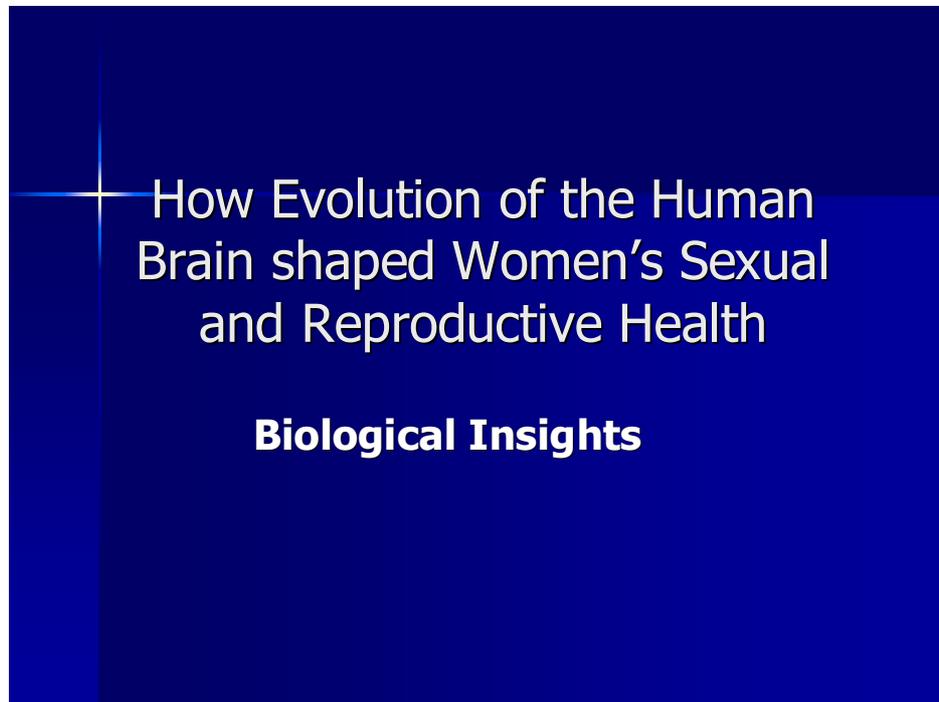
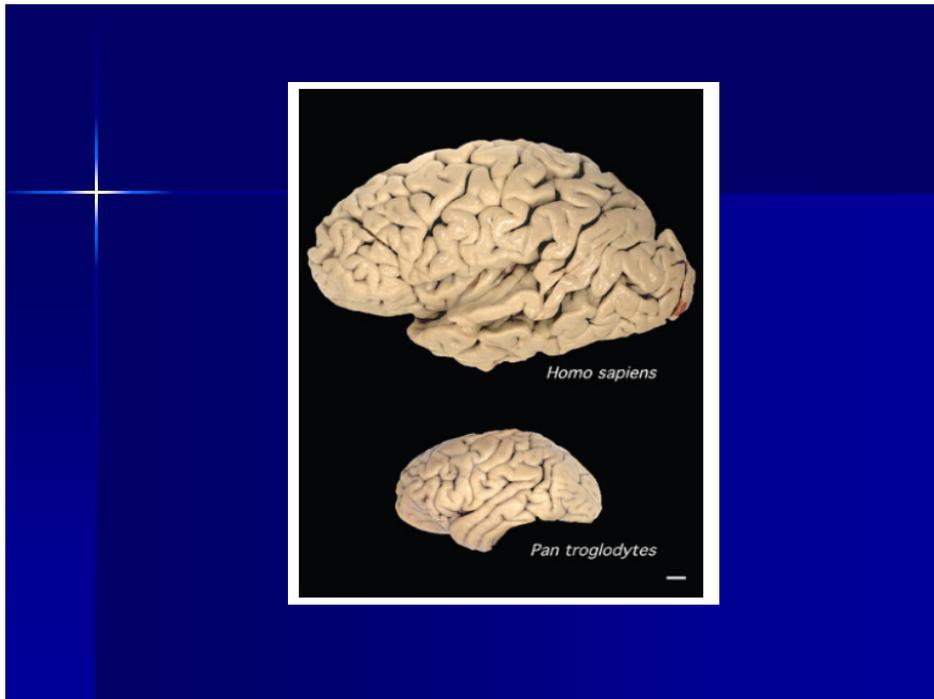


On Women's Health and Rights  
Lectures, Speeches and Statements  
Mahmoud F. Fathalla



The human female carries a big burden for sexual and reproductive health.<sup>1</sup> Biological insights can shed light on how in the evolution of the Homo sapiens, and particularly for the evolution of the human brain, the female of our species had to make many adaptations, at a big cost to her health and even a risk to her life

As early humans faced new environmental challenges, encephalization evolved with the progressive development of larger and more complex brains which can process and store a lot of information.



