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A SHETTLE'S METHOD MODEL FOR AUTOMATING PRECONCEPTION SEX SELECTION

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ABSTRACT
The world over, and especially in Africa and Asia, couples show a preference for particular sex of children; either male or female. This preference may arise due to economic reasons, customs of the people, or simply for a "gender balanced family". Whatever the reasons, the fact still remains that couples would like to be able to choose the sex of their children. While there are various options to achieve sex selection, all of them are either too expensive or too invasive. This paper presents how Shettles' method being the least expensive and the most reliable method of preconception sex selection was modeled to enable automation. The results show that it is a more consistent and reliable method for gender selection. In addition, the result also shows that the Shettles' method lends itself favourably to computer programming and would be very useful in the lives of couples that desire a particular gender of offspring.

Keywords: Computer assisted, Preconception, Sex selection, Model, Programming.

1. INTRODUCTION

Preconception Sex selection refers to couples choosing to have a baby of a particular gender. It is currently a topical issue among medical practitioners and social commentators [1]; while some believe that it is unethical, others believe that there is nothing wrong with it. Preconception sex selection is not only useful for human beings but also has a promising future even in agriculture for food production [1]. If we can find an economical method to tilt the probability of the sex of offspring to what we desire, parents will find joy in their quest for children with the gender of their choice.

The world over, and especially in Africa and Asia, couples show preference for a particular sex of children; either male or female [2]. In a survey conducted in Hungary, results showed that 94% of women had a sex preference for their next child after the first child [2]. This statistics shows that a large number of people, even in Europe, also have a preference for a particular gender in a baby. Successful sex selection is necessitated by social factors, economic factors or psychological factors. Sometimes, it can also be as a result of religious beliefs [2].

In Hindu belief for instance, it is believed that a son must light up the funeral pyre of a deceased for his/her spirit to be saved and it is also believed that male children are better suited to help with farm work and thereby improve the economic situation of the family [2]. In many African tribes, lineage is considered on the paternity side. Therefore, the inheritance/ascension of monarchies is through male offspring. This social factor makes the need for a particular sex very rampant. In fact, in some tribes, a woman cannot inherit any part of her father's estate.

This paper focuses on preconception sex selection in human beings, not necessarily for medical purposes but to satisfy the aspirations of a couple on the sex of children they desire; it should be noted that sex selection can also be very useful in economic terms for animal husbandry. There are some aspects of animal husbandry that may become very profitable with a particular sex of the animals being raised at some particular points in time. For instance, it would be of great economic advantage to goat rearers in Saudi Arabia if they can make their goats bear more male offspring about six months before the hajj period since a lot of Muslim pilgrims would require to slaughter a ram for sacrifice during the hajj period and only male goats can be used for the sacrifice. Another aspect of animal production where sex selection can be of immense advantage is in the area of dairy production. Since only female goats can produce milk, it would be beneficial for the farmer to have more female goats than male goats. These examples bring to fore, some of the many possibilities of sex selection both in human beings and animals.

2. STATEMENT OF THE PROBLEM

The need for an offspring of a particular sex has made some families have more children than they originally planned for, and sometimes, more children than they can really take care of [1]. This could lead to overpopulation and/or irresponsibility on the part of the father. Also, when the number of children of a particular sex has gotten to a degree, some cultures resort to selective infanticide [2]. This unnecessary over population and infanticide can be reduced if not eliminated by successful preconception sex selection [1]. In addition, there is also the psychological effect associated with giving birth to only a particular gender of children in some cultures. In Nigeria for instance, the term “Mama Abigail” or “Iya Bomboy” is used to describe a woman with all female children or all male children respectively. These names are social stigmas and women who are called such names just bear the hurt at the very best. Sometimes calling a woman by these names can result in violence.

