 1

Table 1: Name of Femtech Companies and Products

S.No	Name of Company	Detail of App/ devise developed
1	OKY	The first period tracking app with personalized monthlies trackers and calendars, tips, and period information. It is girl-centric and managed through a gamified design.
2	Clue	Menstrual and reproductive health of women
3	Glow	Ovulation, pregnancy and women's reproductive health
4	Ava	Tracks and predict ovulation and woman's fertile time period.
5	Natural Cycles	Women's fertility status
6	Bonzun	A custom-made IVF app developed to achieve the goal of fertility management.
7	Bloomlife	Rent wearable devices so that pregnant women and doctors can handle the complications related to pregnancy in a better way
8	Coroflo	Monitor the flow of milk to the baby of Breastfeeding mother.
9	Apricity	Online clinic for women to discuss and help women to improve her chances of conceiving a child.
10	Thermai Scan	By designing a cost efficient, accurate and remote devices to screen for early detection of breast cancer using a small thermal camera and smart phone
11	Niramai	Start up for Detecting early breast cancer in an effective and safe manner using disruptive artificial intelligence algorithm.
12	Skin health	App to predict relationship between skin health and the menstrual cycle

These products have following advantages:

- Age and culturally appropriate, restricted to a particular area in their own local languages.
- Digitally comprehensive for low connectivity/mobile literacy
- Manageable both online and offline depending on internet connectivity.
- Open source, with high data privacy and security
- Responsible with cycle-prediction, and period and body-positive language
- Fun, girl-centered and gamified, to drive user engagement and encourage learning.
- This process also used feedback and input at every development and design stage — informed everything from the technical specifications and features to the app's look and feel.
- Also central to the project is UNICEF's deep commitment to protecting children's online data and privacy. In a region where girls typically share phones with family members or with friends, and where data privacy risks are often gendered, data security is critical. Oky has individual log-in information with password protection to ensure that girls can access information and track their periods privately, with their personal data only ever stored locally on their device.

Various Social media apps such as tracking the periods, ovulation patterns and the personalized messages alerts on the smart phones with password protection have promoted more women to avoid the stigma related to female intimate and menstrual hygiene and made them better informed to take decisions for themselves. There is lack of knowledge and discussions about stigmatized topics among women about their personal care, hygiene and how this can lead to various diseases. Most of the girls don't know about the menstrual cycle until they get it and are feared about this event in their life. There is necessity for organic, recyclable, reusable products ranging from organic pads, and ecofriendly herbal products to avoid waste generation. FemTech can lead to social and health care ecosystems by overall improved women's healthy during the latter stages of their life in menopause.

FEMTECH –MORAL IMPLICATIONS

The women of the house take majority of the decisions related to their families' health issues. The expenditure on women's health issues is more but still the digital health investments have focused on women's health is very less since 2011.

The health care market related to women's products is very small, as it focusses on a specialized market with less investors with the women centric products. In addition, femtech companies require data security and have individual information (10). Femtech apps like pregnancy status, the menstrual cycles information, and cancer-related health data and their sexual activity of women.

Presently the Femtech companies are not governed by the law. There are issues related to the misuse of personal data as most of the apps are not registered. The user is never told about which data has been used for prediction and diagnosis of the said disease. There are always chances of cyber-attack. These technologies cannot replace the treatment by doctor. Still Femtech has been very useful for awareness about female issues(11).

CONCLUSION

Femtech covers a variety of technologies which covers the innovations in health technology for females especially for feminine hygiene product. As women are becoming more aware about general and sexual health there priorities are also changing. Femtech has been giving them various opportunities through various apps, devises and virtual clinics.

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