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Simulation Model for Fertility Awarness Method

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Abstract: One of the cardinal functions of the Ministry of Health is to monitor the attitude and behaviour of childbearing woman. When women have complete, unbiased information about their ovulation, they are empowered to make their own decision leading to healthy whole lives. A woman can use any of the existing modern fertility awareness methods to speculate or monitor her own ovulation and use this information to avoid or encourage a pregnancy. Many of these method which gives information based on observation, some mental or manual estimation, are usually associated with high level of risk and failure on decision making. Fertility Awareness for birth control theory has been investigated to explain the pathological basis of many medical conditions. This study presents a decision support model for fertility awareness method. It addresses the concept of ovulation and menstruation in women. The ovulation and menstrual cycle in women is statistically modeled and software that is capable of analyzing the ovulation characteristic behaviour of a woman and its menstruation period is developed. An implementation is carried out and the tabulated results from the software can equip women with complete, unbiased information on possible date of ovulation and menstruation period within a specified period thereby encouraging precise decision making with regard to fertility measurement to avoid or encourage pregnancy. The software has the basic components of knowledge base, model base and user interface.

Key words: Fertility, ovulation, simulation, DSS, menstrual cycle, model and knowledge base

INTRODUCTION

One of the cardinal functions of the Ministry of Health is to monitor the attitude and behaviour of childbearing woman. When women have complete, unbiased information about their ovulation, they are empowered to make their own decision leading to healthy whole lives. In recent times, some countries have began to experience overpopulation as a result of inadequate information concerning birth control. Woman can use any of the existing modern fertility awareness methods to speculate or monitor her own ovulation and use this information to avoid or encourage a pregnancy. Many of these method which gives information based on observation, some mental or manual estimation of physical measurements. These estimates are usually associated with high level of risk and failure on decision making. Fertility awareness for birth control theory has been investigated to explain the pathological basis of many medical conditions.

Fertility Awareness is a form of Natural Family Planning. However, the term 'Natural Family Planning' does not always mean the comprehensive approach known as Fertility Awareness Method. With the new innovations on application of computer in medicine, medical practitioners have been able to make precise and accurate decisions on the physiological experience of human beings.

There are varieties of definitions of Decision Support Systems (DSS) in published work. The DSS paradigm appeared at the end of the 70s. DSS were developed for applications in different fields of specialization (Haseman and Whindton, 1977). In Keen and Scott (1978) DSS is any computer system, which should support human decision-making. Most of the existent published works coincide in their understanding of DSS as tools to aid decision-making with problems that are not well structured. The characteristics of Decision Support Systems as identified in Keen and Scott Morton (1978) is as presented below.

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- Explicit design to solve semi-structured problems
- Powerful user interface and easy use.
- Ability to combine analytical models with data in a flexible way.
- Ability to explore the solution space building alternative.
- Capacity to support variety of styles in decision making.
- Problem-solving in an interactive and recursive way.

Stephanie *et al.* (2000) identified some Decision Support Systems (DSSs) that are successful in practice. The list includes: The Antibody Identification Assistant (AIDA), also adapted as the Transfusion Medicine Tutor (TMT)-a DSS that uses an expert knowledge base to critique blood bank practitioner as they perform a medical laboratory analysis task (Guerlain *et al.*, 1995). This system is currently in use as an intelligent tutor for medical technologists throughout the United Nations (Smith *et al.*, 1999). The Regional Crime Analysis Program (RECAP) as explained in Brown (1998) is a DSS that mines large crime databases and uses intelligent clustering techniques and other statistical techniques combined with a geographic information system to help crime analysts to discover patterns in the data. This system is in use by law enforcement in several cities. A River Flooding Forecasting System is a DSS that uses probabilistic (Bayesian) reasoning to predict the likelihood of river flooding based on weather forecasts (Gunderson and Krzysztofowicz, 1999). This system is in use by the National Weather Service.

A typical DSS has four components: Analytical tools enabling data investigation; decision models enabling "what-if"/scenario investigations; a spatial database and a user interface providing easy access to decision models, databases, analytical tools and an attractive and comprehensive display of the output.