Although sex selection is sometimes criticized on ethical grounds, the moral dilemmas concerning sex selection for clinical purposes are much less troublesome. Effective preconception sex selection can be a therapeutic alternative in cases of sex-linked genetic disorders [1]. It was contended that more than 400 such disorders are inherited in a sex-linked recessive manner for example, the muscular dystrophies, the fragile X syndrome (mental retardation), haemophilia, Lesch-Nyhan syndrome, Hunter’s syndrome, Fabry disease, and testicular feminization Syndrome. The current medical approach to sex-linked diseases is prenatal diagnosis. For families at risk, preconception sex selection helps to avoid the physical discomfort and psychological burden of prenatal diagnosis, which usually involves karyotyping of the embryos and selective abortion [1]. Isolation of desired sex chromosome- bearing spermatozoa and its use to preferentially produce offspring can thus eliminate the risk of conceiving genetically problematic foetuses. Preconception sexing of gametes (spermatozoa) can therefore eliminate the necessity of costly prenatal diagnosis and post conception selective abortion [1].

In Africa, it is not unusual to find marriages that break up because of the gender of the offsprings, especially, when the gender of the children are all females. In a bid to have “heir(s)” that would inherit them, some men would marry a second wife or keep mistresses that would bear them the elusive male child(ren). In Nigeria, one of the reasons for polygamy amongst the Christians (Christianity in Nigeria accepts only one wife) is because of sex infertility, i.e., the inability of a couple to have children of a particular sex. From the foregoing, it is evident that Preconception Sex Selection would help alleviate a lot of social, economic and medical problems couples face today. There are some who argue that Preconception Sex selection would cause a social imbalance in the boy to girl ratio populations. They argue that this imbalance in the ratio of boys to girls would eventually trigger some other social problems like non availability of ladies for marriage [2]. However, contrary to this belief, it has been proven that most parents want a gender balanced family. Previous research showed that only a total of 8.1% of 250 couples surveyed preferred exclusively one gender, which may theoretically lead to a gender imbalance, but the choices of only male or only female children were nearly equal [3]. Over 90% of the couples wished for an equal number of both genders. Similar surveys have been carried out in Germany, United Kingdom and USA. In all of these surveys, the conclusion has been the same – The desire for a “gender balanced” family would prevent the distortion of the natural sex ratio [1]. This study uses Shettles method to develop a model for Computer Assisted Preconception Sex Selection system.

3. RESEARCH OBJECTIVES

The aim of this study was to develop a model for Computer Assisted Preconception Sex Selection (CAPSS) using one of the most inexpensive and non-invasive medical procedures – The Shettles method. The specific objectives are:

1. To review the existing Preconception Sex selection methods.
2. To develop a computer model based on the Shettles method for preconception sex selection.

4. RELATED LITERATURE

Although sex selection sounds much like a TV show from the Sci-Fi channel, its practice has been around for ages [1]. The concept of gender pre-selection is certainly not new and it can be traced back to ancient times, especially in China, Greece, Egypt, India and many other parts of the world [4]. For many reasons, couples often want to choose the sex of their babies. It was reported that in ancient China, women who wanted a baby girl would hold pearls and those who wanted a baby boy would hold bows and arrows during pregnancy [4]. Likewise in ancient Greece, men who wanted a baby boy would lie on their right side while having sexual intercourse. In the 18th century in France, men actually tied off their left testicle in hopes of getting a baby boy. Of course, those methods never worked perfectly [4].

There are also some sex selection/prediction methods that are astrology based. For example, the Chinese Gender Calendar is an astrologically-based gender selection chart that cross-references the age of the mother with the month of conception. The gender calendar was said to have been discovered in a dynastic royal tomb nearly 1,000 years ago and is believed to provide an accurate means to influence gender outcome. Although there is no shred of scientific evidence to support the efficacy of the Chinese Gender Calendar or other horoscopic/astrological methods of gender prediction, at the very least any gender selection technique, no matter how ludicrous or unfounded, can be assumed to have a 50% accuracy rate.