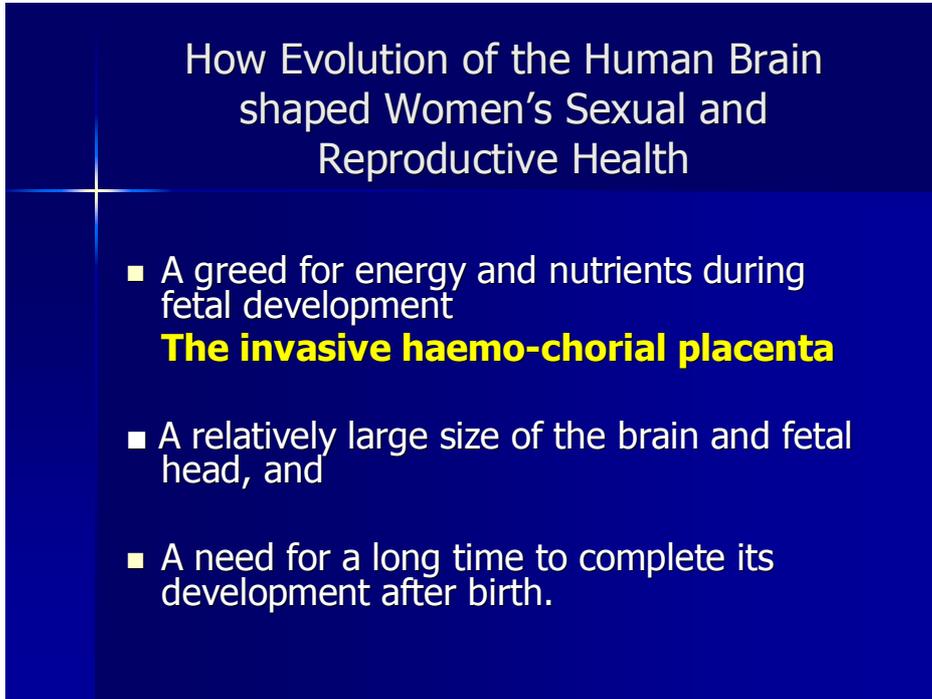
The modern human brain is the largest and most complex of any primate. That was a big advantage to early humans. But it was an expensive undertaking. The human brain consumes an outstanding 20% of the total body energy budget despite representing only 2% of body mass.<sup>2,3</sup>

## How Evolution of the Human Brain shaped Women's Sexual and Reproductive Health

Apart from its greatly increased complexity, compared with other primates, the evolving human brain had three features which shaped women's sexual and reproductive health during evolution:

- a greed for energy and nutrients during fetal development,
- a relatively large size of the brain and fetal head, and
- the need for a long time to complete its development after birth.

Apart from its greatly increased complexity, compared with other primates, the evolving human brain had three features which shaped women's sexual and reproductive health during evolution: a greed for energy and nutrients during fetal development, a relatively large size of the brain and fetal head, and the need for a long time to complete its development after birth.<sup>4,5</sup>



How Evolution of the Human Brain shaped Women's Sexual and Reproductive Health

- A greed for energy and nutrients during fetal development  
**The invasive haemo-chorial placenta**
- A relatively large size of the brain and fetal head, and
- A need for a long time to complete its development after birth.

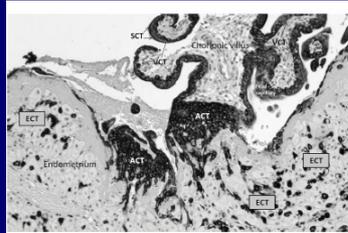
**The invasive haemo-chorial placenta**

## The invasive haemo-chorial placenta

The developing fetal brain needs and consumes a lot of energy. To meet this need, a more intensely invasive placenta evolved, with the risk of excessive bleeding when the placenta separates partially or completely from the uterine wall, a major cause of maternal death.

The placenta in mammals has evolved as an extra-somatic fetal organ, designed to secure drawing nourishment from the mother to the growing fetus. Mammalian placentas differ widely in the degree with which they invade the maternal tissue. Three main phenotypes are described.<sup>6</sup> The least invasive is the epithelio-chorial placenta, in ruminants, horse and swine, in which the fetal chorion simply adheres to the epithelial lining of the uterus. Nutrients are transposed and diffused to the fetus across several layers of maternal tissue. The next phenotype, in order of invasiveness is the endothelio-chorial placenta, seen in cats and dogs, where the fetal chorion is in contact with the endothelial lining of the maternal blood vessels but not in direct contact with maternal blood. The most invasive phenotype is the haemo-chorial placenta, seen in rodents and primates. Here, the fetal chorion, with its complex branching villi, is bathed in maternal blood. There are different degrees of invasiveness of the haemo-chorial placenta. The human placenta is not only among the most invasive, but it embarks on a second wave of invasiveness around the 16<sup>th</sup> week of pregnancy, in response to the growing fetal needs particularly of the developing human brain.<sup>6</sup>

## Villous trophoblast, anchoring trophoblast and extra-villous trophoblast



In the early placenta, most of the fetal trophoblast covers the mesodermal core of the chorionic villi containing the fetal blood vessels. Other trophoblastic cells serve the function of anchoring the placenta to the uterine wall. In the second wave of invasiveness, cells get detached from this anchoring non-villous trophoblast, and migrate deeply in the uterus. They surround the maternal spiral arterioles and initiate a breakdown of their muscular and elastic layer, replacing it with a thick fibrinoid non-contractile layer. Vascular resistance is thus reduced, the diameter of the vessels becomes wider and they open in a funnel pattern in the maternal blood lake bathing the fetal chorionic villi.

