USAARL Report No. 94-44

Pregnancy and Flying Duties

(Reprint)

By

Kevin T. Mason

Aircrew Protection Division

August 1994

U.S. Army Aeromedical Research Laboratory
Fort Rucker Alabama 36362-0577

Notice

Qualified requesters

Qualified requesters may obtain copies from the Defense Technical Information Center (DTIC), Cameron Station, Alexandria, Virginia 22314. Orders will be expedited if placed through the librarian or other person designated to request documents from DTIC.

Change of address

Organizations receiving reports from the U.S. Army Aeromedical Research Laboratory on automatic mailing lists should confirm correct address when corresponding about laboratory reports.

Disposition

Destroy this document when it is no longer needed. Do not return it to the originator.

Disclaimer

The views, opinions, and/or findings contained in this report are those of the author(s) and should not be construed as an official Department of the Army position, policy, or decision, unless so designated by other official documentation. Citation of trade names in this report does not constitute an official Department of the Army endorsement or approval of the use of such commercial items.

Reviewed:

Kevin T. Mason

KEVIN T. MASON
LTC, MC; MFS
Director, Aircrew Protection Division

Released for publication:

Dennis F. Shanahan

DENNIS F. SHANAHAN
Colonel, MC, MFS
Commanding

ROGER W. WILEY, O.D., Ph.D.
Chairman, Scientific Review Committee

Unclassified
SECURITY CLASSIFICATION OF THIS PAGE

REPORT DOCUMENTATION PAGE

Form *Approved* *OMB* No. *0704-0188*

1a. REPORT SECURITY CLASSIFICATION Unclassified	1 b. RESTRICTIVE MARKINGS
2a. SECURITY CIASSIFICATION AUTHORITY	3 DISTRIBUTION /AVAILABILITY OF REPORT Approved for public release, distribution unlimited
2b. DECLASSIFICATION /DOWNGRADING SCH.EDULE	
4. PERFORMING ORGANIZATION REPORT NUMBER(S) USAARL Report No. 94-44	5. MONITORING ORGANIZATION REPORT NUMBER(S)
6a. NAME OF PERFORMING ORGANIZATION U.S. Army Aeromedical Research Laboratory 6b. OFFICE SYMBOL *(If applicable)* SGRD-UAD-IE	7a. NAME OF MONITORING ORGANIZATION U.S. Army Medical Research, Development, Acquisition and Logistics Command
6c. ADDRESS *(City,* Stdte, dnd *ZIP Code)* P.O. Box 620577 Port Rucker, AL 36362-0577	7b. ADDRESS *(City,* State, *dnd ZIP Code)* Fort Detrick Frederick, MD 21702-5012
3a. NAME OF FUNDING /SPONSORING ORGANIZATION Bb. OFFICE SYMBOL *(If applicable)*	9. PROCUREMENT INSTRUMENT IDENTIFICATION NUMBER
3c. ADDRESS (city, *State, and ZIP Code)*	10. SOURCE OF FUNDING NUMBERS PROGRAM ELEMENT NO. 62787A PROJECT NO. 3M162787A878 TASK NO. E C WORK UNIT ACCESSION NO. 144

11. TITLE *(Include Security Classification)*
Pregnancy and flying duties

12. PERSONAL AUTHOR(S)
Kevin T. Mason

13a. TYPE OF REPORT	13b. TIME COVERED	14. DATE OF REPORT *(Year, Month, Day)*	15. PAGE COUNT
Final	FROM _____ TO _____	1994 August	9

16. SUPPLEMENTARY NOTATION
Reprint from U.S. Army Aviation Digest, July/August 1994, pp. 22-27

17. COSATI CODES			18. SUBJECT TERMS *(Continue on reverse* if *necessary* and *identify by block number)*
FIELD	GROUP	SUB-GROUP	Databases, epidemiology, pregnancy, physical forces, aviators
05	02		
06	05		

19. ABSTRACT *(Continue on reverse* if *necessary and identify by block number)*

Some Army aircrew members want to fly during pregnancy Current Army policy significantly restricts flying duties during pregnancy. There are multiple physical forces and biochemical exposures in the Army flying environment which may adversely affect the course of a pregnancy and the developing fetus. Noise, whole-body vibration, and acceleration forces are of particular concern. The adverse effects of these forces have been documented in animal models and by human observational studies

This paper discusses the issues and concerns surrounding pregnancy and flying for the lay aircrew member from the perspective of an aerospace medicine specialist and family physician. The literature supporting our current state of knowledge on the topic of pregnancy and flying is reviewed. Psychosocial and physiological complications of pregnancy are tabulated. Army policy for flying duties during pregnancy, old and new, are tabulated.

