International Journal of Science and Research Archive
eISSN: 2582-8185
Cross Ref DOI: 10.30574/ijsra
Journal homepage: https://ijsra.net/

(REVIEW ARTICLE)

Check for updates

Management of labor and delivery in space

Elnaz Ghaffari *

Iran University of Medical Sciences, Tehran, Iran.

International Journal of Science and Research Archive, 2024, 13(02), 1603–1610

Publication history: Received on 16 October 2024; revised on 24 November 2024; accepted on 26 November 2024

Article DOI: https://doi.org/10.30574/ijsra.2024.13.2.2296

Abstract

In the zero-gravity environment of space, astronauts experience significant physiological and biochemical changes. Upon returning to Earth, they undergo another transformation and must participate in rehabilitation to readapt to Earth's gravity. Notably, female astronauts of the European Space Agency and NASA are currently prohibited from becoming pregnant during their missions. However, there is no such prohibition for pregnancy during commercial space missions. for a mother-astronaut, the physiological changes are multi-staged and complex. These changes encompass various phases: during pregnancy, throughout the active phase of labor, while being in space, and finally, upon returning to Earth. Comparing the physiological changes a woman undergoes during pregnancy with those experienced due to the absence of gravity provides valuable insights.

Keywords: Space; Childbirth; Multi-planet; Pioneering; Midwifery; Ethics

1. Introduction

1.1. Physiological and Biochemical Changes in Space

Astronauts in zero gravity face various challenges, including fluid redistribution, muscle atrophy, and bone density loss. The absence of gravitational force causes fluids to shift towards the head, which can lead to facial puffiness and pressure on the eyes, potentially affecting vision. Muscle atrophy and bone density loss occur because muscles and bones no longer have to support the body against gravity, leading to weakening and loss of mass over time.

1.2. Rehabilitation Upon Return to Earth

Upon returning to Earth, astronauts must readjust to gravity, which can be a strenuous process. Rehabilitation programs typically include physical therapy to rebuild muscle strength and bone density and cardiovascular exercises to help normalize circulation and fluid distribution. It can take several weeks to months for astronauts to fully recover and regain their pre-flight physical condition.

1.3. Pregnancy in Space

Considering pregnancy in space introduces another layer of complexity. During pregnancy, a woman's body undergoes significant physiological changes to support the developing fetus. These changes include increased blood volume, changes in cardiovascular function, hormonal fluctuations, and alterations in metabolism and immune function.

* Corresponding author: Elnaz Ghaffari

1.4. Comparative Analysis

Comparing these pregnancy-induced physiological changes with those induced by microgravity reveals several interesting points:

1.4.1. Fluid Distribution:

- **Pregnancy**: Blood volume increases significantly to support the growing fetus, leading to changes in fluid distribution.
- **Microgravity**: Fluids shift toward the upper body due to the lack of gravity, resulting in facial puffiness and changes in pressure.

1.4.2. Muscle and Bone Health:

- **Pregnancy**: Weight gain and changes in posture can place additional stress on muscles and bones, sometimes leading to discomfort or pain.
- **Microgravity**: Absence of gravitational load causes muscle atrophy and bone density loss, requiring countermeasures like resistance exercise.

1.4.3. Cardiovascular Function:

- **Pregnancy**: The heart works harder to pump increased blood volume, potentially leading to cardiovascular strain.
- **Microgravity**: The cardiovascular system adapts to fluid shifts and reduced blood volume, affecting heart function and blood pressure regulation.

A pregnant woman is not ill; she simply undergoes natural changes in her body. Given the changes detailed in the above table, it appears that the potential risks of sending a pregnant woman to space are manageable and controllable.

2. Understanding Pregnancy: A Natural Process

Pregnancy involves a series of natural physiological changes that are designed to support the development of the fetus. These changes include increased blood volume, hormonal fluctuations, and adjustments in cardiovascular function, all of which are perfectly normal and expected. It is crucial to understand that pregnancy, in itself, is not a state of illness but a natural phase in a woman's life.