With this second wave of invasion and remodeling of the maternal spiral arterioles, the fetus ensures unrestricted access to the maternal blood flow to satisfy the needs of its growing brain. But there is a cost and a risk to the mother. When the placenta separates from the uterine wall, partially or completely, during pregnancy or in the end of labor, severe bleeding may occur. The spiral arterioles, which have lost their muscle layer, cannot contract to close their lumen. The mechanism of shutting the blood flow in the rich arterioles depends on retraction of the uterine muscle, which may fail.

## The invasive haemo-chorial placenta

If the second wave of placental invasion fails to adequately remodel the spiral arterioles, the vessels retain their endothelial linings and muscular walls, and remain relatively narrow-bore, high-resistance vessels. The condition of placental insufficiency may prevail, and can be a factor in the development of the potentially serious or fatal condition of pre-eclampsia and eclampsia.

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### **The obstetric dilemma of the large fetal head in a bipedal pelvis**

## How Evolution of the Human Brain shaped Women's Sexual and Reproductive Health

- **The invasive haemo-chorial placenta**
- **The obstetric dilemma of the large fetal head in a bipedal pelvis**

In our fellow primates, the size of the fetal head at the time of birth is such that it can be accommodated easily in the pelvis and can sail smoothly through the straight birth canal driven by uterine contractions and a final bearing down push.





In the female *Homo sapiens*, evolution of the human brain and the consequent large head, came several million years after evolution of bipedalism. The bipedal pelvis has evolved to support upright locomotion. With bipedalism already established, there was no much room for concession to allow an easier birth of the large head. The pelvis can stretch only a little through relaxation of ligaments of its joints at the end of pregnancy. A large head needs a large pelvis. Bipedal locomotion needs a narrow pelvis. If the pelvis were to be too large, a woman will waddle like a duck.<sup>11,12,13,14</sup>

The fetal head can undergo a certain degree of molding. The platelets of bone of the vault of the large skull are not fused till sometime after birth. For this molding to take place slowly without damaging the brain, the head has to come down first. In cases of breech presentation, where the body comes down first, this causes a problem.

## The obstetric dilemma of the large fetal head in a bipedal pelvis

Delivering the large fetal head is an obstetric dilemma, particularly with the relatively narrow and irregular bipedal pelvis.

The human fetus has to make certain “gymnastic” movements to negotiate its course along the curved rather narrow and irregular birth canal. These are what we obstetricians call the cardinal movements of the normal mechanism of labor.

The human fetus has to make certain “gymnastic” movements to negotiate its course along the curved rather narrow and irregular birth canal. These are what obstetricians call the cardinal movements of the normal mechanism of labor. Increased flexion allows the head to pass with a smaller circumference. Internal rotation has to take place in the middle of the pelvis as the head moves from the wider transverse or oblique diameter of the inlet of the pelvis to the wider antero-posterior diameter of the pelvic outlet. As the head emerges, the increased flexion and the internal rotation are corrected by extension and restitution. The human fetus has large shoulders that have also to undergo rotation as they descent in the birth canal, shown as external rotation of the head after it emerges from the pelvis. Any difficulty in the completion of these cardinal movements can lead to obstructed labor.

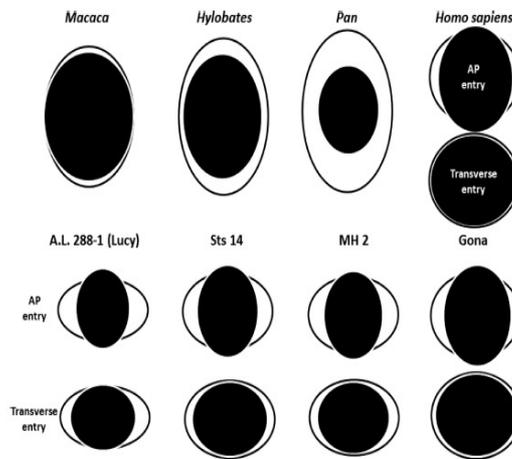


Fig. 1. Redrawn from Rosenberg and Trevathan (1996); based on Schultz (1949). Relative cranial dimensions in infant primates (filled ovals) are superimposed on pelvic openings (outer oval), with the offspring head in anterior-posterior orientation (upper row) and transverse orientation (lower row). All pelvises are scaled so that the mediolateral dimensions are equal. Notice the anteroposteriorly deep birth canal in chimpanzees (*Pan*), allowing for relatively easy passage of the neonatal head. Broad ape shoulders may require some rotation as has been observed recently (Hirata et al., 2011). Monkeys, lesser apes (*Hylobates*) and humans present more of an "obstetric dilemma" with the neonatal head close to, or even exceeding, the dimensions of the birth canal. In the bottom row are four hominin fossils illustrating the relative difficulty of birth in *Australopithecus* and early *Homo*. Modeled here are the inlet dimensions of the birth canal. As in humans, the maximum dimension of the pelvic inlet in early hominins is oriented mediolaterally, indicating that the neonatal cranial entered the pelvic inlet obliquely or transversely during birth. Based on estimates of cranial dimensions and minimum dimensions of the birth canal, birth was particularly difficult in the earliest australopithecids represented here by Lucy and Sts 14.

