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Review article

Commercial Air And High-Altitude Travel by Pregnant Women: A scientific review commissioned by the European Board and College of Obstetrics and Gynaecology (EBCOG)

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ABSTRACT

Air travel and long distance travel may have adverse effect on the pregnancy-induced physiology and these effects are more marked among those with pre-existing medical conditions. There are significantly increased risks of deep venous thrombosis, inflight transmission of infections, preterm labour, and other significant obstetric and medical complications that may be exacerbated by the flight and may require emergency care. Transient changes in cardiotocographic tracings during third trimester of pregnancy have been reported following air travel. It has been suggested that pregnant members of the flight crew may be at a slightly higher risk of spontaneous miscarriages. There are no contra-indications for healthy pregnant women on air travel. Those with underlying medical conditions should only embark on long distance travel following consultation with their obstetrician. Pregnant women should be advised to familiarise themselves with the healthcare system in the country/region they will be visiting and draw up an emergency plan of how they will contact the healthcare system at their destination.

Introduction

Air travel has become a common means of commute both for business and leisure. In the pre-Covid era, about 6.5 billion people globally travelled by air every year [1]. There are general risks associated with air travel, but the likelihood of an air traffic fatality remains low. Air travel however is associated with a significantly altered environment that may have adverse effects on individuals with health issues. The environmental stresses brought about by air travel can have a potential adverse effect on the pregnancy-induced altered physiology. In addition, the different medical profile of the visited country may present novel medical challenges to the pregnant visitor. Most airlines allow pregnant women to use their services up to at least the 35-36th week of gestation, though some require a letter from the attending healthcare professional to confirm the gestation and to confirm that there are no mitigating factors that place the woman at a higher inflight risk after the 28th week of pregnancy. Some travel health insurers will cover pregnant women only up to the 32nd week of pregnancy. It is always best to advise the woman to check the specific conditions placed by the insurer and the airline companies.

Air travel effects

Effect of cabin pressure

The environment within an aeroplane is tightly controlled, especially in the regulation of the cabin pressure, which is maintained at an acceptable physiological limit. Commercial flights generally cruise at altitudes of 7,010–12,498 m above sea level. At an altitude of 12,192 m or 40,000 feet, the absolute barometric pressure is about 140 mmHg, the absolute atmospheric pressure about 18.7 kPa and the outside temperature about −56 °C. Most regulatory agencies require the cabin pressure environment to not exceed that experienced at 2,438 m or 8,000 feet and passenger cabin pressures are generally maintained at altitude equivalent of 1,524–2,438 m [2]. At 2,438 m, the absolute barometric pressure is about 564 mmHg, the absolute atmospheric pressure is about 75.6 kPa, and the outside temperature at this altitude is about −1.2 °C. At sea-level, the absolute barometric pressure is about 760 mmHg, the absolute

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atmospheric pressure is about 101 kPa, and temperature about 15 °C [3]. The 2438 m limit set by the airline industry is a best practice compromise between an environment of an acceptable 'mild hypoxia' with a comfortable ambient temperature and the inherent engineering requirements of the aircraft.

The effect of oxygen saturation on cardiovascular and respiratory systems

The mild hypoxia experienced at the 2,438 m altitude environment, with a resting oxygen saturation (SpO_2) estimated at about 90–95%, is generally considered safe in healthy individuals but may present significant physiological challenges to individuals with compromised cardiopulmonary systems [4]. While this level of SpO_2 is presumed safe for the medically-compensated pregnant individual, effects of hypoxia can still potentially be experienced especially in the light of the normal physiological cardiopulmonary changes engendered by the pregnancy state – an increased minute ventilation, compensated respiratory alkalosis, a low expiratory reserve volume, an increased cardiac output, an expanded blood volume, and a reduced systemic vascular resistance and blood pressure.

Underlying medical conditions and effect on mother and the fetus

Mild effects of hypoxia are often insidious and not recognised, giving rise to reduced cognitive function and hyperventilation leading to shortness of breath [2]. Pregnant women with pre-existing cardiopulmonary disease, severe anaemia (<8.0 g/dL) and sickle cell disease may experience inflight symptoms. Because of the increased oxygen affinity of HbF and the Bohr effect, the fetus is relatively protected during the inflight period because of its relatively higher oxygen saturation [5]. However, the fetus affected by significant placental insufficiency may have a reduced background oxygen reserve. A study by Petrikovsky et al had indicated that the post-flight third trimester non-stress tests were more likely to show a non-reactive pattern and appearances of variable decelerations [6]. Other symptomatology brought about by the inflight reduced atmospheric pressure is the result of gaseous expansion in closed spaces. This is generally experienced within the ear. The nasal congestions brought about by the general vasodilatation in pregnancy may attenuate the symptomatology. Similarly, the gastrointestinal distension brought about by the reduced atmospheric pressure superimposed on the physiological smooth muscle relaxation can bring about abdominal discomfort and vomiting especially in the first trimester. Pregnant women should therefore be advised to not consume foods that can result in nausea and indigestion and avoid gas-containing drinks before a scheduled flight.

Cosmic radiation risk

Another concern with air travel is related to an increase in the background cosmic radiation experienced during the flight. There is however evidence to suggest that the radiation exposure resulting during a 10-hour flight is about 0.05 milliGray units (mGy) (1 mGy = 0.1 rads = 100 mrem) being approximately half the dose received during a chest x-ray. An abdominal x-ray exposes the fetus to an irradiation dose of 1.5–2.6 mGy; while an abdominal CT scan provides 8–30 mGy. The fetal developmental risks from radiation appear to be unaffected in exposure doses of less than 50 mGy [7–9]. The data therefore suggests that pregnant women can be reassured about the safety to their child from cosmic radiation during flight. However, flight crews can be exposed to an additional 0.2 to 5.0 mGy per year depending on the number, duration, and altitude of flights flown per year [10].