WOMEN PUBERTY AND PERIOD

According to a report in Starnberg (2002) when girls begin to go through puberty (usually starting between the ages of 8 and 13), there bodies and minds change in many ways. The hormones in their bodies stimulate new physical development, such as their hips become curvier, they grow several inches in height and their breasts grow larger. About 1½ to 2 years after a girl's breasts begin to develop, she will get her first menstrual period (known as menarche, pronounced: Meh-nar-kee). Menarche does not happen until all the parts of a girl's reproductive system have matured and are working together. About 6 months

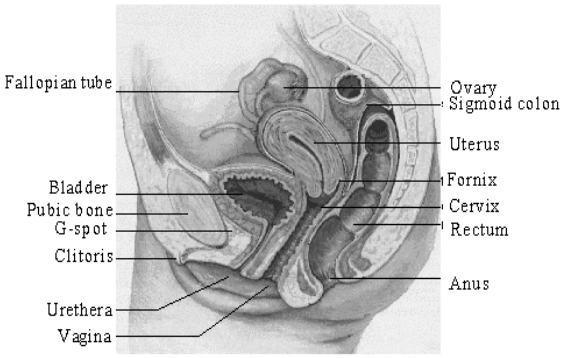


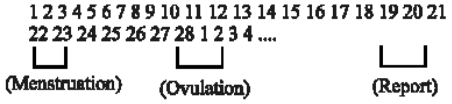
Fig. 1: Female internal sexual

before a girl gets her first period, she might notice an increased amount of clear vaginal discharge. This discharge, which shouldn't have a strong odor or cause itchiness, is common and should not worry a teen.

Girls are born with ovaries, fallopian tubes and a uterus. The two ovaries are oval-shaped and sit on either side of the uterus in the lowest part of the abdomen called the pelvis. They contain thousands of eggs, or ova. The two fallopian tubes are long and thin-like hollow strands of spaghetti. Each fallopian tube stretches from an ovary to the uterus, a pear-shaped organ that sits in the middle of the pelvis. The uterus, or womb, can enlarge quite a bit if it later becomes the home for a developing baby (Fig. 1).

Just as some girls begin puberty earlier or later than others, the same applies to periods. Some girls may begin to menstruate as early as age 9 or 10, but others may not get their first period until their mid to late teens. Some girls will find that their menstrual cycle lasts 28 days, while others might have a 21-day cycle, a 30-day cycle, or even a 45-day cycle.

A woman's cycle: In [11], every woman's body is different in shape, size, color and cycle. A typical woman's cycle runs as such.



However, for many women ovulation can occur as early as day 5 or 6, or as late as day 27 or 28! Inside the woman, there are many changes that happen throughout the cycle with her different reproductive organs.

During menstruation, the uterine lining and endometrium (what the embryo would attach itself to) is shed, making way for a fresh lining for any incoming

fertilized egg. After menstruation the lining begins to build up, preparing for the egg. By the time ovulation occurs there should be a thick endometrium waiting.

During menstruation the ovaries are barren, waiting to begin the cycle. Sometime during menstruation or soon after, an unripened egg is encased in a cyst called a follicular cyst. This cyst is both healthy and necessary. The egg then ripens inside the cyst, preparing it for ovulation. When the cyst reaches approximately 1.5 cm in diameter, the cyst will rupture, spewing forth the ripened egg. This act of rupturing the cyst and releasing the egg is called ovulation and usually occurs on day 14 of the cycle, but this is not a rule, but a generalization. There is a slight twinge that some women feel when they ovulate and spotting blood is not uncommon either. The egg will travel down two tubes (fallopian tubes) on its journey toward the uterus.

The egg ripens inside a cyst in the ovary. After ovulation the egg has 24 h in which it can be fertilized, after that it is useless. Because it takes 8-10 days for the egg to travel down the tubes into the uterus, it needs to be fertilized while INSIDE the fallopian tubes.

While the uterus is building up its endometrium, the cervix's job is to keep EVERYTHING out of the uterus. This is to prevent infections in the uterus as well as to prevent anything unclean inside the uterus or reproductive system (outside the vagina). The uterus is a small "nub" of an opening inside the vagina and leads to the uterus. To keep everything out, including sperm, it produces very tacky mucus and is held tightly closed. But, as the woman's cycle continues and the body knows that ovulation is about to occur, the mucus surrounding the cervix begins to change. By the time ovulation occurs, the mucus has become a stringy fluid spilling out from the cervix, allowing a sort of "stream" for the sperm to swim up. The cervix itself also opens slightly, just enough to allow sperm up inside. After ovulation occurs, the mucus begins to return to it is normal tacky texture to prevent anything else from entering.

Fertility Awareness Method (FAM) is a collection of practices which help a woman know which days of the month she is most likely to get pregnant. A woman can learn when ovulation is coming by observing her own body and charting physical changes. She can then use this information to avoid or encourage pregnancy.