Different from our fellow primates, the fetal head of a full-term fetus just fits snugly in the pelvis. If it remains impacted there for a long time, the soft pelvic tissues between the head and the bony pelvis can undergo such compression that they can become necrotic, slough and result in the dreadful complication of a fistulous opening between the vagina and the urinary bladder or rectum.

## The obstetric dilemma of the large fetal head in a bipedal pelvis

In the biped female, different from our quadruped relatives, the pelvic organs are not lying horizontally. They are subject to the pull of gravity if their supporting mechanisms, which have been strengthened through evolution, are damaged or weakened during childbirth. This can result in different degrees and manifestations of pelvic organ prolapse, including urinary stress incontinence.

Even when such tissue damage does not occur, overstretching of the ligaments supporting the pelvic organs can take place. In the biped female, different from our quadruped relatives, the pelvic organs are not lying horizontally. They are subject to the pull of gravity if their supporting mechanisms, which have been strengthened through evolution, are damaged or weakened during childbirth. This can result in different degrees and manifestations of pelvic organ prolapse, including urinary stress incontinence.

*The birth of midwifery*

## The obstetric dilemma of the large fetal head in a bipedal pelvis

### Midwifery: the oldest human profession

- Human birth, at its best is long, uncomfortable, painful and uncertain. The human female is the only mammal or primate who needs assistance during childbirth. Birth is not the private business of our fellow mammals and primates, where the female seeks a secluded place to give birth, probably also not to expose her to predators at this vulnerable time.
- The human female needs not only the moral and emotional support and encouragement of other females. She needs actual assistance. Because of the large size of the fetal head and the configuration of the bipedal pelvis, the head is normally delivered with the occiput anterior, and the newborn baby facing the back of the mother. In non-human primates, the head emerges with the face of the newborn to the front of the mother, allowing her, from her squatting position, to extend her hand and ease the head out.<sup>15</sup> If the human female tries to catch the baby's head herself, and to ease it out, she may break its neck.

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## A tribute to midwives

"Then Pharaoh, the king of Egypt, instructed the Hebrew midwives to kill all Hebrew boys as soon as they were born, but to let the girls live. But the midwives feared God and didn't obey the king- they let the boys live too.....

And God blessed the midwives [because they were God fearing women].

Holy Bible. Exodus 1:15-17; 20

Midwives deserve a lot of credit for the survival of our species, not least for saving the life of great prophet Moses. Birth attendance, however, carried the risk of infection in the days before asepsis, anti-sepsis and antibiotics. When the concept of help evolved in to the establishment of lying in hospitals, the contagiousness of childbed fever did cost many women their lives.<sup>16</sup> It took a long time until the eminent Hungarian Semmelweiss drew out attention to it



### Altriciality

How Evolution of the Human Brain shaped Women's Sexual and Reproductive Health

- **The invasive haemo-chorial placenta**
- **The obstetric dilemma of the large fetal head in a bipedal pelvis**
- **Altriciality**

Infant development, across species, can be described as precocial or altricial.<sup>17</sup>

## Altriciality

Infant development, across species, can be described as precocial or altricial. **Precocial infants** are those that are well developed at birth, with motor skills that enable them to follow or cling to their mothers. **Altricial infants** are helpless at birth, and must be left in nests or carried by their mothers. Human infants are born with a degree of helplessness not seen in most members of the Primate order.

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## Altriciality

**From a biological perspective, it can be stated that all human newborn babies are born prematurely. They had to be delivered “half done”. The human brain, because of its complexity, needs time to develop. However, there is a limit to how long it can be left to develop in utero. If pregnancy was allowed to continue, the size of the head will be too large to pass through the pelvis. The newborn brain is only about a quarter of the way through its growth trajectory at the time of birth. Additional time is needed for the postnatal growth of the brain, which in humans reaches its full adult size only by about the time of puberty.**

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It has been proposed that the brain serves as a pacemaker for the growth of other body systems. In primate species, relative brain mass scales with the time after birth required to reach maturity, implying that the development of larger brains requires more time.<sup>5</sup>

*Altriciality and the need for paternal investment*

## **Altriciality and the need for paternal investment**

- **Altriciality indicates the need for extended maternal investment over long periods of time that go well beyond the period of lactation, and until the child can go in life on its own.**
- **For this, the mother needs and will benefit from prolonged sustained joint parental investment.**

Altriciality indicates the need for extended maternal investment over long periods of time that go well beyond the period of lactation, and until the child can go in life on its own.<sup>5</sup> For this, the mother needs and will benefit from prolonged sustained joint parental investment. The concept of paternal investment is not completely novel in evolutionary history. It is seen, in different degrees in some of the species.<sup>19</sup> In our nearest relatives, the primates, the concept of paternity has been out of use in the polygamous promiscuous society, and where the paternal investment is limited to the minimal effort of the act of copulation.<sup>5</sup> To achieve and sustain parental investment, the female *Homo sapiens* had, through evolution, to develop mechanisms to strengthen the pair bond. Sex was the tool in the hands of evolution.