(Continued on next page)

20. DISTRIBUTION /AVAILABILITY OF ABSTRACT ☒ UNCLASSIFIED/UNLIMITED ☐ SAME As RPT. ☐ DTIC USERS	21. ABSTRACT SECURITY CLASSIFICATION Unclassified
22a. NAME OF RESPONSIBLE INDIVIDUAL Chief, Science Support Center	22b. TELEPHONE *(Include Area* Code) (205) 255-6907 22c. OFFICE SYMBOL SGRD-UAK-SI

DD Form 1473, JUN 86 *Previous editions are* obsolete.

SECURITY CLASSIFICATION OF THIS PAGE
Unclassified

19. Abstract (Continued).

The issues and concerns of pregnancy and flying are complex. Knowledge of the effects of the flying environment on pregnancy is incomplete. Numerous legal and ethical issues complicate study of the controversies. Until further information is available, the Army likely will maintain a conservative policy of restricting flying duties during pregnancy, primarily for the safety of the unborn child.

Pregnancy and Flying Duties

Kevin T. Mason M.D., M.P.H.
LTC, MC, MFS
Director, Aircrew Protection Division
U.S. Army Aeromedical Research Laboratory

Joy of new life

One of my greatest joys has been delivering babies for aircrew members and their families. I was even lucky to have one delivery room with a window facing east. It seemed most kids like to come into this world between three and seven o'clock in the morning. So I have many memorable moments holding up a worried-looking newborn, eyes blinking and pupils constricting, with the first rays of morning sun flooding the room. As I said, a joyful time. There have been some sad moments --- delivering miscarriages and stillborn infants. These events remind us of our inevitable mortality and that not all pregnancies are free of problems.

Since pregnancy and flying is a subject of controversy, balanced by evolving knowledge and policies, this article shares my current perspective on the issues and policies.

A look over our shoulder

In this century, women gradually entered certain occupations previously thought to be exclusively in the male domain, such as aviation, law enforcement, construction, and auto racing. Despite the accomplishments of pioneer aviatrixes in the 1910s through the 1930s, the bias against women entering aviation is reflected in the comments of others of the time. For example, Claude Graham-White said in 1911, "Women are temperamentally unfit to fly and prone to panic in any calamity." In the 1930s, Amelia Earhart said, "Men do not believe us capable." In 1939, women were barred from U.S. air traffic control school. School administrators said, "NO woman could keep her head in heavy traffic." Even after American women proved their capabilities as instructor and transport pilots in World War II, it was not until the early 1970s that we saw our first female airline command pilot and modem military pilot in the U.S. Today women are just now entering combat mission training in U.S. military aviation.

Until the last two decades, considerable mystique surrounded the female reproductive cycle, even in the medical community. This was due largely to the lack of knowledge and the inaccurate belief that women were fragile, most certainly so while pregnant. Standard medical care in developed countries into the early 1960s placed women on 10 days of strict bed rest after delivery. With maternal mortality remaining a significant problem well into this century, perhaps these precautions were warranted at the time, though not well supported by fact.

Since the 1960s, the veil of this mystique has gradually lifted. Analysis of hormones and other key biochemical processes, ultrasonic and fiberoptic imaging of the fetus, and other fetal monitoring devices are improving our understanding. Still, the effects of the workplace on the developing fetus are not

well known. Our scope of knowledge is limited by the small number of women in certain occupations and the medical-legal ethics against exposing humans, especially pregnant humans, to an environment with potential harmful effects.