Fertility Awareness relies upon the following assumptions:

- An egg (ovum) can live inside a woman's body for 12-24 h. However, in calculating the fertile time we use 48 h in case more than one egg is released.
- Sperm can live in a woman's body up to 5 days after intercourse, though more often 2 days. Pregnancy is most likely if intercourse occurs anywhere from 3 days before ovulation until 2-3 days after ovulation.
- The exact time of ovulation cannot be predicted, so, we add 2-3 days to the beginning and end.

There are several approaches people use to estimate the time of ovulation, this includes:

Calendar charting: With Calendar charting a woman uses past menstrual cycles as a guide. She calculates the average number of days in her cycle and estimates future fertile times. When you know the shortest and longest cycles over several months, you can use a formula to determine an estimate of your fertile time.

Cervical mucus monitoring: Cervical mucus changes consistency during the menstrual cycle and plays a vital role in fertilization of the egg. Present in the days preceding ovulation, fertile cervical mucus aids in drawing sperm up and to the fallopian tubes where fertilization usually takes place. It also helps maintain the survival of sperm inside the woman's body.

Basal Body Temperature (BBT): When a woman monitors her Basal Body Temperature (BBT) she can see when ovulation happens after it has occurred. BBT helps identify post-ovulatory infertile (safe) days. Using an easy-to-read thermometer, take your temperature every morning immediately upon waking and before any activity. Use graph paper so you can see the rise and fall of temperature.

Cervical observation: The position of a woman's cervix changes over the course of her menstrual cycle. Typically, during and in the first few days after menstruation, the cervix is fairly low and firm like the tip of your nose. When the wet cervical fluid begins to show, the cervix begins to move up, become more soft, wet and open. During ovulation, the cervix is at its highest and most open. After ovulation, the cervix returns to the firm, low and closed position. To observe the changes in cervical position, wash your hands, insert your middle finger and feel your cervix for softness, height, opening and wetness. A plastic speculum can be helpful in the beginning while you are getting used to finding and feeling your cervix. Check your cervix about the same time of day and in the same position (squatting, sitting on the toilet, or with one leg raised).

ARCHITECTURES OF A DECISION SUPPORT MODEL FOR FAMILY AWARENESS METHOD

The system component includes

- Database Management System (DBMS).
- Model Base Management System (MBMS).
- Dialogue generation and management system.

The data management subsystem: The data management subsystem composed of the database, DBMS, Data dictionary and Query facility. The Database is a collection of interrelated data organized to meet the needs and structure of an organization and can be used by more than one person for more than one application. The data in the database come from 3 generalized sources, viz., internal data, external data and private data. The internal data comes mainly from within the medical or health organization, transaction processing system and some data are available over an Intranet. The external data comes mainly from outside the organization. Data also be obtained over the Internet. The private data comes as a guideline used by gynecologist decision makers and assessments of specific data such as laboratory technologist and/or situations. The data from the internal, external and private were extraction. In other words, extraction means capturing data from several sources, importing files, summarization and condensation of data, creation of reports and management of the DBMS. Database Management System, manages database creation, access and updates, supports general navigation among records, support for creating and maintaining a diverse set of data relationships, support for report generation and is integrated with DSS (Fig. 2).

Raw data are collected manually or by instrument such as sensors. Regardless of how this data are collected, data needs to be validated. The quality of integrity of the data are critical for the DSMFAM. The data involves in this DSMFAM is of a particular case and as such required the use of a relational database model. Relational Database Management System (RDBMS) are better suited for DSS because their records do not contain predefined links to associated records in other files. This provides them with greater flexibility retrieving the data. In the RDBMS, the use of standard interface called Structured Query Language (SQL) is guaranteed (Fig. 2).

The relational database supported by the system includes

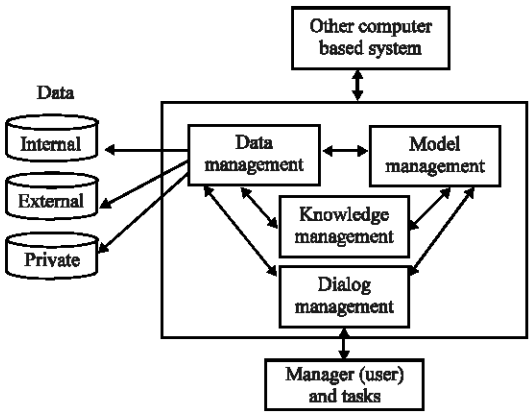


Fig. 2: Architecture of DSSFAM

Bio_Data[personal_id, name, sex, date_birth, place_birth, address, marital_status, no_children, marriage_ method].