*Sex and the pair bond*

## Altriciality and the need for paternal investment

### Sex and the pair bond

In mammals and non-human primates, sex is only a tool for reproduction. The female will only be receptive, proceptive and attractive to the male when she is ovulating and ready to conceive.

**Receptivity** is defined in terms of female responses necessary and sufficient for the male's success in achieving intravaginal ejaculation.

**Proceptivity** connotes various reactions by the female toward the male which constitute her assumption of initiative in establishing or maintaining sexual interaction. Receptivity and proceptivity are behavioral traits mediated by the hormonal changes associated with ovulation.

**Attractivity** refers to the female's stimulus value in evoking sexual responses by the male. Attractiveness may be visual or olfactory.

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Olfactory messages are mediated by pheromones, secreted by the female around the time of ovulation, a distinctive feminine perfume that is difficult for the male to resist. It can be sniffed by the male, and when secreted in the urine, it can leave a track for the lover male to follow.

To maintain the pair bond and continued paternal investment, sex in the human female was dissociated from reproduction. All external evidence or clues to ovulation were completely suppressed. Feminine beauty was put on permanent display. Non-reproductive sex became a norm, not an exception.

***Concealment of ovulation***

## Ovulation: the best kept human secret

Ovulation is the best kept secret, because it is not only hidden from the prospective male partner or other females, but also from the woman herself.

Ovulation is a best kept human secret. It is the best kept secret, because it is not only hidden from the prospective male partner or other females, but also from the woman herself. Although a lot of research has attempted to look into the question of whether in our species, males and/ or females show behavioral clues of female receptivity, and proceptivity around the time of ovulation, the evidence, if any is only minimal, not consistent and subject to alternative interpretations.<sup>21</sup> It has been suggested that because of our obsession with cleanliness and clothing our phermones lost their ability to indicate the time of ovulation. However, a study in a primitive community to test this hypothesis did not confirm any change in sexual behavior around the time of ovulation.<sup>22</sup>

## Incessant ovulation

Not only is ovulation concealed, but it evolved to take place monthly, irrespective of any opportunity for conception or even sexual intercourse, and the uterus is prepared monthly to welcome a pregnancy through endometrial decidualization. In most mammals, decidualization does not occur until there is an embryonic signal. The decidua will be useful if there is a pregnancy, but otherwise it must be shed by the monthly menstruation.

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### *Feminine beauty on permanent display*

Rather than being attractive to the male only around the time of ovulation, the human female put her feminine beauty on permanent display. The female breast is unusual among mammals and primates, where it is only an organ for milk production.<sup>24</sup> In other primates, the breast only becomes prominent during pregnancy and lactation. In the human female, it is an organ of sexual adornment, made up of fat and connective tissue. The buttocks also store more fat, resulting in rounded female buttocks and an hourglass figure, which remains attractive to modern males.

### *Non-reproductive sex*

Although non-reproductive sex has been observed in some other mammals and primates, it is the exception rather than the rule. It is possible that our primitive human ancestors did not conceive the relation between the sexual act and pregnancy until they have observed it in domesticated animals. To ensure and strengthen the pair bond, the female had to make herself available for sex all the time, even when pregnant or already past the time for childbearing, for which she may deserve the title of the sexiest of mammals. Sex changed from being a reproductive duty to a pleasure and tool for human bonding. The euphemism “to make love” is a true statement.

In one of our closest primates, the Bonobos, (*Pan paniscus*), non-reproductive sex is a norm. However, it is not used for pair bonding. Our promiscuous relative uses sex to reduce tension, in a sense making love, not war, or using pleasure for peace.<sup>25,26</sup>

*A price to pay*

To maintain the pair bond and continued paternal investment, sex in the human female was dissociated from reproduction. All external evidence or clues to ovulation were completely suppressed. Feminine beauty was put on permanent display. Non-reproductive sex became a norm, not an exception.

But women became vulnerable to sexual violence, sexually transmitted infections and unwanted pregnancy.

With concealment of ovulation, and making sex available all the time, the human female succeeded through this evolution to establish the pair bond and increase and maintain paternal interest and investment in the offspring. But there was a price to pay.

