Menstruation, Pregnancy, DCI and Diving: 17 Years Focus on Female Divers

Marguerite St Leger Dowse

Studies at DDRC

Men & Women in Diving


Scuba Diving & the Menstrual Cycle


Women & Decompression Illness


Pregnancy and Diving


Men & Women in Diving

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- Retrospective dive data
- Comparative - males with females
- Based on a study by Dr William Fife
Men & Women in Diving

- general health
- smoking, alcohol, prohibited drugs
- diving habits and histories
- decompression illness
- female issues ... menstrual histories
- contraception
- dived pregnancies

Men & Women in Diving

- 2,250 males & females
- 53% males ... 47% females
- 159 diagnosed & self diagnosed DCI
- 458,827 dives
- Males 56 dives per year
- Females 37 dives per year

Men & Women in Diving

- 20% of respondents estimated 28% of the total dives in the study
- 77% of the estimated dives were from males

Men & Women in Diving

- number of dives
  - females did less
- dives with deco. stops
  - females did less
- divers with >1 dive per day
  - no difference
- no. of days >1 dive per day
  - no difference
- maximum depths
  - no difference
- extra safety stops
  - females did less

Men & Women in Diving

- Recreational Drugs
- Derivatives of the Cannabis sativa plant
- Cocaine
- LSD
- Amphetamines
Men & Women in Diving

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"Not immediately before a dive. My buddy did and got a bend!"

Men & Women in Diving

diagnosed DCI  self diagnosed DCI

<table>
<thead>
<tr>
<th></th>
<th>males</th>
<th>females</th>
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<tbody>
<tr>
<td>males</td>
<td>50%</td>
<td>50%</td>
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<tr>
<td>females</td>
<td>64%</td>
<td>36%</td>
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<tr>
<td>Total</td>
<td>55%</td>
<td>45%</td>
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Men & Women in Diving

rate per 1000 dives

- from all dives, estimated & logged
  - males 0.16
  - females 0.26
- from logged dives only
  - males 0.12
  - females 0.29

Men & Women in Diving

Years of Experience

- males had a higher rate than females
- susceptibility vs rates?
- overall rate per 1000 dives 0.19
The menstrual cycle and diving: reported problems during diving (RPDD)

- Longitudinal, prospective field study of diary data over an extended period of time, involving recreational female scuba divers

- Information gathered included:
  - General health, social status, gynecological health, oral contraceptive pill (OCP) use
  - All basic dive profiles, type and length of menstrual bleed
  - Reported problems during diving (RPDD) were recorded via fixed option and free text responses

- Respondents were asked to complete menstrual records irrespective of whether or not they were diving during that particular month/cycle, and complete diving details irrespective of whether or not they were menstruating

- Women were asked to detail any irregular aspect of a particular dive choosing from the series of fixed options which were not menstrual related:
  - alcohol, illness, drugs, pushing tables/computer, visibility, buoyancy, cold, equipment, out of air, symptoms, and “none of these”

- There was also the opportunity to detail in their own words contributing reasons and factors for the RPDD

- The length of every recorded cycle was known
  - not all cycles are of equal length
  - reported cycle lengths varied from <21 to >40 days

- Menstrual cycles were standardised into 28 days
  - The observed number of days from last menstrual period (LMP) to RPDD was transformed into a proportion of a 'standardised cycle length' of 28 days

- Respondents also recorded trouble-free dives
  - The standardising transformation was also used to give the phase in the cycle of all trouble-free dives
570 women (533 menstruating) kept diving and menstrual diaries for periods of between 6 months and up to 3 years—regular updates on background data—basic details on all dives carried out—details of every menstrual cycle—61% women kept diving and menstrual diaries for the full three years!

The menstrual cycle and diving: reported problems during diving (RPDD)

Results at the start of the study—
- the age range was 14 to 57—
- the diving experience in years ranged from 1 to 34 years—
- dives logged ranged from 1 to 3,000—
- collective experience of >117,000 dives—
- 49% had dived to 40 meters or more—
- 49% had already logged >100 dives

During the time of the study:
- >30,000 dive days were recorded—
- >50,000 dives were logged—
- 44% of diarists dived to 40 meters or more during the study—
- 174 metres was the deepest dive recorded!—
- 30% of diarists used the OCP—
- 95% continued to dive when menstruating
  - 8% of that group with more conservative profiles—
  - >14,000 menstrual cycles were recorded—
  - >7,000 with diving taking place—
- 65% of all women reported RPDD at some time whilst keeping diaries

