AIRCREW VOLUNTARY ACCEPTANCE OF RISK (AVAR): MEDICAL RISKS FOR FLYING WHILE PREGNANT

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During pregnancy, your body changes in significant wide-ranging ways. Many of the normal physical changes of pregnancy create potential risks in the flight environment. The overall impact of these changes is unpredictable and varies between individuals and even between your own pregnancies. Additionally, there are certain pregnancy-related conditions that can cause sudden incapacitation or life-threatening emergencies. The intent of this document is to educate you on these risks, in order for you to make an informed decision on whether or not to request to fly while pregnant.[1]

To be considered for approval of crewed flight duty, you must personally request to continue flying. You are not required to fly during pregnancy and cannot be made to fly against your will. This document is to help inform you of both known and potential but unmeasured risks associated with flying while pregnant in order to make that informed decision. In order to return to flying duties, you, your flight surgeon, your obstetrical care provider, and your commander must all collaborate to determine if the flight risk in your current condition is acceptable.

Air Force policy requires medical certification of all aircrew to ensure fitness for flight duties. As with any medical condition, flying during pregnancy is permitted only after certification by a flight surgeon that the medical condition is associated with an acceptable level of flight safety risk. Appropriate evaluation and acceptance of this risk may require waiver processing. A signed "UP" DD Form-2992, Medical Recommendation for Flying or Special Operational Duty, from your flight surgeon informs your commander about your medical fitness to perform flying or special operational duty. It is possible you will not be granted permission to continue to fly during pregnancy if doing so would present a risk to flight safety.

Some of the common physical changes in pregnancy and potential hazards to you and your pregnancy are described below; to include possible health outcomes to your baby. The degree to which you experience symptoms associated with these changes may differ from other pregnant women and may change from week to week or even day to day. In accordance with AFMAN 11-202 Vol 3, Flight Operations, if you experience changes in these symptoms, you should not initiate flight duty until cleared by your local flight surgeon.

Flying while pregnant may expose the aircrew member and their pregnancy to risks that are not fully known. Some risks identified below are risks to the member and pregnancy expected as possible by aerospace medicine experts, but the frequency of occurrence is not known. The decision to request to continue to fly while pregnant is personal. You have the option to request either approval to fly, or not to fly, based on your individual understanding of these known and unknown health risks. You also have the right to change your decision at any time over the course of your pregnancy by talking with your flight surgeon.

<u>Changes of pregnancy:</u> These factors may cause symptoms that impact flight safety and potentially maternal and fetal health.

Vision:[2] Thickening of the front surface of the eye due to swelling can occur as early as 10 weeks into pregnancy, and can last for several weeks after delivery.[3] This condition may change over time during your pregnancy.[4] Your vision must be checked every four weeks during your flight medicine follow up to ensure vision standards for flying duties are met. Additionally, if you notice any changes in your vision, you should be checked by your flight surgeon to ensure you meet vision standards.

Blood Clotting: Pregnancy increases your risk of developing blood clots.[5] Blood clots can develop in any vein and migrate to the lungs. This is the leading cause of maternal deaths in developed countries. The risk of forming blood clots when pregnant is at least five times higher than the non-pregnant state. Some elements of flight duty, including long periods of inactivity or remaining in a cramped cockpit during flying duties, can contribute to the risk of blood clots.[6] Due to the low likelihood of forming blood clots, this risk is usually determined to be acceptable for flight safety.[7] Screening for clotting disorders is not recommended routinely in pregnancy. However, if you or a family member has a history of prior blood clots, you should be sure to discuss this with your obstetrician and flight surgeon. Additionally, if you experience symptoms of a blood clot (leg or arm swelling or pain, chest pain, or difficulty breathing), you should immediately seek medical care and should not initiate flight duties until cleared by your flight surgeon.

Distribution of Blood Flow: Blood volume increases during pregnancy in order to meet the need for increased blood flow to the placenta that delivers oxygen and nutrients to the fetus.[8] Your heart and lungs will be supplying sufficient oxygen and blood flow for both you and your fetus while you are pregnant.[9] Additionally, the developing fetus' blood cells bind oxygen more easily than your cells as the mother. These factors may combine to increase your risk of hypoxia, reduce your ability to withstand G-forces, and cause you to fatigue faster than before you were pregnant.