Current issues and concerns

While the physiologic effects of flying are very well known the specific effects of the aviation environment on pregnancy are not well known but potentially harmful. Although pregnancy is a natural process, it is accompanied by psychophysiologic changes influencing all major body systems. Pregnancy may be unpredictably complicated by acute changes in health at any time, even when the pregnancy appears to be progressing normally with a low risk for complications. Multiple social and legal issues encircle pregnancy, some conflicting with flying or the study of pregnant women while flying. The rights of the spouses of pregnant women and the rights of the unborn child are argued in today's courtrooms, often in favor of the spouse and fetus. Many new national and international standards advocate the protection of the unborn child, regardless of the mother's or attending doctor's willingness to assume certain occupational risks.

A search of the U.S. Army Aviation Epidemiology Data Register shows there were about 480 female aviators in our peak aviator work force in the calendar year of 1989. About 25 per year were restricted from flying duties due to pregnancy from 1988 to 1992.

The U.S. Army Aeromedical Consultant Advisory Panel (ACAP) regularly reviewed the issue of pregnancy in aircrew members since young women first entered the Army aviation force. Dozens of consultants have been involved to include aircrew members, flight surgeons, aerospace medicine specialists, and obstetricians of both genders. The medical literature has been reviewed continuously. This aeromedical review process has provided a basis for updating aeromedical policy.

Table 1 summarizes the major issues and concerns addressed by the ACAP. The key aviation stressors involve hypoxia, noise, whole-body vibrations, acceleration forces, high environmental temperatures, and toxins.

We are sure fetuses can tolerate moderate levels of hypoxia up to physiologic equivalents of 10,000 feet altitude above mean sea level. Fetuses have been monitored in airline cabins with cabin altitudes up to 8,000 feet without adverse effects. Above an altitude of 10,000 feet above mean sea level, some studies show increased risk for infant morbidity and mortality. Additional caution is required since anemia is common in pregnancy. Anemia increases the physiologic altitude, increasing the degree of fetal hypoxia at a given exposure altitude. Smoking while pregnant, besides the direct harmful effects of chemicals in the smoke, also increases the physiologic altitude.

Our aviation environment, especially rotary-wing cockpits, is rich with high decibel, low and high frequency sounds which damage hearing. The uterus and amniotic fluid may accentuate low frequency sounds, and only weakly attenuate high frequency sounds, perhaps by no more than 10 decibels as determined with direct measurement inside the uterus in the third trimester of pregnancy. The unborn child is more susceptible to hearing damage than adults for a given sound pressure exposure. Since children are devel-

oping language and listening skills, they cannot tolerate the same degree of hearing loss as adults and still function normally. The effects of high decibel noise on the fetus are not completely known, but studies in Scandinavian countries and Canada link a three-fold increase in infant hearing loss to occupational noise exposure during pregnancy as low as 90 decibels. We must assume the fetus is exposed to harmful sound levels in Army aviation, and the fetus is without the benefit of hearing protection available to the mother.

Rotary-wing aircrew are exposed to significant levels of whole-body vibrations. Whole-body vibrations damage fetal animals, causing developmental failures and birth defects. Whether the suspension systems of the human uterus and amniotic fluid protect or accentuate whole-body vibrations is unknown. The effects of whole-body vibration on the development of the human fetus are unknown, but some studies have shown women with occupational exposure to whole-body vibrations are at increased the risk for miscarriage and birth defects. Some caution is even warranted in Synthetic Flight Training Simulators with the "seat shaker ON" mode.

It is thought the fetus is protected partially from injury when exposed to acceleration forces in the first trimester. But in the second and third trimester, there is an increased risk for uterine rupture, separation of the placenta from the uterine wall, and fetal mortality. These notions were developed from study of pregnant women and animal models in X-axis forces (forward-backward) found in motor vehicle accidents. The effects of high Z-axis (up-down) acceleration forces, and seat and restraint systems on pregnancy are unknown in aviation mission profiles and mishaps. Theoretically, with Z-axis forces, the uterus would be forced downward into or across the edge of inflexible pelvic bones, increasing intrauterine pressures and accentuating the risk for injury. The highest risk for injury might be in the third trimester when the restraint system would ride over the uterus at different angles than designed. As with X-axis forces, uterine rupture and placental separation from the uterine wall with exposure to otherwise minor Z-axis forces are possible.

High environmental temperatures are common in Army aviation. Pregnant women have decreased tolerance to heat in all stages of pregnancy. Body temperatures greater than 101 degrees Fahrenheit may cause structural or functional damage to the fetus. It is suspected heat exposure may cause certain major central nervous system defects.

