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DAN Explores Fitness and Diving Issues for Women

By **Donna M. Uguccioni, M.S., DAN Associate Medical Director Dr. Richard Moon, and Dr. Maida Beth Taylor**

When I first began working with Divers Alert Network some 13 years ago, there was one group of questions that presented a special challenge to me: they were about women and some of their unique characteristics as divers.

At the time, it seemed that the answers provided by the diving medical community were not based predominantly on information or evidence that supported these responses, but rather on long-held biases with little substance. Women, for example, were considered to be more susceptible to decompression illness because they had more body fat than men. Adipose tissue takes longer to offgas after a dive, so the more fat, the greater the chance of decompression illness, right?

Not necessarily. Many other individual and environmental factors must be taken into account.

Women, in fact, generally do have more body fat than men; but somewhere along the line, the connection was made that this was the cause of decompression illness in women. If that extra bit of body fat caused DCI in women, then it follows that men who have extra adipose tissue should run the same risk. This simply isn't the case.

When we break down dive injuries by the sex and experience of the diver, we find a much stronger relationship between females and their dive experience: women who have been diving for less than two years generally account for 39 percent to 50 percent of all injuries in female divers.

Many other questions remain about women's issues in diving: for example, what about pregnancy, breast feeding, breast implants? Of the many questions commonly asked by or about women and diving, we have selected 11 of the most frequently asked. The following article is a collaboration of three main authors: Donna Uguccioni, M.S., DAN's diving physiologist and researcher on women-and-diving issues, DAN Associate Medical Director Dr. Richard Moon, and Dr. Maida Beth Taylor, who is an expert on the topic of women and diving and an author on these issues. These experts have produced the most current, realistic and logical answers for DAN's most commonly asked questions on women and diving. Dr. Taylor has added additional text and references for some questions that cannot be easily answered. We think the answers here can help dispel many unsubstantiated opinions in the diving community.

Although we don't have all the answers for women-and-diving issues, DAN continues to research these topics and promote safer, healthier diving.

Joel Dovenbarger, BSN,
Vice President, DAN Medical Services

Breast Cancer, Cancer and Surgery

The Condition: Tumors in the breasts are not uncommon, especially after age 30. Tumors may be cancerous (malignant) or non-cancerous (benign). Approximately one in nine women will develop breast cancer. Early detection can be made with regular, manual self-examinations of the breasts, but not all tumors can be detected in this manner. Mammography (X-ray of the breast) can detect tumors that manual examination cannot. The American Cancer Society recommends the following:

1. Women 20 years of age and older should perform breast self-examination every month.
2. Women ages 20-39 should have a physical examination of the breast every three years, performed

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by a healthcare professional such as a physician, physician assistant, nurse or nurse practitioner.

3. Women 40 and older should have a physical examination of the breast every year, performed by a healthcare professional such as a physician, physician assistant, nurse or nurse practitioner.
4. Women 40 and older should have a mammogram every year.

Tumors are often removed surgically and treatment of malignant tumors may involve surgery, radiotherapy, chemotherapy - or a combination of two or three of these procedures.

Both chemotherapy and radiotherapy can have toxic effects on the lung, surrounding tissue and body cells that have a rapid growth cycle such as blood cells.

Fitness and Diving Issues: Cytotoxic drugs (chemotherapy) and radiation therapy can have unpleasant side effects such as nausea and vomiting, and a prolonged course of therapy can result in greatly decreased energy levels. This makes diving while experiencing such side effects inadvisable. Radiation and some chemotherapeutic drugs can cause pulmonary toxicity.

An evaluation to establish the safety of a return to diving should include an assessment of the lung to ensure that damage likely to predispose the diver to pulmonary barotrauma (arterial gas embolism, pneumothorax or pneumomediastinum) is not present.

Finally, before diving, healing must have occurred, and the surgeon must be satisfied that immersion in salt water will not contribute to wound infection. Strength, general fitness and well-being should be back to normal. The risk of infection, which may have increased temporarily during chemotherapy or radiotherapy, should have returned to normal levels.

Ovarian Tumor

The Condition: Ovarian tumors may be malignant (cancerous) or benign (non-cancerous). Tumors may be solid or a hollow sac (cysts). Cysts are sometimes filled with fluid and usually are the non-cancerous form of an ovarian tumor. Ovarian tumors are not all that uncommon and, if identified early, they can be removed surgically or with radiation treatments.

Fitness and Diving Issues: With respect to diving, the major issues are the effects on the body from the surgery and/or radiation/chemotherapy treatments (See the section above on "Breast Cancer and Cancer in Women").