2.1. Physiological Changes during Pregnancy

- **Increased Blood Volume:** To meet the growing needs of the fetus, a pregnant woman's blood volume increases significantly, which helps in providing essential nutrients and oxygen.
- **Hormonal Fluctuations:** Hormones such as progesterone and estrogen rise, supporting the development of the fetus and preparing the body for childbirth.
- **Cardiovascular Adjustments:** The heart works harder to pump the increased blood volume, leading to an overall increase in cardiac output.
- **Metabolic Changes:** Metabolism increases to support the energy needs of both the mother and the developing fetus.
- **Immune System Adaptations:** The immune system adjusts to protect both the mother and the fetus, reducing the risk of infections.

2.1.1. Comparing Pregnancy and Space Travel

Similar to the natural changes during pregnancy, astronauts experience physiological adaptations due to the lack of gravity in space. These changes include fluid redistribution, muscle atrophy, and bone density loss, which are addressed through countermeasures such as exercise and nutritional support.

3. Potential Risks and Mitigation Strategies

Given the natural physiological changes of pregnancy and the controlled environment of space travel, the potential risks associated with sending a pregnant woman to space appear to be manageable. With proper planning and support, these risks can be mitigated effectively.

3.1. Fluid Managemen

- **Pregnancy:** Increased blood volume and fluid retention.
- **Space:** Fluid shifts towards the head due to microgravity.
- **Mitigation:** Monitoring fluid levels and ensuring adequate hydration can help manage these changes.

3.2. Muscle and Bone Health:

- **Pregnancy:** Weight gain and changes in posture can affect muscles and bones.
- **Space:** Muscle atrophy and bone density loss occur without gravity.
- **Mitigation:** Regular exercise routines and nutritional supplements can support muscle and bone health.

3.3. Cardiovascular Health

- **Pregnancy:** The heart adapts to pump increased blood volume.
- **Space:** Cardiovascular adjustments due to fluid shifts and reduced blood volume.
- **Mitigation:** Close monitoring of heart function and blood pressure, along with appropriate cardiovascular exercises, can ensure heart health

Table 1 Comparisons of Physiological Adaptations, Systemic Changes During Labor, and Body Changes in Space

Physiological adaptations in pregnancy	Systemic changes in the active phase of labor	Body changes in space/ microgravity
Cardiovascular system Hypertrophy of the heart Relocation of the heart Increased heart rate and blood volume Increased blood pres- sure while lying down Increased fibrinogen and hemoglobin Decreased hematocrit	Cardiovascular system Increased blood pressure Increased cardiac output Decreased blood pres- sure while lying down	Cardiovascular system During the launch, astronauts suffer from complications such as rupture of vital vessels, internal bleeding, that›s why astronauts must lie down on their chests. Loss of plasma volume, fluids and electrolytes Astronauts lose 20% of their blood volume within 2-3 days (heart pumps less blood, weakens and increases heart size) Decrease in cardiac muscle volume Decreased venous pressure Dysrhythmia, heart rhythm disorder (due to electrolyte disor- ders and stress); The most common cause of cardiac arrest is an abnormal heart rhythm (ventricular fibrillation). This abnormal rhythm occurs when the oxygen supply to the heart is insufficient or the heart is damaged as a result of a heart attack. Change in CVP Fluid shift to the head (to prevent negative pressure devices to push blood to the legs) microgravity eliminates the hydrostatic pressure caused by gravity, and as a result, body fluids are distributed to the head. Iden is moved, the volume of red blood cells decreases. Micro- gravity causes a shift of 700 to 1400 CC of liquid in the direction of the head (decreasing cardiac endurance) On the ground, when standing, the blood pressure in the legs is 200 mm/HG and the blood pressure of the brain is 60 to 80. In space, due to gravity, the blood pressure in all parts of the body becomes the same and reaches 100