In the olden days in Nigeria, Africa, the palm crease of a child is used to determine the gender of the next child that would be born after the child. Until recently, it had been believed that the palm crease determination of sex was unfounded. But recent research showed that the palm crease prediction of the next child is over 90% accurate for children conceived naturally [1],[5]. A common (and very likely mythological) gender choice method is based on a simple bifurcation between sweet and salty foods [1]. According to this theory, a preconception diet heavy in salty foods will increase the odds of having a boy. A preconception diet dominated by sweet foods is purported to yield girl children. Either way one looks at it, this method would appear to pose somewhat of a health risk. Better to heed the words of the doctor and integrate a healthy, balanced diet into the preconception lifestyle!

More recent research suggests that diet (and particularly the mineral component of certain diets) can have an impact on the baby's gender[6]. The zona pellucida is a protective shield around the egg that a sperm must penetrate in order for fertilization to take place. Here, the sperm must "unlock" certain receptors in the pellucid membrane to gain access to the egg's genetic core. To summarize research conclusions, differential ratios of potassium to calcium/magnesium exert an effect on the make-up of the receptor sites or pellucid "locks" that traverse the surface of the egg. These changes in the sperm receptors produce a biological tendency to attract either X chromosome sperm or Y chromosome sperm. Thus, a preconception diet rich in calcium and magnesium (and low in sodium and potassium) will effectuate changes in the ovum receptor sites that tend to turn away Y sperm and attract X sperm, with a resultant female gender outcome. Conversely, a preconception diet rich in sodium and potassium but low in calcium and magnesium would have the opposite effect, cultivating a receptor site attraction for Y sperm and a resultant male gender. While this theory may have some theoretical-sounding talk behind it, it is best that one consults with a doctor before making any alteration in diet.

Other theories suggest that the pH acidity level in the vagina and cervix can have an effect on the gender of a baby [1]. In short, X or girl sperm, while more robust and slower than Y or male sperm, are more resilient to acidity in the vagina. X's may be slower, but they may also be able to withstand an acidic environment where pH levels "weed out" the male-chromosome sperm. Male or Y sperm are quick and speedy, but weaker, so if knocked out by unfavourable pH levels, the "girl sperm" will ostensibly make it to the egg. High alkalinity, on the other hand, would tend to favour the alacrity of "male sperm", or at least even the pH odds. The pH level in the vagina may be altered, in theory, by a number of external or naturally-occurring variables. Here, diet could be a factor, as well as the presence of fertile-quality cervical mucus. Healthy cervical mucus around the time of ovulation tends to establish a vaginal pH level that is conducive to general sperm survival. External factors like douching may also have some impact. All in all, there is very little science that substantiates either the diet or pH level theories about controlling gender outcome, expert's advice to be wary of gender selection products that suggest invasive techniques or alterations in a healthy diet regimen.

5. METHODOLOGY AND CONCEPTUAL FRAMEWORK

The Shettles method for sex selection can be said to be based on the following broad criteria: [1][5]

1. Time of intercourse
2. Characteristic differences between the X and Y chromosomes of the sperm
3. The PH-Level of the vagina.

Each of these three criteria can be manipulated in different manners to help achieve the desired baby gender. However, the criteria that lends itself more, to be taken advantage of, is the second criteria (i.e., characteristics differences between the X and Y chromosomes of the sperm). This is illustrated in the Table 1.

Table 1: Characteristics differences between the X and Y chromosomes of the sperm

X Chromosomes	Y Chromosomes
Produces a female baby	Produces a male baby
Always larger than Y	Always smaller than X
Has a longer life span than Y Chromosomes	Has a shorter life span than X Chromosomes
Noticed to be a long distance swimmer with slow speed	Noticed to be a short distance swimmer with more speed than X chromosomes
Can survive in relatively higher acidic vagina	Cannot survive in high acidic vagina. Prefers an alkaline surrounding

Having all these characteristics information about the sperm, and knowing the sex of the child that is required, we can then proceed to manipulate the characteristics and some other variables, to achieve our goal. Thus, the design of a sex selection engine that would simulate the outcome of the sex of a baby that would be conceived under different situations is described as follows:

- **The Sex Selection Engine Inputs and Outputs**

The function of the Sex selection engine is to give the probability result of having a particular sex of a baby based on the inputs that go into the Sex Selection Engine.