Pregnancy

Description of Condition: Having a developing embryo or fetus in the body. Duration of pregnancy from conception to delivery is approximately 266 days/9 months.

Fitness and Diving Issue: There is little scientific data available regarding diving while pregnant. Much of the available evidence is anecdotal. Laboratory studies are confined to animal research and the results are conflicting. Some retrospective survey type questionnaires have been performed but are limited by data interpretation.

An issue to keep in mind is the risk of decompression illness to the mother due to the physiological changes which occur while pregnant. During pregnancy, maternal body fluid distribution is altered, and this redistribution decreases the exchange of dissolved gases in the central circulation. Theoretically, this fluid may be a site of nitrogen retention. Fluid retention during pregnancy may also cause nasopharyngeal swelling, which can lead to nose and ear stuffiness. In regards to diving, these may increase a pregnant woman's risk of ear or sinus squeezes. Pregnant women experiencing morning sickness, which could then couple with motion sickness from a rocking boat, may have to deal with nausea and vomiting during a dive. This is an unpleasant experience and could lead to more serious problems if the diver panics.

Due to the limited data available and the uncertainty of the effects of diving on a fetus, diving represents an increased exposure for the risk of injury during pregnancy. There's a baseline incidence of injury including cases of decompression illness in diving. One must consider the effects on the fetus if the mother must undergo recompression treatment.

Additional Considerations: This is a summary of the available studies of diving during pregnancy:

Diving and Pregnancy Outcome

1. Bangasser Survey 1978 - no increase defects
2. Bolton Survey 1980 - 109 women who dived prior to pregnancy, 69 stopped when pregnant higher

rate of defects in groups who continued including two major cardiac anomalies multiple hemivertebrae, absent hand, VSD, coarctation, pyloric stenosis, birthmark - no major defects in group that stopped (but no higher than the general population and may be influenced by recall bias)

3. Turner Case Report 1982

- twenty dives in 15 days, days post LMP 40-50
- most less than 60 ft., three dives 100 ft., one 110 - one rather rapid ascent from 60 ft., three dives 100 ft., one 110 - one rather rapid ascent from 60 ft.
- Sudafed also taken
- multiple anomalies
- head circumference normal, development normal, karyotype, EMG, muscle biopsy normal
- mechanism of DCS injury - fetal embolism or bubbling.

Please remember that one anecdotal report does not create a syndrome or disease

4. Fife Survey 1991 -- 1,037 female divers -- only 1.4 percent dived while pregnant

Animal studies of DCS during pregnancy also have noted increases in cardiac malformations. If a woman dives inadvertently before pregnancy is diagnosed during the first trimester of pregnancy, acknowledging that a very limited amount of literature and experience exists, I suggest getting a second trimester ultrasound (sonogram) with emphasis on limb and spinal development and with good detailing of the cardiac structures and the configuration of the great vessels around the heart -- aorta, pulmonary arteries, etc.

Return to Diving After Giving Birth

The Condition: Diving, like any other sport, requires a certain degree of conditioning and fitness. Divers who want to return to diving postpartum (after having a child) should follow the guidelines suggested for other sports and activities.

Fitness and Diving Issues: After a vaginal delivery, women can usually resume light to moderate activity within one to three weeks. This depends of several factors: prior level of conditioning; exercise and conditioning during pregnancy; pregnancy-related complications; postpartum fatigue; and anemia, if any. Women who have exercise regimens prior to pregnancy and birth generally resume exercise programs and sports participation in earnest at three to four weeks after giving birth.

Obstetricians generally recommend avoiding sexual intercourse and immersion for 21 days postpartum. This allows the cervix to close, decreasing the risk of introducing infection into the genital tract. A good rule of thumb is to wait four weeks after delivery before returning to diving.

After a cesarean delivery (often called a C-section, made via a surgical incision through the walls of the abdomen and uterus), wound-healing has to be included in the equation. Most obstetricians advise waiting at least four to six weeks after this kind of delivery before resuming full activity. Given the need to regain some measure of lost conditioning, coupled with wound healing, and the significant weight-bearing load of carrying dive gear, it's advisable to wait at least eight weeks after a C-section before returning to diving.

Any moderate or severe medical complication of pregnancy - such as twins, pre-term labor, hypertension or diabetes - may further delay return to diving. Prolonged bed rest in these cases may have led to profound deconditioning and loss of aerobic capacity and muscle mass. For women who have had deliveries with medical complications, a medical screening and clearance are advisable before they return to diving.

Additional Information: Caring for a newborn may interfere with a woman's attempts to recover her strength and stamina. Newborn care, characterized by poor sleep and fatigue, is a rigorous and demanding time in life.