The effects of aviation toxins, such as hydrocarbons, carbon monoxide and other combustion byproducts, on pregnancy are unknown. Theoretically, the greatest harm would occur during the first trimester when the embryo, and later fetus, are at greatest risk for toxic injury.

There are potential electromagnetic hazards in our operational environment that may harm the developing fetus. While it is thought the levels of electromagnetic radiation exposure in aviation and the workplace are safe, studies on this potential hazard are ongoing and controversial.

Other aviation concerns related to the health of the mother include the common medical complications of pregnancy, such as fatigue, nausea, vomiting, frequent urination, fluid retention, weight gain and change in body habitus, acute bleeding, and anemia. The main concern is some complications occur unpredictably with acute incapacitation, even during an otherwise normal or low risk

pregnancy. For example, one in 5 to 10 pregnancies ends in miscarriage generally with the acute onset of pain and heavy bleeding.

Policy, old and new

The old policy prohibited flying duties of any kind while pregnant. It resulted in the status of "Duties not to include flying" for greater than 180 days, resulting in medical termination from aviation service. This required requalification at the waiver authority level after recovery from the pregnancy.

Based upon an ongoing and thorough review of the issues and concerns of flying while pregnant, a new policy has been issued for the management of pregnant Army aircrew members. Tables 2 and 3 summarize the old and the new U.S. Army aircrew member pregnancy and flying duties policy.

The new policy minimizes the administrative burdens of medical termination from aviation service, gives the commander greater flexibility in keeping pregnant aircrew members at higher levels of training and proficiency, speeds the return to unrestricted aviation service after delivery, and still meets the intent of protecting the mother and unborn child based on current medical knowledge and ethical/legal constraints.

The absolute pregnancy success rate among Army aircrew members is unknown. One reason is that our aircrew health database mostly contains reports of pregnancies that went past 28-weeks gestation, and even then, the information often provided is limited to dates of delivery. The new policy requires flight surgeons to report the outcomes of all pregnancies and pregnancy complications involving cockpit aircrew members. This is one step to help answer many questions posed by the aviation line and medical community concerning pregnancy outcomes in the aviation and military environment. It also will help formulate future policy.

Departure

The issues and concerns of pregnancy and flying are complex. Knowledge about the effects of physical forces and toxins found in the aviation environment on pregnancy is not complete, but the potential for fetal injury and death is real. Pregnant women cannot be used as "guinea pigs" in Army aircraft to deny or verify these effects. It is difficult to balance the conflicting requirements and recommendations of the patient, family, unborn child, command, and medical community. Legal and ethical considerations conflict as well. Despite these hurdles, it is the opinion of the ACAP that a better balance has been achieved by the new policy.

Table 1.
Issues and concerns in pregnancy and flying.

General military duties	Limited deployability Restricted physical training and environmental exposure Restricted wearing of military equipment
Aviation duties	Hypoxia High decibel noise Whole-body vibration, significant in rotary wing aircraft Acceleration forces and restraint system issues in mishap Increased heat exposure Aviation toxins
Social & legal issues	Spouse rights when objecting to flying duties Fetus rights to protection from harmful environments Tort liability in event of adverse pregnancy outcome Restrictive guidelines in the conduct of human research
Common complications in the first trimester, 0-12 weeks gestation	Morning sickness, 1 per 2 pregnancies Miscarriage and/or acute bleeding, 1 per 5-10 pregnancies Fetal malformations Fainting and fatigue Decreased heat tolerance
Common complications in the second trimester, 13-24 weeks gestation	Ectopic (outside womb) pregnancy, 1 per 50-130 pregnancies Miscarriage and/or acute bleeding, 1 per 5-10 pregnancies Diabetes of pregnancy, 1 per 120-300 pregnancies Anemia Fainting and fatigue Decreased heat tolerance
Common complications in the third trimester, 25 weeks gestation to delivery	High blood pressure Pretoxemia or toxemia of pregnancy, 1 per 10-50 pregnancies Premature labor and/or acute bleeding Rupture of placenta, 1 per 200-500 pregnancies Decreased respiratory capacity Anemia Fainting and fatigue Decreased heat tolerance Blood clots in veins Heartburn (gastritis, esophagitis) Backaches
Other complications	Kidney and gall bladder stones Genitourinary tract infections, 1 per 3-10 pregnancies Twins, increased complication rates

Table 2.