Changes to your endurance or perception of fatigue should be discussed with your flight surgeon at the next opportunity. You must immediately report any symptoms of hypoxia or other physiologic event to the nearest flight surgeon before returning to flight duties.

Anemia: Anemia is defined as a condition where you do not have sufficient red blood cells in the blood to deliver adequate oxygen to your body's tissues. A variety of factors in pregnancy contribute to the normal concentration of red blood cells in the blood being lower.[10] Your obstetrical care provider may tolerate lower levels of red blood cells as considered "normal" for pregnancy, but these levels may not be adequate for aircrew during pregnancy. Altitude lowers the level of available oxygen. Monitoring for anemia is common in routine prenatal care but requires additional monitoring for symptoms if flying is considered. The standard replacement of iron and folate in prenatal vitamins is generally adequate, but higher doses may be required for aircrew during pregnancy. Any diagnosis of anemia, including "normal physiologic anemia of pregnancy," must be discussed with your flight surgeon to ensure you remain cleared to fly.

Vaginal Bleeding: Vaginal bleeding can occur in all stages of pregnancy. Up to 25% of females will experience vaginal bleeding during the first trimester of pregnancy. Bleeding can range from minimal to excessive to life-threatening.[11] It can be gradual and painless, or sudden and associated with incapacitating pain. In most cases, small amounts of vaginal bleeding are not associated with dangerous conditions. However, vaginal bleeding can indicate more serious conditions and must always be immediately evaluated.[12] Miscarriages are common events, occurring in 10 to 20% of all recognized pregnancies.[13] Nearly 80% of miscarriages occur in the first trimester. Many miscarriages occur unpredictably without an identifiable cause. If a miscarriage occurs, vaginal bleeding is frequently the first sign. Even small amounts of vaginal bleeding may be an early sign of medical conditions that can be distracting or disabling during flight duties. If you experience any vaginal bleeding, you should not initiate flight duties until after you have been cleared by your obstetrician and flight surgeon.

Heart and Blood Pressure: Heart rate gradually increases throughout a normal pregnancy. Some pregnant women experience a decrease in blood pressure when lying down, leading to possible fainting. During a normal pregnancy, the average blood pressure begins to decrease by 7 weeks of gestation, reaching a low point by 24 to 32 weeks, gradually increasing in the third trimester, and returning to pre-pregnancy levels following delivery. These changes can have significant or subtle effects on heart function, and in turn, can affect G-tolerance, vision, endurance, fatigue, and hypoxia tolerance.[14] If you experience unexpected changes in your vision or heart rate or experience lightheadedness or dizziness, you should discuss these with your flight surgeon before returning to flight duties.

Lungs: Changes in the lungs can be significant in the flight environment. Aircrew who have passed a standard flight physical usually have lung function that is well above average in this country. However, pregnancy will significantly alter normal lung function.[15] Pregnancy will increase your need for oxygen, causing an increase in breathing rate and other changes in your ability to absorb and use oxygen.[16] The volume of air that the lungs can hold is decreased during pregnancy, and the normal breathing rate is increased due to physical changes with the enlarging abdomen. In the flight environment, these changes can impact hypoxia tolerance. In a situation of rapid decompression during flight, the time of useful consciousness may be dramatically shortened during pregnancy. You must immediately report any symptoms of hypoxia or other physiologic event to the nearest flight surgeon before returning to flight duties. Restricting planned flight profiles and missions to keep cabin altitude below 10,000 ft can help mitigate these risks.

Renal (kidney function): In pregnancy, blood flow to the kidneys and filtering of blood increases by 50%.[17] This increase in kidney function, along with pressure on the bladder from the uterus, results in more urine production during a normal pregnancy.[18] This results in more frequent urination, a higher risk of dehydration, and increased potential for kidney stones. The dry flight environment can contribute to dehydration during flight. These factors may cause very few symptoms, or they may significantly impact your G-tolerance, endurance, and hypoxia tolerance. Dehydration lasting greater than 60 minutes has the potential to decrease cognitive function and cause delays in reaction time.[45] Urinary tract infections are more prevalent in pregnancy and must be treated with more vigilance in pregnancy due to a higher risk of complications. If you have any symptoms of urinary tract infection, such as burning with urination, you should seek care with your obstetrician. You should not fly if you have any urinary tract symptoms until after being cleared by your flight surgeon.