Breast-Feeding

The Condition: A mother may choose to breast-feed her infant while maintaining an otherwise active life. This may continue for weeks or months, depending on the mother's preference.

Fitness and Diving Issues: Is it safe to scuba dive while breast-feeding?

From the standpoint of the child, the mother's breast milk is not unduly affected. The nitrogen absorbed into the body tissues is a component of breathing compressed air or other gas mixes containing nitrogen. This form of nitrogen is an inert gas and plays no role in body metabolism. Although nitrogen accumulates in all of the tissues and fluids of the body, washout after a dive occurs quickly. Insignificant amounts of this nitrogen would be present in the mother's breast milk; there is, however, no risk of the infant accumulating this nitrogen.

From the mother's standpoint, there is no reason for a woman who is breast-feeding her child to avoid diving,

provided there is no infection or inflammation of the breast.

Endometriosis

The Condition: With endometriosis, the tissue containing typical endometrial cells occurs abnormally in various locations outside the uterus. During menstruation this abnormally occurring endometrial tissue, like the lining of the uterus, undergoes cyclic bleeding. The blood in this endometrial tissue has no means of draining to the outside of the body. As a result, blood collects in the surrounding tissue, causing pain and discomfort.

Fitness and Diving Issues: Because endometriosis can cause increased bleeding, cramping, amount and duration of menstrual flow, diving may not be in a woman's best interest when she experiences severe symptoms. Nevertheless, there is no evidence that a woman with endometriosis diving at other times is at any greater risk of diving-related disease than a person without this condition.

Hysterectomy

The Condition: This is a surgical procedure in which the entire uterus is removed through the abdominal wall or through the vagina.

All that has been said about diving after a cesarean section (see "Return to Diving After Giving Birth," above) applies to diving after general surgery, including a hysterectomy.

Women may resume diving after a hysterectomy, but they should wait until they have recovered general strength and fitness before they take the plunge - usually six to eight weeks, and sometimes longer.

Fitness and Diving Issues: As far as it relates to scuba diving, a hysterectomy is considered major surgery. It is recommended that anyone undergoing an abdominal surgery allow six to eight weeks of recovery before resuming diving. If the procedure is complicated in any way, by infection, anemia or other serious issues, it may be wise to further delay diving.

These recommendations apply to all types of hysterectomy:

1. Removing the uterus abdominally (total abdominal hysterectomy);
2. Removing the uterus vaginally (vaginal hysterectomy);
3. Removing the uterus plus the tubes and ovaries (hysterectomy plus salpingo-oophorectomy);
4. Removing the top of the uterus, but leaving the cervix intact (subtotal hysterectomy).

Breast Implants

The Condition: Silicone and saline implants are used for cosmetic enhancement or augmentation of the normal breast size and shape of reconstruction, particularly after radical breast surgery for cancer or trauma.

In one study, by Dr. Richard Vann, Vice President of Research at DAN, mammary (breast) implants were placed in the Duke University Medical Center hyperbaric chamber. The study did not simulate the implant in human tissue. Three types were tested: silicone-, saline-, and silicone-saline-filled. In this experiment, the researchers simulated various depth / time profiles of recreational scuba diving. Here's what they found: There was an insignificant increase in bubble size (1 to 4 percent) in both saline and silicone gel implants, depending on the depth and duration of the dive. The least volume change occurred in the saline-filled implant, because nitrogen is less soluble in saline than silicone.

The silicone-saline-filled type showed the greatest volume change. Bubble formation in implants led to a small volume increase, which is not likely to damage the implants or surrounding tissue. If gas bubbles do form in the implant, they resolve over time.

Fitness and Diving Issues: Once sufficient time has passed after surgery, when the diver has resumed normal activities and there is no danger of infection, she may begin scuba diving.

Breast implants do not pose a problem to diving from the standpoint of gas absorption or changes in size and are not a contraindication for participation in recreational scuba diving.

Avoid buoyancy compensators with constrictive chest straps, which can put undue pressure on the seams and contribute to risk of rupture.

Additional Considerations: Breast implants filled with saline are neutrally buoyant. Silicone implants are heavier than water, however, and they may alter buoyancy and attitude (trim) in the water, particularly if the implants are large. Appropriate training and appropriate adjustment of weights help overcome these difficulties.

Menstruation During Diving Activities

The Condition: Menstruation is the cyclic, physiologic discharge through the vagina of blood and mucosal tissues from the non-pregnant uterus. The cycle is controlled hormonally and usually occurs at approximately four-week intervals. Symptoms may include pain, fluid retention, abdominal cramping and backache.