## **Dissociation of sex from reproduction A price to pay**

**With concealment of ovulation, and making sex available all the time, the human female succeeded through this evolution to establish the pair bond and increase and maintain paternal interest and investment in the offspring. But there was a price to pay. Concealing of ovulation from the woman herself made it impossible for her to avoid an unwanted pregnancy. Women throughout history had to struggle, through unsafe abortion, to terminate unwanted pregnancies.**

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## **Dissociation of sex from reproduction A price to pay (cont)**

**Putting her feminine attractions on display all the time meant that she could be exposed to or forced to have unwanted sex. Sexual violence encompasses acts that range from verbal harassment to forced penetration, and an array of types of coercion, from social pressure and intimidation to physical force.<sup>27</sup>**

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## **Dissociation of sex from reproduction A price to pay (cont)**

**Sex provided a good medium for microbes (ranging from viruses to bacteria, protozoa and parasites) to be sexually transmitted between partners.<sup>28</sup> Most women are acquiring the infection (including HIV) not because of their own sexual behaviors but because their partners engage in unsafe behaviors. For a mix of biological, social and medical reasons, the burden of sexually transmitted infections falls disproportionately on women.<sup>1</sup> Women are more likely to be infected, are less likely to show signs of infection, and are at greater risk for severe disease sequelae, including pelvic inflammatory disease and cancer of uterine cervix caused by human papillomavirus infection.**

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**The human brain is paying women back in the currency of science**

## The human brain is paying women back in the currency of science

Women made major sacrifices of their sexual and reproductive health to allow that spectacular human brain to develop in utero, to be delivered safely and to be nurtured till complete development. It was high time for this same human brain, at long last, to pay women back in the currency of science, and to ease their sexual and reproductive health burden. **And it did.**

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## The human brain is paying women back in the currency of science

- Making motherhood safer
- Developing women-controlled contraceptive technologies.

*Making motherhood safer*

The World Health Organization estimates that where nothing is done to avert maternal death, “natural mortality” is around 100-1500 per 100 000 births.<sup>29</sup> If women were still experiencing “natural” maternal mortality rates today, the maternal death toll would be four times its current size. Three quarters of these deaths are currently avoided throughout the world: nearly all the “natural” maternal mortality in developed countries, but only one third to two thirds in developing country regions. The blame is not on science. The inconvenient truth is that mothers are not dying because of conditions we cannot now prevent or treat, thanks to science, They are still dying because societies have yet to make the decision that their lives are worth saving.

Skilled birth attendance, the availability of blood transfusion, and the resort to Caesarean section are products of our human brains to ease the burden of the obstetric dilemma on women. Abdominal delivery, originally only performed on a dead mother to get the baby out, and later only when vaginal delivery would put the baby's or mother's life or health at risk, is now a relatively safe procedure available on request, even when there is no medical indication for it.<sup>30,31</sup>

*Fertility regulation and control*

Women, throughout human history, have tried desperately to have control on their fertility. With ovulation concealed, it was difficult. Men, on the other hand, had a simple means, to spill their seed on the ground. The human brain came to help. Thanks to a contraceptive technology revolution, for the first time in human history, women had access to reliable, safe and reversible contraceptive methods that they can use on a daily basis, or as long acting methods: every month, every two or three months, every 3 years, every five years or for 10 years.<sup>32</sup> Contraception has been moved outside the bedroom. Women had methods of contraception which they can use without the need for cooperation of their male partners. In the world today, more than 60% of married women of reproductive age are using contraception.<sup>33</sup> Contraception has become a way of life. Women now do not use contraception when they do not want to get pregnant. Rather, women stop contraception when they want to get pregnant.

The contraceptive technology revolution still has an unfinished agenda.<sup>34,35,36</sup> A sustained research effort is needed if men are to have broader contraceptive choices to enable them to share effectively in the responsibility for fertility regulation. Women still need back up methods to reduce the need for abortion.<sup>37</sup> Women still lack woman- controlled methods which they can use to avoid contracting a sexually transmitted infection from their partner.<sup>38</sup>

**Challenges still stand**

## The human brain is paying women back in the currency of science

### Scientific challenges still stand

- Women have already fulfilled the divine obligation to replenish the earth, and it is time for science to help the woman to finally emerge from behind the mother.

Women can feel happy that the human brain which they nursed and for which they sacrificed, is finally rewarding them back. But challenges still stand.

*From the hunter gatherer to the modern woman*

## From the hunter gatherer to the modern woman



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## **From the hunter gatherer to the modern woman**

**The modern woman in the post-industrial society has to cope with new life while burdened with a reproductive system that has evolved to serve well the survival and reproductive success in her life in a hunter gatherer society.<sup>17</sup> A female in a hunter gatherer society will get her first pregnancy soon after puberty, will lactate for three or four years, then will have other successive pregnancies and breastfeeding periods. During her reproductive life span, she will probably have no more than 50 menstrual cycles. The woman of today will reach puberty earlier, will delay the time for first childbearing, will breastfeed for only brief periods or not at all, and will have fewer pregnancies. She will also survive for a much longer time after cessation of ovarian function.**

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### **From the hunter gatherer to the modern woman**

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### **Incessant ovulation and ovarian cancer**

- Evidence has been accumulating to implicate incessant ovulation, without intervening period of pregnancy and lactation, in the causation of ovarian neoplasia.
- Our only ovulation competitor, in this regard, is the domesticated egg laying hen, and it is no coincidence that it is the recognized animal model for ovarian cancer.
- Significant duration-dependent reductions of ovarian cancer incidence in the general population are associated with oral contraceptive use which suppress ovulation.

