

## Physiological Concerns of Women Scuba Divers

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Many women now enjoy the sport of scuba diving. The number of women certified from the basic diver through instructor levels is continuously increasing. Yet many women divers experience anxiety over participating in some scuba diving activities due to personal problems. For example, can a female dive in the ocean when she is having her menstrual period? Most scuba classes don't touch on these subjects and most female students are reluctant or embarrassed to ask the instructor. Furthermore, this is not a very popular topic for diving magazines, since the majority of their readers are male. I will cover most of the physiological areas that are of concern to women divers. These areas include diving in thermal comfort, diving during the menstrual period, diving while using birth control pills, and diving during pregnancy.

### Thermal Comfort

The first subject, diving in thermal comfort, covers the sensitivity of females to cold and hot conditions. Women have a layer of subcutaneous fat which acts to retain body heat because of the low thermal conductivity of fat. This has been shown to be an asset to the Ama divers of Korea. However in my experience as an instructor, many female divers suffer from diving in cold water sooner than their male colleagues. A recent study indicates that there is indeed a physiological basis for this phenomenon. In considering an individual's sensitivity to cold, two factors must be considered: (1) the degree of body fatness, and (2) the ratio of surface area to body mass.

Lean women (less than 27% body fat) have a large surface area to body mass ratio and therefore cool at a faster rate. Above a fatness of 30%, men and women maintain similar low levels of heat production when placed in cool water. To solve this problem, anyone who cools easily should invest in an adequate and properly fitting wet or dry suit. If uncontrollable shivering begins, get out of the water.

Sensitivity to heat is important to divers carrying heavy gear and suiting up during the hot summer months. The female's body temperature will rise 2° to 3° higher than the male's before the cooling process of sweating begins. Also, the female has fewer functional sweat glands. The solution to this problem during prolonged periods of very strenuous activity is to periodically cool off. A dunk in the water before donning one's tank and weight belt usually is easy to do.

### Menstrual Period

Another area of concern to women is diving during the menstrual period. Whether a woman should dive during this time depends on just how well she feels. If the diver feels fine, go ahead and dive. In the Olympics of 1972 and 1976, female medal winners were at all stages of the menstrual cycle. The menstrual period did not prevent top performances by the athletes. If however, severe cramps or discomfort are experienced, the woman should postpone her diving. One complication of the menstrual period is fluid retention. Oedema may make a woman more sensitive to decompression sickness. Females should follow conservatively the No Decompression Table of the Navy Diver Tables, if diving three days prior or during her period.

Women who dive in salt water during their period frequently ask, "What about the sharks?" The average blood loss during a period is 25 to 70 cc, over three to four days. Internally worn protection, eg. a tampon, is preferable to an externally worn napkin. There is no evidence of increased shark interest in a menstruating female,

so the woman diver should concentrate on the other factors of her dive and enjoy herself.

### Birth Control Pills

The third area of discussion is that of diving while using birth control pills. First, I would like to cover the possible susceptibility to decompression sickness of women in general. Decompression sickness has been studied in nurses undergoing flight training at the United States Air Force School of Aerospace Medicine. Much of the work was done by Dr Bruce Bassett, Major, USAF, from 1968-1972. During these five years at the USAF SAM, there were nine cases of decompression sickness out of 12,246 exposures. The females had a ten-fold greater incidence than the males undergoing the same exposures. More recent studies have verified the increased incidence of decompression sickness in women over men undergoing flight training. As a result of these studies, flight nurses are now exposed to different altitude chamber flight profiles. Some observations were made at this time of the characteristics of decompression sickness in nurses. The onset of the bends was four to eight hours after reaching ground level. Also, many of the reactions were similar to migraine headaches with neurological findings, and a prodrome of acute anxiety occurred. Factors that are postulated to increase one's risk of decompression sickness are the following: history of migraine headache, use of birth control pills, fluid retention during the menstrual period, severe dieting resulting in some vitamin deficiencies, and anaemia.

The female scuba diver should therefore be aware of the possibility of increased risk to decompression sickness if using birth control pills. To avoid incidence of the bends, I recommend avoiding decompression dives, avoiding "deep" dives, and using the No Decompression Table conservatively (ie. stay at a particular depth less than the time indicated). The women scientists in the Tektite II project discontinued use of birth control pills three months prior to their saturation dive to avoid any increased chance of decompression sickness.