Gastrointestinal (GI): During normal pregnancies, hormone changes that support the pregnancy may cause decreased activity of the GI tract and increased vomiting.[19,20] Pregnancy-associated vomiting ("morning sickness") occurs most commonly during the first trimester but can occur throughout the pregnancy. Vomiting may become frequent enough to require medications to reduce nausea and vomiting.[21] Additionally, acid reflux into the esophagus ("heartburn") is also more common during pregnancy, particularly when lying down. Even levels of nausea and vomiting that are considered normal to an obstetrician may result in significant distraction or dehydration that contributes to fatigue. Any symptoms of nausea and vomiting of pregnancy should be discussed with your flight surgeon to ensure that you are safe to fly.

Gestational Diabetes (Control of Sugar Levels): Pregnancy can reduce the function of insulin in some females. This may result in a relative increase in circulating blood sugar or frank (gestational) diabetes.[22, 23] Maternal screening for diabetes generally happens at 26-28 weeks of gestation, but it may be performed earlier for risk factors or clinical findings.

Abnormally high or low blood sugar (glucose) levels can contribute to a variety of changes that are concerning to flight safety including sudden fatigue, blurred vision, dizziness, confusion, excessive thirst/urination, and tingling/numbness. Any abnormal glucose screening during your pregnancy should be discussed with your flight surgeon before return to flight duties.

Aircrew Flight Equipment (AFE) Considerations: Uterine growth during pregnancy will lead to abdominal changes which will probably be visible around 12 weeks of gestation or soon after. Other effects of pregnancy may also impact the fit and function of flight equipment. In particular, changes in size and weight distribution (center of gravity) may occur due to swelling, weight gain, or decreased joint stability. You will need to work with your AFE shop during your pregnancy to adjust equipment accordingly.

Sleep: Sleep disturbances during pregnancy are common[24] and can contribute to excess fatigue during pregnancy. A wide range of pregnancy symptoms frequently disrupt sleep quality. These disturbances tend to increase as pregnancy progresses, resulting in acute and chronic fatigue and increasing flight safety risk. You should discuss any significant changes in sleep patterns with your flight surgeon.

General: Alone or in combination, several conditions might lead to distraction and a loss of situational awareness; these include distraction/loss of mental alertness,[25, 26] morning sickness, sleep disturbance, contractions, lower abdominal discomfort, increased urinary frequency and gastroesophageal reflux.

If you have any concerns or questions about whether your symptoms may pose an increased risk to flight safety at any time during your pregnancy, you should self-ground and ask for evaluation with your flight surgeon.

During pregnancy you are expected to have frequent follow-up with your obstetrician and your flight surgeon to monitor the changes associated with pregnancy. If your obstetrician discusses any new concerns or prescribes any new medicines, you should discuss these changes with your flight surgeon before flying. Every effort should be made by the flight surgeon and the command to cultivate an environment that would facilitate this process.

<u>Hazardous Exposures to Aircrew Member and Pregnancy:</u>

Sound and Vibration: Sound and vibration exposure during the second trimester has been associated with hearing changes identified in the newborn.[27,28,29] The hearing organs are developed around 20 weeks gestation and may be susceptible to vibration and noise damage.[30] Significant noise and vibration exposures have been associated with permanent damage to hearing and inner ear anatomy, fetal growth restriction and preterm labor.

The location of the fetus within your body provides a small amount (3-6 dB) of noise protection, but less noise protection than is typically worn by aircrew wearing double hearing protection (20-30 dB).[31] While commercial aircraft are configured to dampen noise and vibration to improve the safety of passenger travel, military aircraft generally do not have the same level of protection due to the constraints of operational technology. It is not currently known if there are specific noise exposure levels that are safe during pregnancy.