Past policy for pregnant U.S. Army aircrew prior to 27 January 1993.

Time line->	Date of diagnosis to 4-6 weeks after delivery
Class 1/1A	Disqualified
Class 2/2F/2 S/3	DNIF For Class 2/2F, DNIF with termination from aviation service (permanent medical suspension) since DNIF is for greater than 180 days (AR 600-l 05 and DOD Pay Manual). Requalification 6 weeks after delivery.
Class 4 (ATC)	FFD unless medical complications or hospitalization will prohibit/interfere with ATC duties

* DNIF is “duties not to include flying.”

** FFD is "full flying duties,” with or without restrictions.

Table .

New policy for pregnant U.S. Army aircrew effective 27 January 1993.

<table>
<tr><td>Time line-></td><td>Date of diagnosis
to
12 weeks gestation</td><td>13 weeks gestation
to
25 weeks gestation</td><td>26 weeks gestation
to
delivery</td><td>Delivery to
4-6 weeks
after delivery</td></tr>
<tr><td>Class 1/1A</td><td colspan="4">Disqualified</td></tr>
<tr><td rowspan="2">Class 2/2F2S/3</td><td colspan="3">Uncomplicated pregnancy:
Temporary FFD with restriction to SFTS; an exception is from 13 weeks to 25 weeks gestation may fly FFD with restriction to multiengined, nonejection seat, fixed-wing aircraft with dual pilot status and cabin altitude ≤ 10,000 feet.</td><td>DNIF</td></tr>
<tr><td colspan="4">Complicated pregnancy:
DNIF with termination from aviation service (permanent medical suspension) if DNIF is for greater than 180 days (AR 600-105 and DOD Pay Manual). Requalification, with or without waiver, upon resolution of condition.</td></tr>
<tr><td>Class 4 (ATC)</td><td colspan="4">FFD unless medical complications will prohibit or interfere with ATC duties</td></tr>
</table>

* DNIF is “duties not to include flying.”

** FFD is "full flying duties,” with or without restrictions.

Bibliography

Ales, K. L. 1989. Functional status in pregnancy. American journal of medical science. 297: 355-360.

Andersen, H. T. 1991. Pregnancy- a cause for grounding of female aircrew. Recruiting, selection. training and military operations of female aircrew. Neuilly Sur Seine, France: Advisory Group for Aerospace Research and Development. AGARD-CP-49 1.

Bentur, Y. 1991. The three most common occupational exposures reported by pregnant women. American journal of obstetrics and gynecology. 165: 429-37.

Bia, F. J. 1992. Medical considerations for the pregnant traveler. Infectious disease of clinics of North America. 6: 371-388.

Blackwell, R. 1988. Video display terminals and pregnancy. British journal of obstetrics and gynecology. 95: 446-453.

Cameron, R. G. 1973. Should air hostesses continue flight during the first trimester of pregnancy? Aerospace medicine. 44: 552-556.

Cotton, E. K. 1980. Study of babies born to mothers living at an altitude of 3,100 meters, American joumal of obstetrics and gynecology. 138: 220-22.

Council on Scientific Affairs. 1984. Effects of physical forces on the reproductive cycle. Journal of the American Medical Association. 25 1: 247-50.

Crosby, W. M. 1971. Safety of lap-belt restraint for pregnant victims of automobile collisions. New England joumal of medicine. 284: 632-636.

Culver, C. C. 1990. Anthropometry of seated women during pregnancy: Defining a fetal region for crash protection research. Human factors. 32: 625-636.

Daniell, W. E. 1990. Pregnancy outcomes among female flight attendants. Aviation. space, and environmental medicine. 6 1: 840-4.

Department of the Army. 1988. Memorandum for all flight surgeons. Subject: Aeromedical policy letter 12-88, Pregnancy.

Department of the Army. 1993. Memorandum for all flight surgeons. Subject: Aeromedical policy letter 12-93, Pregnancy.

Flournoy, A. C. 1990. Selected legal issues related to sound and vibration in pregnancy. Seminars in perinatology 14: 334-339.

Fort, A. J. 1970. Pregnancy outcome after non-catastrophic maternal trauma. Obstetrics and gynecology. 35: 912-15.