- **The Engine Inputs**

1. Last menstruation date: This is the date the last menstruation cycle period ended. The last menstruation date, when combined with the number of days in a regular cycle can be used to determine the ovulation dates.
2. Usual number of days in a period cycle: This is the usual number of days between the end of a menstrual period and the beginning of the next menstrual period. This would work only for ladies with regular menstrual cycles.
3. Date of copulation: This is the date of occurrence of sexual intercourse
4. Coital Position: The sexual position being used at the time of male ejaculation also forms an input into the engine. The coital position determines how far the sperm may travel before reaching the egg of the woman.

- **Engine Output**

The decision to be made by the Sex Selection engine is the sex of the child with the greater probability to be conceived. The engine simulates the known properties of each of the variables and gives the result of combining the variables when in different states.
From Shettles' theory:
Speed (X) < Speed (Y)
Lifespan(X) > Lifespan (Y)
Size (X) > Size(Y)

This implies that Speed is inversely proportional to Lifespan and also inversely proportional to Size, i.e.,
Speed α 1/Lifespan (1)
Speed α 1/Size
(2)

- **Distances Covered By Sperm**

The average length of the vagina is 6 inches when a woman is not aroused but can expand when aroused or during child birth. An average vagina can expand to 10 inches long and 2 inches wide during sexual intercourse. The average length of the cervix is 2 inches. The length of the fallopian tubes is averagely 4 inches [1],[4],[5],[6]

The speed of sperm is averagely 1 inch per 15 minutes. It therefore implies that the sperm would travel a total of 19 inches (10 inches [Vagina] + 2 inches [Cervix] + 3 inches [Uterus] + 4 inches [Fallopian Tubes]) to fertilize an egg just released from the ovum. The sperm may travel less distance if the egg had been released previously. The sperm cells can live approximately for 3 days in the woman's body once it gets past the cervix. The sperm cells can live only for approximately 6 hours within the vagina.

- **Distance Covered By Egg**

The egg moves from the ovum to the uterus (a distance of 5 inches) within 24 hours and if not fertilized by any sperm, disintegrates. This implies that the egg moves at a speed of 4.8 inches per hour. Furthermore, it has been proven that the X chromosome is approximately 2.5% larger than the Y chromosome [1],[5],[6],[7],[8]. Going by equation (2), it is safe to assume that Y chromosomes would be at least 0.5% faster than X chromosomes. Also, going by equation (1), it is safe to assume that the X chromosome life span is at least 0.5% longer than that of the Y chromosomes. The distance from the entrance of the vagina to the cervix is averagely 10 inches when a woman is aroused. The sexual position can make the reach to this cervix closer. So does the length of the man's penis.

5.1 The Inference Mechanism

The inference mechanism has two basic tasks.

1. **TASK 1: Prediction**

The aim of this function is to give the sex with the highest probability of being conceived based on all the input parameters supplied. This task is more of a predictive one when all parameters are known. The prediction task would be most useful for couples who do noot have a sex in mind but want to know what gender of baby they would get if they choose to make babies given some conditions.

2. **TASK 2: Suggestion**

This function aims to suggest conditions under which couples should try to make babies if a particular gender is sought. This task is more of a suggestive one and is best suited for couples who have a particular baby gender in mind. This task of the inference mechanism takes as input, the desired gender of the baby and one or more input criteria. It subsequently advises on the expected state of the other factors for the desired gender to have the higher probability of being conceived.

Table 2: Summary of gender requirements according to Shettles:

MALE CHILD	FEMALE CHILD
Sex on ovulation day	Sex about two day before ovulation
Deep penetration coital positions	Shallow penetration coital positions
Alkaline vaginal pH level	Alkaline vaginal pH level
Long penile length	Shorter penile length

The actual implementation considers the dynamics of combining the outlined criteria and the inputs to the engine to give a result.