Some aircraft in the USAF have noise levels that are comparable to commercial airline aircraft during normal operation. Some aircraft in the USAF have noise levels that may be many times louder than commercial airline aircraft. The noise level in some aircraft is far higher than levels known to cause injury with prolonged exposure in factory workplace settings. Some aircraft and aircrew positions currently have incomplete noise exposure data. You should talk with your flight surgeon about levels of noise exposure in your aircraft and crew position.

Most studies of workplace noise exposure during pregnancy are based on exposure time of 40 hours per week and have found noise exposures **≥** 85dB increased risk of hearing dysfunction in children by up to 82%.[32] Flight duty presents shorter exposure times but may introduce exposure to much louder noise levels than current studies. The degree to which this changes risk to your baby is not currently known. Study of the frequency of hearing loss in the children of USAF aircrew exposed to noise in flight during pregnancy is ongoing. In a small study of the effects of flying on pregnancy outcomes, the Air Force Medical Service has identified a trend toward increased rates of hearing loss in the children of female flyers.[33] However, because of the low number of patients in this initial study, the number of children with hearing loss has been small enough that this may not actually represent harm caused by a specific exposure to noise. Further research is ongoing, and the larger number of patients evaluated will help to determine whether the effects are related to flying or not. The only known way to reduce the risk of injury to your baby from these exposures is to reduce the amount of time exposed to loud noise and vibration.

Altitude: Civilian research comparing populations living at high altitudes suggests that living at high altitudes during pregnancy may lead to lower birth weight due to a possible association with decreased fetal growth due to hypoxia.[34] Aircraft altitude restrictions designed to guide whether flight duty risk is acceptable for waiver may not protect against these possible harms.[35] The extent to which shorter periods of altitude exposure actually impacts the growth of the fetus and what exposure time might be acceptable is not currently known.[36] Using supplemental oxygen to avoid hypoxia may reduce this risk. However, routine use of oxygen in all phases of flight is not recommended as abnormally high levels of oxygen in the blood may also cause injury.

Heat: Pregnancy alone increases heat production and decreases your body's ability to control its temperature in hot settings. The flight environment, pre-flight ground environment, and safety equipment may further increase heat exposure to the flyer.

The combination of increasing body mass, the flight environment including operational gear, and fetal heat production increases the amount of heat that the aircrew member has to cope with through sweating (called heat load).[37] The increased heat load increases the short-term risk of heat injuries to the aircrew member that could impact flight safety. Even if heat injury to the aviator does not occur, there may still be injury to the fetus that may not become apparent until after birth. [38] While studies of intentional heat exposure are not conducted on pregnant people for ethical reasons, case reports and population-level database comparisons regarding women who experienced elevated core body temperatures during pregnancy have shown it doubles the risk of neural tube defects (birth defects of the brain and spinal cord). Second trimester exposure to heat extremes is associated with an increased risk of stillbirth and third trimester exposure to heat extremes may trigger preterm labor.[39, 40] Additionally, animal studies suggest elevated ambient temperatures are associated with an increase in risk of preterm labor and growth restriction. You should have additional conversation with your flight surgeon about these risks if your normal duties include flight in hot environments.

Radiation: Radiation exposure is a potential risk factor to the fetus, particularly during organ development in the first trimester. Evidence suggests solar radiation exposure from flight duties would normally require thousands of hours of flight time to produce unsafe levels of solar radiation to the fetus. Studies of pregnant commercial airline workers and the associated radiation exposure are reassuring, showing no adverse fetal outcomes. However, some military flight duties may include radiation exposures that are different than those experienced by commercial airline crews. Some additional sources of exposure in the flying environment may be known for your specific aircraft (ie: radar, HF radio) and mission (ie: altitude, payload). Additional research is underway regarding the considerations for airframe, flight profile, and position-specific exposure risk; you should discuss the risks with your flight surgeon. There is not currently data to establish safe limits for all of these exposures during pregnancy.