Gerhardt, K. J. 1990. Prenatal and perinatal risks of hearing loss. Seminars in perinatology. 14: 299-304.

Goodlin, R. C. 1984. Fetal malformations associated with maternal hypoxia. American journal of obstetrics and gynecology. 149: 228-229.

Hartikainen-Sorri, A. 1988. Occupational noise exposure during pregnancy: A case control study. Occupational and environmental health. 60: 279-283.

Huch, R. 1986. Physiologic changes in pregnant women and their fetuses during jet travel. American joumal of obstetrics and gynecology 154: 996-1000.

Lalande, N. M. 1986. Is occupational noise exposure during pregnancy a risk factor of damamge to the auditory system of the fetus? American joumal of industrial medicine. 10: 427-435.

Lidstrom, I. 1990. Pregnant women in the workplace. Seminars in perinatology 14: 329-333.

Kissinger, D. P. 1991. Trauma in pregnancy. Archives of surgery. 126: 1079-1086.

Magann, E. F. 1991. Pregnancy outcome in an active-duty population. Obstetrics and gynecology. 78: 391-393.

Mason, K. T. 1989. History of the female aviator. Paper presented at the 7th Medcom Operational Aeromedical Problems Course, 1989. Santhoffen, West Germany.

Mason, K. T. 1990. Waiver and suspensions in female Army aviators from 1986 to 1990. Paper presented at the U.S. Army Operational Problems Course, 1990. Fort Rucker, Alabama.

Mayhew, T. M. 1991. Scaling placental oxygen diffusion to birthweight: Studies on placentae from low- and high-altitude pregnancies. Journal of anatomy. 175: 187-94.

McMurray, R. G. 1990. Thermoregulation in pregnancy. Sports medicine. 10: 146- 158

Moore, L. G. 1987. Altitude-aggravated illness: pregnancy and prenatal life. Annals of emergency medicine. 16: 965-973.

Nurminen, T. 1989. Shift work, fetal development and course of pregnancy. Scandinavian journal of work and environmental health. 15: 395-403.

Parker, J. T. 1982. Effects of hypoxia on the mother and fetus with emphasis on maternal air transport. American journal of obstetrics and gynecology. 147: 957-60.

Pearlman, M. D. 1990. Blunt trauma during pregnancy. Current concepts. 323: 1609-16 13.

Pelmear, P. L. 1990. Low frequency noise and vibration: Role of government in occupational disease. Seminars in perinatology. 14: 322-328.

Pries, C. N. 198 1. Reproductive effects of occupational exposures. American family physician. 24: 161-165.

Ramirez, G. 1990. Occupational physical activity and the other risk factors for preterm birth among U.S. Army primigravidas. American journal of public health. 80: 728-730.

Richards, D. S. 1992. Sound levels in the human uterus. Obstetrics and gynecology. 80: 187-190.

Rubovits, F. E. 1964. Traumatic rupture of the pregnant uterus from seat-belt injury. American journal of obstetrics and gynecology. 90: 828-29.

Scholten, P. 1976. Pregnant stewardess- Should she fly? Aviation. space and environmental medicine. 47: 77-8 1.

Schorr, T. M. 1990. The NIOSH study of reproductive outcomes among video display terminal operations. Reproductive toxicology. 4: 6 l-65.

Scorpio, R. J. 1992. Blunt trauma during pregnancy: Factors affecting fetal outcome. Journal of trauma. 32: 213-216.

Stewart, W., and Ouellet-Hellstrom, R. 1991. Adverse reproductive events and electromagnetic radiation. National Institute of Occupational Safety and Health, Cincinnati, Ohio. National Institute of Occupational Safety and Health Report No. PB92-145796

Snyder, R. G. 1968. Impact iniury to the pregnant female and fetus in lap belt restraint. Washington, D.C.: Federal Aviation Administration. Report No. AM-68-24.

Willson, R. J. 1992. Obstetrics and gynecology. St. Louis: C.V. Mosby Company.

World Health Organization. 1982. Women and occupational health risks. Copenhagen: World Health Organization. EURO Report and studies 76.

Zhang, J. 1992. Occupational hazards and pregnancy outcomes. American ioumal of industrial medicine. 2 1: 397-408.