### Risk to Foetus

A final concern of women divers is the possibility of risk to the foetus due to scuba diving during pregnancy. Is there any chance of harming the foetus due to changes in the partial pressure of oxygen (pO<sub>2</sub>) or due to nitrogen bubble formation? Research has been done on mammals on the transfer of gases across the placenta. Oxygen transfer to the foetus across the placenta must be rapid and continuous to assure successful growth. There are special mechanisms that assist the foetus in transplacental oxygen exchange:

- (1) higher haemoglobin concentration in the foetal blood, increasing its oxygen carrying capacity, and
- (2) higher affinity for oxygen of the foetal haemoglobin.

Only severe hypoxia in the mother will cause changes in the foetal oxygen content. The placenta prevents transient fluctuations in foetal blood pO<sub>2</sub>.

Scuba divers, however, must be concerned with increasing pO<sub>2</sub> and the possibility of subsequent increased pO<sub>2</sub> in foetal blood. In experiments on gravid ewes, the maternal arterial oxygen tension was increased by providing 100% oxygen at one atmosphere. (This pO<sub>2</sub> is equivalent to breathing air at a depth of 132 feet of sea water). There was only a very small increase in foetal blood pO<sub>2</sub>. In sheep, cow, pig, and primate, only small changes occurred in foetal blood pO<sub>2</sub> when maternal oxygen intake was increased. In contrast, an experiment on rats did demonstrate foetal wastage with hyperbaric oxygen.

In most of the animal studies foetal oxygen content remained relatively stable during significant maternal pO<sub>2</sub> increase. Also there appears to be differences in placental gas transfer between different groups of mammals.

Another consideration of the pregnant scuba diver is that of nitrogen absorption and elimination. The gas nitrogen does not play a significant role in sustaining the life of the foetus. Therefore, exchange of nitrogen through the placenta during a dive probably depends on the tissue half time of the foetus, just like other tissues of the body. After a deep dive or prolonged dive to moderate depths, rapid reduction of ambient pressure can cause nitrogen bubble formation. The presence of these nitrogen bubbles in the foetus can cause serious destruction.

The pregnant diver therefore has to consider two areas that are possibly hazardous to the developing foetus, increased pO<sub>2</sub> and nitrogen bubble formation. The research on mammals and pO<sub>2</sub> elevation in the foetus is reassuring. However, humans have not been studied and the effects of minor increases in foetal pO<sub>2</sub> are not known. The pregnant diver can continue to enjoy the underwater environment but should extend her prenatal care to include limiting the depth of her dives. I recommend depths of 33 feet or less, to avoid even the possibility of problems due to increased pO<sub>2</sub> or to nitrogen bubbles.

#### Summary

The information presented here may help answer some questions women may have had about their own physiology and its relation to safe and enjoyable scuba diving. In essence, common sense prevails if a question arises about the safety of the scuba diver.

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#### PREGNANT DIVER UPDATE

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The safety of diving while pregnant is a topic that has only recently been investigated. Although there has been much speculation on the subject, very little data is available. Animal studies are being conducted and the information they provide will hopefully be applicable to humans.

In order to gather data on this subject and other related medical areas on the woman diver, I began distributing a survey in the fall of 1977. This was entitled the Medical Aspects of Women Divers Survey. About 680 responses were analysed and of these, 72 respondees dived while pregnant (10.5%). This number included women who made even one dive while pregnant. If the woman quit as soon as she discovered she was pregnant, but had made a dive in the first six weeks, she was included in these results. Twenty-two women stated they did not dive while pregnant; apparently they made no dives prior to being diagnosed as pregnant and then decided not to dive.

Now let us look at the pregnant diver. Thirty-nine percent quit diving during the first trimester (the first three months), usually as soon as she learned she was pregnant. Most of the women (41%) discontinued diving during the second trimester, about the time when increased size becomes a problem. Twenty percent dived during the third trimester. Only seven women continued to dive through the ninth month. Most of the respondees were seasoned divers, with six years as the median (most frequent) number of years diving. Forty-one percent were certified as Basic Scuba divers, 14.5% were Instructors, and the remaining had intermediate levels of