		mm/HG, and as a result, the astronauts› appearance becomes abnormal. Astronauts› legs become very thin due to the loss of about 2 liters of fluid (about one liter in each leg) (the large vein becomes wider with the increase in blood volume, which causes a decrease in body water.) When astronauts return to Earth, the blood flow is quickly diverted to the lower parts of the body, which causes very low blood pressure and un- consciousness (orthostatic failure). Doctors advise astronauts to drink plenty of water before returning to Earth to replace lost fluids to prevent them from passing out while standing up or disembarking from the spacecraft (75% of astronauts experience orthostatic hypotension when they return to Earth). TIGHT OCCLUSION CUFFS and exercise are used to deal with orthostatic incapacity. If accompanied by heart failure, sudden volume changes may cause heart failure, shock and death of the astronaut. Women tend to have a reduced ability to maintain cardiovascular output; the main mechanism is probbly hormonal. Blood circulation is also affected by gravity. Therefore, the heart does not pump hard enough because it does not need to work harder. As a result, the organs and organs do not receive enough blood. For a mother giving birth in space, proper circulation is very important.
Respiratory system • Increased vascularization of the respiratory system • Shortening of the length of the lungs • The diaphragm moves upwards • Poor hyperventilation • An increase in the chest diameter of about 6 cm • Change in breathing (gradually changes from thoracic to abdominal) • Slight increase in breathing rate (2 breaths per minute)	Respiratory system • Increased oxygen consumption • the possibility of hyperventilation due to alkalosis, hypoxia and hypercapnia	Respiratory system • The effect of low oxygen pressure on the body and respiratory disorders

• An increase in pH that causes mild alkalosis		
Neurological system Confusion	Neurological system Increased pain threshold and feeling of sedation due to internal endorphin release The perineal tissues become numb, which is due to the intense continuous pressure on the nerve endings.	Neurological system
Digestive system Gum swelling Displacement of the intestine to the postero-lateral side Displacement of the stomach upwards and laterally Delay in bowel and stomach movements and time to empty the gallbladder and consti- pation Displacement of the appendix from McBur-ney›s point Increased tendency to form gallstones	Digestive system Nausea Dehydration Decreased bowel movement Slow absorption of solids Diarrhea	Digestive system Nausea They feel less thirsty In humans and animals, the amount of energy consumption in space is reduced com- pared to the earth. Absorption, metab- olism and release of drugs are reduced in space.
Ears	Ears	Ears Vestibular disturbance
Eyes, head and face	Eyes, head and face	Eyes, head and face •The pressure applied to the back of the eyeball due to the displacement of fluids in the direction of the head as a result of intracranial pressure and swelling of the head and face of the astronauts, which causes swelling of the connec- tion between the optic nerve and the eyeball and leads to farsight- edness.
Kidney and urinary system The Renal pelvis and ureter are dilated Increased glomeru- lar filtration and renal blood circulation (flow) at the beginning of pregnancy Urea is reduced and the levels of non-pro- tein nitrogen are also reduced Glucose excretion in urine	Kidney and urinary system Difficulty urinating Excretion of protein from urine (1+ is consid- ered Normal)	Kidney and urinary system Kidney produces more urine (decrease of antid-iuretic hormone ADH) and will drink less water (they feel less thirsty.) The kidney reduces the discharge of the erythropoietin hormone, as a result, the blood cells decrease. kidney stones (excre- tion of Ca in urine)

Decreased bladder tone Increased sodium retention under the influence of hormones Increasing the clearance of urea and creatinine		
Immune system	Immune system	Immune system Immunosuppression and infection
Uterus and genitals The diameter of the uterus increases The muscles of the uterus become hypertro- phied; each cell becomes 5-10 times larger Increased vaginal se- cretions with 3.5-6 PH Absence of ovulation and maturation of the new follicle In endocervical glands, we have increased vascularity, edema, hypertrophy and hyperplasia. Thickening of vaginal mucus and softening of soft tissue in the cervix and hypertrophy of smooth muscle cells Change in libido	Uterus and genitals	Uterus and genitals In animal studies, labor (uterine) contrac- tions are twice as more, which means twice as much pain.
Endocrine BMI increase (up to 25% per semester) weight gain of about 11.3-13.6 kg Increased cortisol levels Increased metabolism of iodine Mild parathyroidism Increased plasma parathyroid levels A slight increase in the size of the pituitary gland Increased prolactin production Lowering maternal blood glucose levels Decreased insulin se- cretion at the beginning of pregnancy Increased production of estrogen-progester- one and human chronic	Endocrine Decreased progester- one levels Increased estrogen levels Increased prostaglan- din levels Increased oxytocin levels Increased metabolism Decreased blood glu- cose levels	Endocrine The circadian rhythm of urine cortisol is not in sync with the sleep and wake schedule. Decreased antidiuretic hormone ADH Hypofunction of the thyroid gland and reduction of thyroxine hormone occurs. The level of the tes- tosterone hormone (in males) decreases. Decreased estrogen levels as a result of low gravity and weightless environments may lead to decreased gonadal function in both men and women. Body temperature decreases in space. Sweat