Chemical: A growing pregnancy may be susceptible to the harmful effects of chemical exposures. This risk is often the greatest in the first trimester. Animal studies suggest that a number of chemicals can cause birth defects and miscarriage, but definitive studies in humans do not exist. A number of potentially toxic chemicals are present in the flight environment such as fuel, hydraulic fluid aerosolized in bleed air, APU oil, engine oil, acetone, anti-icing/de-icing fluids, Trichloroethylene (TCE), and fire suppression foam are all known hazards to fetal well-being, and contact with these should be avoided.[41] The type and amount of these exposures can vary by aircraft and aircrew position. Some chemicals in the flight environment currently believed to be safe may later be shown to have harmful effects. Some chemical exposures may be present only in the case of mishap or other significant flight event such as the presence of smoke or fumes in the aircraft. You should discuss any aircraft-specific exposures with your flight surgeon.

Other Cautions and Concerns:

Pregnancy-Specific Medical Conditions: Pregnancy-specific conditions that would introduce a flight safety risk could be identified at any point during a pregnancy. As with any other new medical condition when you are not pregnant, these changes should be discussed with your flight surgeon before returning to flight duty. Prompt communication with your flight surgeon is necessary to ensure the most rapid return to flight duties whenever it is safe to do so. Some conditions that may be considered routine to obstetric providers may cause life-threatening situations for aircrew and risk to the pregnancy in flight. For example, increased cabin altitude could exacerbate maternal cardiovascular or respiratory conditions by increasing heart rate and blood pressure. A condition such as placenta previa or incompetent cervix could pose a catastrophic risk to the pregnant individual or fetus if bleeding and/or contractions occurred in flight.[42] In addition, such conditions could result in subtle or profound distraction or incapacitation in the flight environment.

Preexisting Medical Conditions or Medication Use Affected by Pregnancy: There are a variety of medical conditions where the disease, the treatment, or both are affected by pregnancy. Such conditions include high blood pressure, elevated blood sugar, diabetes, thyroid disease, inherited blood clotting disorders, migraines, and others. In many cases, a chronic medication or its dose must be changed. Therefore, if you have a preexisting medical condition and/or stable use of a medication previously waived, these must be re-considered during your pregnancy prior to a return to flying duties.

Behavioral Health: It is estimated that depression affects up to 1 in 7 women during the pregnancy/post-partum period. Comprehensive screening for mood disorders is recommended at least once during pregnancy and post-partum. Changes in sleep, mood, and appetite, that can be attributed to a normal pregnancy could also be a sign of depression or anxiety. Less than 20% of women who were diagnosed with post-partum depression had self-reported symptoms to a health care provider.[43]

Treatment for mood disorders in pregnancy is safe. Selective serotonin reuptake inhibitors are perhaps one of the best studied class of medications in pregnancy. Although randomized trials to assess safety have not been conducted, multiple observational studies support a favorable safety profile with no compelling evidence of increased risk of pregnancy loss or congenital malformations.[44] Depression during pregnancy has been associated with small increases in pregnancy loss and pre-term birth. Timely diagnosis and treatment can have both maternal and fetal benefits.[45]

Other: A retrospective cohort study of female aviation and nonaviation officers in the Military Health System from October 2002 to December 2019 found that pregnant aviation officers had a decreased risk of composite adverse pregnancy outcomes, including gestational diabetes and gestational hypertension. Pregnant aviation officers also had a decreased risk of depression prior to delivery and hyperemesis gravidarum but an increased risk of placental complications and fetal growth restriction.[46]

A retrospective cohort study of female officers' children born in the Military Health System from October 2002 to December 2019 compared fixed wing aviation officers to non-aviation officers. Children of fixed-wing aviation officers had a significantly lower adjusted risk of overall neonatal growth abnormalities compared to children of nonaviation officers but did not have significant differences in low birth weight or small for gestational age diagnoses. There were no statistically significant adverse neonatal outcomes.[47]

Neither study controlled for whether members flew while pregnant; research in this area is ongoing.

[1]The aeromedical risks described in this document are the result of a consensus statement reviewed by a panel of senior physicians. Medical fields represented include aerospace medicine, emergency medicine, obstetrics, pediatrics, occupational medicine and family practice. Each contributing author has more than 10 years of clinical experience in their respective fields. Medical references cited in this document are presented as representative of relevant clinical studies considered but do not represent the totality of known clinical research relevant to this topic.

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