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## Cancer of the breast

- **The female breast, serving now mostly an adornment function, is the seat of the commonest female cancer.**
- **It is more common when there is a long period between puberty and the first pregnancy, in women who had no or fewer pregnancies and did not lactate at all or only for short periods.**
- **Suboptimal breast feeding is associated with a higher risk for breast cancer and other diseases.**
- **In other mammals, breast tumors are common in domesticated cats and dogs, whose reproductive function we limit and control.**

The female breast, serving now mostly an adornment function, is the seat of the commonest female cancer. It is more common when there is a long period between puberty and the first pregnancy, in women who had no or fewer pregnancies and did not lactate at all or only for short periods<sup>39</sup> Suboptimal breast feeding is associated with a higher risk for breast cancer and other diseases.<sup>43</sup> In other mammals, breast tumors are common in domesticated cats and dogs, whose reproductive function we limit and control.<sup>44</sup> Recently, the American actress Angelina Jolie made the news by opting to remove her breasts to avoid the risk of cancer.



### **A women- centered research agenda**

#### **A women- centered research agenda**

- At a great cost to their health and life, women have already fulfilled the divine obligation to replenish the earth.
- Reproduction has now become a function of women, not the function of men. Women now spend only a relatively shorter time of their life in childbearing and child rearing. Women became producers and not only reproducers.
- In modern human life, production does not need the muscle of the hunter gatherer. It needs brain rather than brawn.
- A women- centered medical and social research agenda is needed to help the woman to finally emerge from behind the mother.

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## References

1. Fathalla M F, Fathalla M M F. Sexual and Reproductive Health: Overview. In: Kris Heggenhougen and Stella Quah, editors, *International Encyclopedia of Public Health*, Vol 5. San Diego: Academic Press, 2008. pp. 695-705.
2. Herculano-Houzel S. The remarkable, yet not extraordinary, human brain as a scaled-up primate brain and its associated cost. *Proc Natl Acad Sci USA*. 2012; 109(Suppl 1): 10661–10668.
3. Aiello, L.C, Wheeler, P. The Expensive tissue hypothesis: the brain and the digestive system in human and primate evolution. *Curr. Anthropol*. 1995;36: 199-221.
4. Barton RA, Capellini I. Maternal investment, life histories, and the costs of brain growth in mammals. *Proc Natl Acad Sci USA* 2011;108: 6169–6174.
5. Allman Jm. Big brains and parenting. *Engineering and science* 1998; 4:9-17.
6. Abrams, E. T. and Rutherford, J. N. Framing postpartum hemorrhage as a consequence of human placental biology: An Evolutionary and Comparative Perspective. *American Anthropologist*. 2011;113: 417–430.
8. Zhou Y, Caroline H., Damsky CH,i and Fisher SJ. J. Pre-eclampsia is associated with failure of human cytotrophoblasts to mimic a vascular adhesion phenotype-One Cause of defective endovascular invasion in this syndrome?. *Clin. Invest*. 1997; 99: 2152–2164.
9. Brosens, I.A., W.B. Robertson, and H.G. Dixon.. The role of the spiral arteries in the pathogenesis of pre-eclampsia. *Obstet. Gynecol. Annu*. 1972; 1:177–191.
10. Rosenberg KR, Trevathan WR.. An anthropological perspective on the evolutionary context of pre-eclampsia in humans.. *J Reprod Immunol*. 2007; 7691.
11. Sharon B.(2011).The evolutionary history of the modern birth mechanism: Looking at skeletal and cultural Adaptations. The University of Western Ontario *Journal of Anthropology*. 2011; 19: Issue 1, Article 7.  
<http://ir.lib.uwo.ca/totem/vol19/iss1/7>  
Accessed June 11, 2013
12. Karen R, Trevathan WR. Bipedalism and human birth:The obstetrical dilemma revisited. *Evolutionary Anthropology* 1972; 4:161-168.
13. Karen R and Trevathan WR. The evolution of human birth. *Scientific American* 2003; 13:80-85.
14. Stewart DB . The pelvis as a passageway. I. Evolution and adaptations *Br J Obstet Gynaecol*. 1984; 91:611-7.
15. Trevathan, WR. Fetal emergence patterns in evolutionary perspective. *American Anthropologist* 1988; 90:674-681.
16. De Costa CM. The contagiousness of childbed fever- a short history of puerperal sepsis and its treatment . *MJA* 2002; 177: 668-671.
17. Trevathan W. Ancient bodies, modern lives. How evolution has shaped women’s health. Oxford University Press 2010. p.108-109