Health_status[personal_id, age_at_puberty, Menarche, ovulation_days, menstruation_day].

Cycle_data[personal_id, last_menstruation_date, next_ ovulation_date, next_menstruation_day].

The model management subsystem: This subsystem is composed of the model base, model base management system, modeling language, model directory and model execution, integration and command processor. Model base contains routine and special statistical, medical models, forecasting and other quantitative models that provide the analysis capabilities in the system. The model supported by this system is analysed as follows:

Domain set:

Sex	=	{male, female}
Age at puberty (years)	=	{8, 9, 10, 11, 12, 13}
Menarche at (years)	=	{1.5years, 2years}
Menstruation Cycle on α days	=	{21, 28, 30, 45}
Ovulation at β days)	=	{11, 12, 13, 14, 15, 16, 17}

Model: A girl Gi, j begin to go through puberty at age i and in about jth years later, the girl Gi,j experiences her first menstrual period. According to medical practice, Gi,j has 2 ovaries with x number of eggs, where $x \geq 1000$.

Let λ_n represents the ending date of menstrual cycle for Gi, j.

Θ_n represents the date of ovulation period for Gi,j if Gi,j experiences an ending menstrual period λ_n at β days and ovulation Θ_n at α day for x days,

Then

$$\lambda_n = \text{date}()$$
$$\Theta_{n+1} = \Theta_n + \beta$$
$$\lambda_{n+1} = \lambda_n + \alpha$$

therefore, the matrix $A_{i,j}$ can be generated as

$$A_{i,j} = \begin{bmatrix} \lambda_{1,1} & \theta_{1,2} & \lambda_{1,3} \\ \lambda_{2,1} & \theta_{2,2} & \lambda_{2,3} \\ \lambda_{3,1} & \theta_{3,2} & \lambda_{3,3} \\ \dots & & \\ \dots & & \\ \dots & & \\ \lambda_{k,n} & \theta_{k,n+1} & \lambda_{k,n+1} \end{bmatrix} \quad (1)$$

The user interface (dialog) subsystem: The User Interface (Dialog) Subsystem covers all aspects of communication between a user and the system. The user interface enhances ease of use, accessibility and human-machine interactions. Management of the User Interface Subsystem has several responsibilities such as:

- Provide GUI
- Accommodates a variety of input devices
- Presents data in a variety of formats
- Helps users through suggestions and prompting
- Allows interaction with other subsystems (database and model base)
- Provides multimedia and visualization features
- Captures and stores dialogs

Hardware: As with all computer systems there is a constant interplay between hardware and software. Hardware choices may be made during the system development. However, often hardware choices are determined by what is already available. For this software, a minimum of Pentium II, 20GB hard disk, 256MB Ram, Flash Disk of 256 MB capacity and internet connectivity is required.

SYSTEM IMPLEMENTATION

User views the knowledge base component of the system in a top down manner and gains access to it by supplying a valid user name and password, both of which serve as access right control mechanism. If access right is obtained, the user is then presented with the system's main menu and subsequently its submenus. Any selected option of the main menu or submenu calls an inference procedure or module of a particular step in the analysis process. The inference procedure is interactive and guides the user intelligently and leaving the user to take a final decision.

On the successful log on by the user, the main menu, which is presented in Fig. 3, is displayed. On main menu, two command buttons viz. 'select' and 'exit' is presented. Command button 'Exit' takes the user out of