somatomammotropin hormones		
Metabolic system Increased fluid reten- tion Decreased serum protein Increased intercap- illary pressure and vascular permeability Increase of fat and lipoprotein and choles- terol in serum Increased need for iron and carbohydrates Increased protein retention	Metabolic system	Metabolic system
Integumentary system (pro- tective layer or skin) •Increase in the function of sweat glands and scrotum Hyperpygma Natation Darkening of the nipples and areola of the cervix, vagina and vulva Pigmentary changes in the nose, cheeks and fore- head (facial klasma) Strea gravidum and Linanigra Breast changes (colostrum secretion) Palmar erythema and increased angioma Fast growth of nails and hair and their softening and thinning	Integumentary system (protective layer or skin)	Integumentary system (protective layer or skin)
Occupational health	Occupational health	Occupational health The amount of accel- eration, vibration and sound during launch and flight The possibility of con- tact with toxic substanc- es, exposure to radiation
Mental health	Mental health	Mental health Asthenia and depres- sion (mostly in long- haul flights)

3.4. Potential Research Opportunities

Exploring pregnancy in space presents unique research opportunities. Understanding how microgravity affects pregnancy could provide insights into human physiology and the adaptability of the human body. It could also inform the development of medical protocols and support systems for future long-duration space missions, including those to Mars or beyond.

4. Conclusion

The physiological changes during pregnancy are natural and can be effectively managed. When considering sending a pregnant woman to space, the potential risks are low and controllable with proper planning, monitoring, and support. Understanding and addressing these changes ensures the health and safety of both the mother and the developing fetus during space travel. The intersection of pregnancy and space travel presents fascinating challenges and opportunities. By comparing the physiological changes of pregnancy with those induced by microgravity, we can gain valuable insights into human adaptability. As commercial space missions expand, understanding these interactions will be crucial for ensuring the health and well-being of future mother-astronauts and their offspring.

Compliance with ethical standards

Disclosure of conflict of interest

No conflict of interest.

References

[1] Ghaffari, Elnaz. “Design a Space Mission: First Human Childbirth in Space: Transform Humanity into a Multi-Planet Species: Ghaffari, Dr. Elnaz: 9798395375445: Amazon.com: Books.” Amazon.com, 2024, www.amazon.com/dp/B0C5P5L3G6/ref. Accessed 18 Oct. 2024.

[2] Elnaz Ghaffari, et al. “Biological Nanocapsules to Prevent Osteoporosis in Astronauts during Space Travel.” Civilica.com, CIVILICA, 2 Nov. 1399, civilica.com/doc/1144811/. Accessed 18 Oct. 2024.

[3] Elnaz Ghaffari. “Checking Compliance with International Air Laws or International Space Laws in Suborbital Flights.” Civilica.com, CIVILICA, 4 Dec. 1400, civilica.com/doc/1406532/. Accessed 18 Oct. 2023.

[4] Elnaz Ghaffari, et al. “Agriculture in Space, Benefits and Challenges in the Future.” Civilica.com, CIVILICA, 16 Aug. 1400, civilica.com/doc/1306359. Accessed 18 Oct. 2024.

[5] Ghaffari E. Spacefaring Childbirth: Pioneering human expansion. International Journal of Science and Research Archive, 2024, 13(01), 2858–2860.

[6] Ghaffari E. Medical support systems for childbirth in space: Equipment, drugs, and practical challenges. International Journal of Science and Research Archive, 2024, 13(02), 321-330.

[7] Ghaffari E. Case report: Balancing acts: How ADHD and Asperger syndrome complement each other in an individual's life. International Journal of Science and Research Archive, 2024, 13(02), 331-334.