Fitness and Diving Issues: Are women at greater risk of experiencing decompression illness (DCI) while menstruating? Theoretically, it is possible that, because of fluid retention and tissue swelling, women are less able to get rid of dissolved nitrogen. This is, however, not definitively proven.

One recent retrospective review of women divers (956 divers) with DCI found 38 percent were menstruating at the time of their injury. Additionally, 85 percent of those taking oral contraceptives were menstruating at the time of the accident. This suggests, but does not prove, that women taking oral contraceptives are at increased risk of decompression illness during menstruation. Therefore, it may be advisable for menstruating women to dive more conservatively, particularly if they are taking oral contraceptives. This could involve making fewer dives, shorter and shallower dives and making longer safety stops. Four other studies have provided evidence that women are at higher risk of DCI, and in one study of altitude bends, menses also appeared to be a risk factor for bends.

Are women at an increased risk of shark attacks during menstruation? There are few reported shark attacks on women, and there are no data to support the belief that menstruating females are at an increased risk for shark attacks. The average blood lost during menstruation is small and occurs over several days. Also, it is known that many shark species are not attracted to the blood and other debris found in menstrual flow.

In general, diving while menstruating does not seem to be a problem as long as normal, vigorous exercise does not increase the menstrual symptoms. As long as the menstrual cycle poses no other symptoms or discomforts that affect her health, there is no reason that a menstruating female should not dive. However, based upon available data, it may be prudent for women taking oral contraceptives, particularly if they are menstruating, to reduce their dive exposure (depth, bottom time or number of dives per day).

Premenstrual Syndrome

The Condition: Premenstrual Syndrome, or PMS, is a group of poorly understood and poorly defined psychophysiological symptoms experienced by many women (25-50 percent of women) at the end of the menstrual cycle, just prior to the menstrual flow.

PMS symptoms include mood swings, irritability, decreased mental alertness, tension, fatigue, depression, headaches, bloating, swelling, breast tenderness, joint pain and food cravings. Severe premenstrual syndrome has been found to exacerbate underlying emotional disorders. Although progesterone is used in some cases, no consistent, simple treatments are available.

Fitness and Diving Issues: Research has shown that accidents in general are more common among women during PMS. If women suffer from premenstrual syndrome, it may be wise to dive conservatively during this time. There is no scientific evidence, however, that they are more susceptible to decompression illness or dive injuries / accidents.

Also, individuals with evidence of depression or antisocial tendencies should be evaluated for their fitness to participate in diving: they may pose a risk to themselves or a dive buddy.

Ovarian Cancer

Description of Condition: Ovarian tumors may be malignant (cancerous) or benign (non-cancerous). Tumors may be solid or a hollow sac (cysts). Cysts are sometimes filled with fluid and usually are the non-cancerous form of an ovarian tumor. Ovarian tumors are not all that uncommon. There is no reliable testing or screening for ovarian cancer. Diagnostic tests CA 125 and ultrasound are often recommended but have a very high false positive false negative, but tests may register as abnormal in many other diseases besides ovarian cancer. Pap smears occasionally can have pieces of calcium on them called psammoma bodies, which can be indicative of ovarian tumors.

Fitness and Diving Issue: In respect to diving, the major concern would be the effects on the body from the surgery and/or radiation/chemotherapy treatments. First, if surgery was done, complete healing to have taken place in the site of the incision. Strength and general feeling of well being back.

Cytotoxic drugs (chemotherapy), have unpleasant side effects such as nausea and vomiting, and a prolonged course of therapy usually results in greatly decreased levels of energy due to their cytotoxic effects. This makes diving while experiencing such side effects unadvisable. Some of these drugs can cause pulmonary toxicity and patients can have residual pulmonary functional impairment for a year or longer after

they have finished treatment. Pulmonary function studies may be necessary to verify adequate ventilation and clear pulmonary airway passages.

Oral Birth Control

Description of Condition: An effective and widely used method of preventing pregnancy. There are several types of pills available and most contain a combination of synthetic estrogen-like and progesterone-like substances. These substances prevent the rise in luteinizing hormone, which leads to ovulation. Also, oral contraceptives thicken and chemically alter the cervical mucus, making the uterine endometrium less receptive to sperm.

Possible side effects of oral contraceptives during the initial therapy include nausea, vomiting, fluid retention, headaches and dizziness. Oral contraceptives may also be associated with an increase in blood pressure and an increased risk of thromboembolic disorders (development of clot-like vein occlusions, which can lead to an emboli).