Airport body x-ray scanners and pregnancy

The airport walk-through "full-body" x-ray scanners uses a very low-energy and low-intensity ionizing radiation that does not penetrate the skin [11]. Thus, exposure to the developing fetus is minimal, if at all. The Airport walk-through metal detectors operate by generating a low-intensity magnetic field using non-ionizing waves that is disrupted and triggers an alarm if a metal object interrupts the field. The non-ionizing field generated by these scanners is therefore considered to be safe in pregnancy. Pregnant members of the flight crew should therefore be advised about radiation exposure and risks, and advised to take short, low-altitude flights or shift to ground duties for the duration of the pregnancy.

Venous thrombo-embolism risk and prophylactic measures

Air travel is invariably associated with long periods of relative immobilisation. 75% of air-travel associated cases of venous thromboembolism have been associated with immobilisation especially in non-aisle seated passengers who are less likely to get out of their seat to move about [12]. The inflight environment further increases the risks of thrombosis as a result of the increased predisposition to lower limb venous stasis and oedema, and the haemoconcentration and hyper viscosity brought about by the relative dehydration caused by the fall in environmental humidity to <10%. While a retrospective study on 546 women who had travelled at least once during pregnancy showed no increased thromboembolic events when compared to women who had not travelled [13], it is still prudent to advise pregnant women planning to travel to take thromboembolic prophylactic measures especially for long-haul flights. These measures include asking for an aisle seat to allow easy access to the cabin corridor and walking inflight, maintaining hydration throughout the flight, perform periodic calf-muscle exercises to reduce venous stasis, and wearing compression stockings. Those at high risk can be prescribed prophylactic anticoagulant agents. When seated, the seatbelt should be always worn with the strap placed across the top of the thighs and below the protruding abdomen.

Possible inherent risks to pregnant woman during air travel

The stress associated with travelling does not appear to pose any significant risk to the pregnancy [13–15], although the American College of Obstetrics and Gynaecology (ACOG) considers it prudent to advise women regarding a significant risk of preterm labour, with placental insertion abnormalities, or with other significant obstetric and medical complications that may be exacerbated by the flight or may require emergency care to avoid air travel [8]. It has been suggested that pregnant members of the flight crew may be at a slightly higher risk of spontaneous miscarriages [16,17].

Destination health influencers

Vaccination requirement

The health profile and available healthcare services in the country of destination may be different from the country of origin. The health profile of the destination country may require a schedule of vaccination and/or malarial prophylaxis. In general, inactivated virus or viral product-based vaccines are considered safe to administer to pregnant women; live attenuated vaccines, e.g. yellow fever, oral polio, oral typhoid, and MMR, should be avoided. Inactivated vaccines may result in fever and generally should be avoided since they may result in a febrile reaction that can predispose to a miscarriage. Antimalarial agents are considered safe in pregnancy [18].

Risk of transmission of infection during flight

Another issue than may arise is that of inflight risk of infection transmittance. Most commercial aircrafts recirculate about 50% of the air using high-efficiency particulate air filters. Risk for inflight transmission of infections is therefore mainly restricted to individuals seated

around two rows of the infected passenger. During the Covid-19 pandemic, measures were taken to reduce inflight risks of infection based primarily on screening passengers for active infection (temperature checks, vaccination certificates and negative PCR tests) and promoting social physical distancing at airports, the continuous use of face masks in airports and throughout the flight, and frequent hand sanitization. In the year 2020, the International Air Transport Association (IATA) reported an inflight infectivity rate among travellers to be 1 in 27 million [19,20].

Underlying medical conditions and its effect on treatments

Other destination influencers involve traversing a significant number of time zones since this would affect rescheduling of any regular medical treatment the patient may be on. This is particularly relevant for the type-1 diabetic pregnant woman following a long-haul flight traversing time zones. Timing of her insulin shot will need careful adjustment especially in the light of the increased metabolic demands and the disruption of a regular life pattern associated with travel, superimposed upon the physiological changes in metabolism associated with pregnancy. Described below is a simple rule of thumb for adjusting basal insulin doses when traversing time zones. Regarding fast-acting insulin, this continues to be administered when needed before meals are taken and according to regular blood glucose testing. The timing of other medication, e.g. thyroid hormone supplements, can be similarly altered.

- When travelling East to West:
  - o One day before travelling, inject the basal insulin 2–3 h earlier than usual and after arrival inject first basal insulin dose 2–3 h earlier than normal time (local time). The next day resume injection at normal time (local time).
- When travelling West to East:
  - o One day before travelling, inject the basal insulin 2–3 h later than usual and after arrival inject your first basal insulin dose 2–3 h later than normal time (local time). The next day resume injection at normal time (local time)

Access to healthcare systems in the new country

Healthcare systems in the destination country may be very different than the pregnant woman is familiar in her home country. She should be advised to familiarise herself as much as possible with the healthcare system in the country/region she will be visiting and draw up an emergency plan of how she will contact the healthcare system at her destination. She should also ensure that she has an appropriate travel insurance that specifically covers pregnancy, including the cost of repatriation of herself and her newborn and the possibility of giving birth to a premature neonate. Many insurers will cover pregnant women only until about 32 weeks of gestation [5].

Conclusions

While there appears to be no contraindication to air travel during pregnancy in women with an uncomplicated pregnancy and no medical or obstetric complication, it is advisable that pregnant women planning to travel should seek professional advice and get themselves assessed. They should also be advised to prepare an emergency plan specifically suited to the destination to act upon should complications occur.

Declaration of Competing Interest

None declared by the authors.

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