5.2 Implementation

Having modeled the dynamics of the chromosomes, the egg and the sperm, the interaction among them have to be simulated in order to compute the inference outputs given its inputs and see the behaviour of the modeled system. This study employs C++ programming language for the implementation of the automated system.

The models are as follows:

- **The Egg Model**

```
class eggClass
{
public:
eggClass(); // Class Constructor
int eggDistanceSwam; // Variable that holds the distance swum by the egg
int eggLifeRemaining; // Variable that holds the remaining lifespan of the egg
int lentOfFalopianTube; // Variable that holds the length of the fallopian tube
void eggMove(); // Method that simulates the movement of the egg
void eggDie(); // Method that simulates the disintegration of the egg
bool eggFertilized; // determining if the egg is fertilized by a sperm
bool eggInUterus; // determining if the egg has reached the uterus
void setLentOfFalopianTube(int lentOfFalTube);
};
```

- **The Chromosome Model**

```
class chromosome
{
public:
chromosome (); // Class Constructor
float distanceCovered; // Distance covered by the chromosome
int lifeSpanRemaining; // Remaining Life span of the chromosome
float spermLifeSpanRemaining;
float elapsedTime; // Time elapsed since chromosome release
bool checkLife(); // Method checking if chromosome still lives
time_t startTime, stopTime; // variables to track time
int chromeLifeSpanReduction (); // Gradual reduction of lifespan
void die(); // Method simulates chromosome's death
};
```

- **The Sperm Model**

```
class sperm
{
public:
sperm (); // Class constructor Method
chromosome x ; // Defining the x chromosome of the sperm
```

```
chromosome y; // Defining the y chromosome of the sperm
bool spermLifeRemains; // variable holding if sperm still lives
void swim(); // Method simulating the swimming of sperm
bool isSpermAlive (); // Method checking if sperm is still alive
};
```

The modeling of the entities involved has to take into consideration, the peculiarities of the entities i.e., the egg, the chromosomes and the sperm itself. The sperm is an aggregate of chromosomes (x and y). This is depicted by having the x and y members of the sperm as type chromosome. The egg class depicts characteristics of the female ovarian egg. This is depicted in the model as we can see in the methods "eggMove" and "eggDie" *also members "eggInUterus" which checks if the egg is already in uterus and can no longer be fertilized*.

6. DISCUSSION, CONCLUSION AND FUTURE WORK

The need for happiness in terms of procreation cannot be quantified and people all over the world would continue to have varying desires in the sex of the child they want based on their socio-economic or religious need. Based on the proposed model, a lot of permutations can be made possible based on the sex of interest considering the parameters set in the model. The implication of this is that, there is high probability of having desired sex all things being equal, if the set parameters are properly observed. While there are quite a number of complex medical procedures that can be explored, as shown in this paper, measurable physical properties also show a promising approach to achieving results. If calculations can be done based on these physical properties, then using computers to aid in the analysis and predictions would go a long way in reducing the errors that may arise and streamlining the process of capturing the information and applying the rules necessary to reach an informed inference.

This study has helped to bridge the divide between medical knowledge and programming knowledge in the field of reproductive medicine. More specifically, the research shows a way to achieve sex selection taking advantage of just the physical properties of the human reproduction system. The limitation of this study is its dependence on a 'normal' physiological and anatomical reading of the human body. However, there are many variations of these physiological and anatomical measurements that cannot be classified as abnormal. Also, as far as this research is concerned, the difference in the speed of the X chromosomes and Y chromosomes have not been categorically stated by anyone in discrete terms. The use of the Shettles method for sex pre-selection holds a promising future for parents and would-be parents as the method is cheap and non-intrusive. Further research work that should be done is the clarification in absolute terms, the difference in speed between the X chromosomes and the Y chromosomes. This would help make the predictions/analysis even more accurate.

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