Fitness and Diving Issue: It has been suggested that oral contraceptives may increase a diver's susceptibility to DCS because of the hormonal changes, which may reduce venous tone and increase water retention. This could affect circulation and theoretically cause the blood to "sludge," which may interfere with the elimination of nitrogen from the body. To date, no research has found evidence to support this belief.

In fact, unless oral contraceptives pose a clinical problem for women, there is no data to show that their use during recreational scuba diving is a contraindication.

Additional Considerations: But what about contraception -- are there any specific hazards attached to contraceptive methodologies which women and their consorts should consider. Current thinking is that oral contraceptives do not impose any increased risks on women divers. Most oral contraceptives used in the USA carry a three- to four-fold increase risk of spontaneous non-fatal thrombotic events, while pills containing desogestrel (and gestodene, a progestin commonly used in pills in the UK and other European countries but not in the US) may carry a 6-8 fold increase in risk compared to no pill use. When considering this increased risk of thrombosis, hyperbaric researchers have been speculated that oral contraceptive use might increase the likelihood of developing DCS or exacerbate the extent or severity of tissue injury by promoting more rapid and profound activation of the clotting cascade after a gas accident.

No animal studies have been done which support this hypothesis. On the contrary, one experiment of DCS was done with pigs wherein half of the pigs were premedicated with oral contraceptives and then subjected to chamber profiles inducing DCS injuries. The study found that extent of injuries was identical in the treated and control pigs. No human epidemiologic surveys of sufficient sample size to offer any information that is clinically useful have ever been done.

Recently the gynecologic literature has suggested that 50 percent of thromboembolic on oral contraceptives may be due to interactions of the medication with inherited clotting disorders, the most common abnormality being a protein substitution in the chain of molecules forming clotting factor V. This substitution renders factor V resistant to cleavage by activated protein C which would inactivate its pro thrombotic action. The resultant disorder is called activated protein C resistance.

Underlying coagulation defects have been implicated as increasing the risk of DCS. As a matter of fact, heritable clotting disorders have been implicated in idiopathic aseptic necrosis of the femoral head and a host of other vascular complications. Those populations with a high incidence of factor V Leiden mutation, the most common genotype responsible for this coagulation defect, should be alert to and aware of clotting disorders. Think of them when you encounter the unexpected, undeserved "hit" that just seems too severe for the dive profiles when reviewing the diver's log and history. And, of course, ask about oral contraceptive use.

Contraceptives Fact Sheet

Progesterone only pills, and long acting contraceptives (Norplant and Depo Provera)

The progestins, similar to those used in injectable contraceptives, all progesterone mini pills, and implants, have effects on inflammatory cells. High doses of progesterone have been found to help to stabilize cell membranes, and thereby limit inflammatory response to injury. Women with sickle cell anemia on high doses of progesterone have fewer and less severe sickle cell episodes. If progestins act to limit inflammation, it might be postulated that they could help limit the damage caused by the inflammatory processes that follow tissue hypoxia in gas accidents. If true, we also might speculate that long acting or high dose progestins might be the contraceptive of choice for women divers.

Barriers and Spermicides

Occasional questions arise about the possibility that the efficacy of barrier methods could be reduced by immersion and dilution of the spermicidal agents if water washes in and out of the vagina. The amount of flushing action in a wet suit is probably minimal; and obviously, is not a consideration for dry suits.

IUDs

Intrauterine contraceptive devices pose no hazard for the female diver. Menstrual flow is increased in amount and duration of flow. This can be a great inconvenience if a woman is diving in a remote locale or on a boat with no sanitary facilities or privacy.

Osteoporosis

Description of Condition:

To date, we have not had significant pool of women who:

1. are post menopausal and at risk of osteoporosis (menopause average at 50, osteopenia at 60-65, and fractures starting at 70-75)
2. have a significant diving experience including appropriate number of dives at profound depth which put them at risk for osteonecrosis
3. therefore, we have no data on coincident osteoporosis and osteonecrosis in women at risk (or men for that matter).

Fitness and Diving Issue: The pathophysiologic mechanisms leading to osteoporosis and osteonecrosis are different. Osteoporosis results from decreases in osteoblast activity and relative increase of osteoclast activity, resulting in bone resorption and demineralization. The infarction of the microcirculation of bone is the triggering mechanism for osteonecrosis.

Women are at increased risk for osteoporosis given that their overall lifetime peak bone mass is lower than men and that the loss of estrogen during menopause, greatly accelerates the rate of bone demineralization.

All we can say at this point is that women should dive as conservatively as possible, thereby trying to minimize their risks of osteonecrosis, so as not to impose this bone damaging disease on top of their already increased risk of fracture due to Type I estrogen dependent osteoporosis.

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