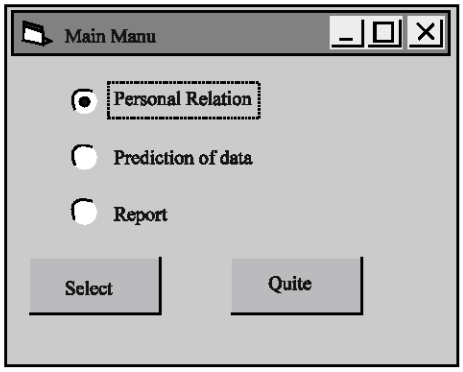


Fig. 3: Main manu of the DSSFAM

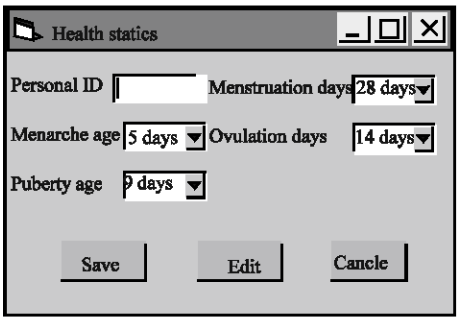


Fig. 4: From view for editing health statistics

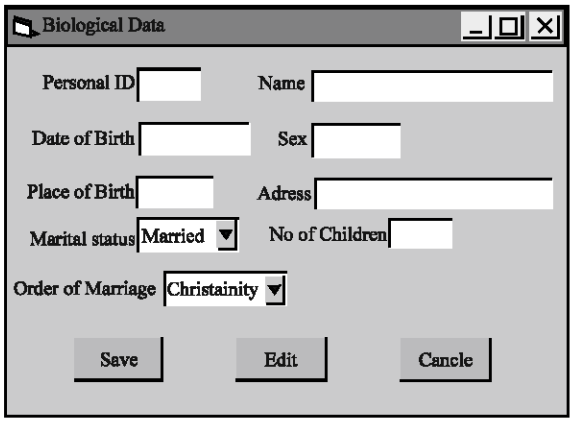
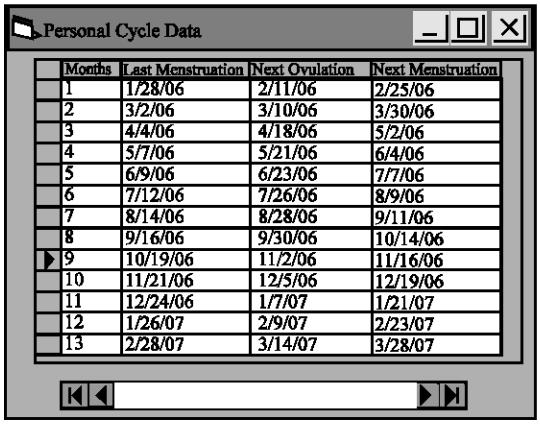


Fig. 5: From view for editing personal dara



Months	Last Menstruation	Next Ovulation	Next Menstruation
1	1/28/06	2/11/06	2/25/06
2	3/2/06	3/10/06	3/30/06
3	4/4/06	4/18/06	5/2/06
4	5/7/06	5/21/06	6/4/06
5	6/9/06	6/23/06	7/7/06
6	7/12/06	7/26/06	8/9/06
7	8/14/06	8/28/06	9/11/06
8	9/16/06	9/30/06	10/14/06
9	10/19/06	11/2/06	11/16/06
10	11/21/06	12/5/06	12/19/06
11	12/24/06	1/7/07	1/21/07
12	1/26/07	2/9/07	2/23/07
13	2/28/07	3/14/07	3/28/07

Fig. 6: Typical evaluation results of DSMFAM

the system while the 'select' button evokes any option marked with value 'true' as depicted on the main menu. The main menu has three possible option commands as Personnel Relation Base and Prediction of menstruation and Report. The form view presented in Fig. 4-6 represent the various screen display when options in Fig. 3 is highlighted.

CONCLUSION

The effectiveness of family awareness method for birth control varies, depending on the dedication and motivation of the woman and her partner, the length of time she has been using it and the regularity of her menstrual cycle. Combining multiple techniques such as those highlighted in this study for observing fertility increase the effectiveness. However, a lot still needs to be in place for better accuracy. In this study, DSMFAM which is interactive and user friendly has been developed. The concept of ovulation and menstruation in women is been considered. The ovulation and menstrual cycle in women is statistically modeled and software that is capable of analyzing the ovulation characteristic behaviour of a woman and its menstruation period is developed. An implementation is carried out and the tabulated results from the software shows that, if a woman can ascertain the number of days of her menstruation life cycle, then with this system, she can have complete, unbiased information on possible date of ovulation and menstruation period within a specified period thereby encouraging precise decision making with regard to fertility measurement to avoid or encourage pregnancy.

The software has the basic components of Knowledge base, Model base and User interface. When a user supplies a starting date of menstruation period, the system automatically project a table for observable ovulation date and menstruation date for a period of 12 months. With DSMFAM, as a means of fertility control, have no health risks or side effects to a woman. It can be used to plan or prevent pregnancy. It can educate women on her fertility if used correctly and consistently, especially for women who have regular menstrual periods. The software has no religious concerns about contraception. It can also increase a woman's awareness and understanding of her body.

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