18. Samuel I. Zeveloff SI, Boyce MS. Why human neonates are so altricial. *The American Naturalist* 1982; 120, 537-542.  
<http://www.jstor.org/stable/2461076> 10.2307/2461076  
Accessed June 11, 2013.
19. Geary, D. C.. Evolution of paternal investment. In D. M. Buss (Ed.), *The evolutionary psychology handbook* . Hoboken, NJ: John Wiley & Sons. 2005. pp. 483-505
20. Beach FA. Sexual attractivity, proceptivity, and receptivity in female mammals. *Hormones and Behavior* 1976; 7: 105-138.
21. Mostafa T, El Khoully G, Hassan A.. Pheromones in sex and reproduction: Do they have a role in humans? *Journal of Advanced Research* 2012; 3: 1–9.
22. Marlowe FW. Is Human Ovulation concealed? Evidence from conception beliefs in a hunter-gatherer society. *Archives of Sexual Behavior* 2004; 33:427-432.
23. Emera D, Romero R, Wagner G The evolution of menstruation: A new model for genetic assimilation. *Bioessays*. 2012; 34: 26–35. doi: 10.1002/bies.201100099
24. Marlowe F. The nubility hypothesis- the human breast as an honest signal of residual reproductive value. *Human Nature* 1998; 9:263-271.
25. Potts M, Short R. Ever since Adam and Eve. The evolution of human sexuality. Cambridge University press. 1999 ,p. 34-35.
26. Stanford CB The Social Behavior of Chimpanzees and Bonobos..*Current Anthropology* 1998; 39:399-420
27. World Health Organization. Global and regional estimates of violence against women: prevalence and health effects of intimate partner violence and non-partner sexual violence. WHO, Geneva. 2013
28. World Health Organization. Global strategy for the prevention and control of sexually transmitted Infections: 2006–2015. WHO, Geneva, 2007
29. World Health Organization. The World Health Report 2005. Make every mother and child count. WHO, Geneva. P 61-62
30. Boley, J.P.,The History of Cesarean section, *Canadian Medical Association Journal*, 1992; 45: 319-322.
31. Stuart W, Monge J, Mann A.. Bipedalism and Parturition: an evolutionary Imperative for Cesarean Delivery? *Clinics in Perinatology* 2008.;35:466-478
32. Fathalla MF.. The contraceptive technology revolution. In: Raff W.-K, Fathalla MF, Saad E., Editors. *New Pharmacological Approaches to Reproductive Health and Healthy Ageing*. Ernst Schering Research Foundation Workshop Supplement 8. Springer- Verlag. Berlin-Heidelberg. New York. 2001. P. 69-81.
33. Population Reference Bureau. 2012World Population Data Sheet. PRB, Washington DC.
34. Fathalla MF. Contraception and the unmet needs of women. *Gynaecology Forum*. 1999; 4:25-27. .
35. Fathalla M.F. Fertility control technology: A woman-centered approach to research. In *Population policies reconsidered- health, empowerment and rights*. Eds: G. Sen, A. Germain and L.C. Chen. Harvard University Press, Boston, MA. 1994. p.223-234.
36. Fathalla MF. Contraception-21. *Int J Gynec Obstet*. 1999; 67 (Supplement No.2):S5-S12.
37. Fathalla MF . Editorial: Reducing the need for abortion. *Contraception* 2003; 68:397-399

38. Fathalla MF. Invited commentary. Vaginal microbicides: A priority need for women's health. *Current women's health reports* 2003; 3: 263-264
39. Eaton SB; Pike MC; Short RV et al. Women's Reproductive Cancers in Evolutionary Context. *The Quarterly Review of Biology*, 1994; 69: 353-367.
40. Fathalla M.F. Incessant ovulation - a factor in ovarian neoplasia. *Lancet* 1971; 2: 1963
41. Amy A., Hakim AA, Barry CP, Barnes HJ et al. Ovarian Adenocarcinomas in the Laying Hen and Women Share Similar Alterations in p53, ras, and HER-2/neu..*Cancer Prev Res.* 2009;2:114-121.
42. Havrilesky LJ, Moorman PG,William J. et al. Oral Contraceptive Pills as Primary Prevention for Ovarian Cancer. A Systematic Review and Meta-analysis. *Obstet Gynecol* 2013;0:1–9. DOI: 10.1097/AOG.0b013e318291c235
43. Bartick MC, Stuebe AM, Schwarz EB, Luongo C, Reinhold AG, Foster EM. Maternal Costs of Suboptimal Breastfeeding. *Obstet Gynecol* 2013;0:1–9. DOI: 10.1097/AOG.0b013e318297a047
44. Munson L, Moresco A. Comparative pathology of mammary gland cancers in domestic and wild animals. *Breast Dis.* 2007;28:7-21.
45. Fathalla MF. Health and being a mother in the twenty-first century. *Int J Gynecol Obstet.* 2007;98:195-9.
46. Fathalla MF. Women, the profession and the reproductive revolution. In P.M.Shaughn O'Brien, Editor. *The Yearbook of Obstetrics and Gynaecology*. Vol. 8. Special Millennium edition. RCOG Press, London. 2000. p.223-231.
47. Cook RJ, Dickens BM, Fathalla MF. *Reproductive health and human rights- Integrating medicine, ethics, and law* Oxford University Press, 2003.

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