The distribution of dives across the standardised menstrual cycle was uniform over the cycle for both OCP and non-OCP groups—RPDD were not evenly distributed over the standardised menstrual cycle

There was a significant, but non-linear, relationship between the standardised phase of the menstrual cycle and RPDD (p = 0.004). The relationship with OCP usage and non-OCP usage was not significant (p-value = 0.298)

62% of women who recorded data for 3 consecutive years accounted for 83% of the dives recorded—averaged 40 dives each per year—

8% of that group with more conservative profiles—
>14,000 menstrual cycles were recorded—
>7,000 with diving taking place
The menstrual cycle and diving: reported problems during diving (RPDD)

- Studies gathering data over the menstrual cycle have recruited women with regularly established 27 to 29 day cycles
  - or have assumed the participants to have a cycle covering days 0 to 29
- The length of every menstrual cycle by every woman in this study was known
  - this allowed an analysis of the rate of RPDDs in relation to the ‘phase’ in the cycle taking into account OCP and non-OCP usage for all the observed dives

By using the data for all menstrual cycle lengths we did not discard or ignore any of the information gathered
  - however, the rather simple transformation to phase based on the proportion of the observed cycle length may not produce the optimal measure of ‘point in the cycle’
- Despite this when the data from 28 day menstrual cycles are examined, the rates of RPDDs appear to follow similar trends to the full data set
  - for the non-OCP group similar peaks are seen at the start and end of the cycle

Are the incidents due to diving or menstruation?
- Studies in non diving women, observing human performance over the menstrual cycle, have been ambiguous in their findings

The observed overall RPDD rate is 28.3 per 1000 dives
  - RPDD were not evenly distributed over the menstrual cycle
  - the rate is greater at the start of the cycle
  - falling during week three
  - rising again in week four.
- When analysing all the data, there was a significant relationship found between the standardised phase in the menstrual cycle and the rate of RPDD
- Although in this data set there is an overall difference in RPDD rates between women on the OCP and the women not on the OCP, this difference was not found to be statistically significant

Decompression Illness (DCI)

A collaborative study QinetiQ & DDRC
The menstrual cycle and diving: DCI

• The aim -
  – To investigate the presence of any relationship between the development of DCI, the phase in the menstrual cycle?

Records were evaluated from 23 treatment chambers worldwide
Women had been physician diagnosed and treated in a chamber for DCI (QinetiQ and DDRC 1997 – 2005)
The study was questionnaire based
Only records fulfilling the inclusion criteria were used where the number of days between the first day of the last menstrual cycle and the problem dive was known

Information gathered:
  oral contraceptive pill use, usual length of menstrual cycle, age, depth of dive prior to onset of symptoms, type of symptoms, and smoking habits
All menstrual cycles were normalised to 28 days (0-27), with day 0 being the first day of bleed
The days from the first day of the last menstrual period (LMP) to the day of the incident were calculated
The Chi-square goodness-of-fit test was used to assess whether the distribution of DCI incidents was uniform across the normalised four weeks (28 days) of the menstrual cycle

The incidence of DCI was not evenly distributed over the 4 weeks of the menstrual cycle
For the non-OCP group there was strong evidence (Chi-square) that the distribution was not uniform (p<.01)
For the OCP group there was no evidence against a uniform distribution using the Chi-square test

QinetiQ Project Data from 250 Records
Percentage of women, non-OCP & OCP users, with treated DCI for each week of the menstrual cycle

Possible mechanism?
- Progesterone
- Estradiol
- FSH
- LH
The menstrual cycle and diving: DCI

Possible mechanism?

The literature & conclusions


Suggested the risk of DCS may be dependent on the phase of the menstrual cycle with greatest risk of DCS, in the non-OCP group, being in the first week of a 28 day cycle. 150 prospective records studied.

Data from the non-ocp women agreed with Dunford, Krause, Lee, & Rudge, showing a reduction in susceptibility from week one through week four of the menstrual cycle. 70 women, 269 altitude exposures.

Pregnancy & Diving


Problems reported during diving were not evenly distributed over a menstrual cycle and suggested a risk factor associated with menstruation and diving. The highest risk in week one, with the lowest risk in week three before rising again at the end of a 28 day cycle. 270 women, 98,000 dives, >1,000 menstrual cycles.


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The aim: To investigate any potential link between diving whilst pregnant and foetal abnormalities by evaluating field data.
Pregnancy & Diving

Human retrospective studies
- 1978 Bangasser - (72) no abnormalities
- 1980 Bolton - (145) abnormalities, 5.5%
- 1985 Betts - (76) data too small, 3 in 30m depths
- 1989 Bakkevig - (34) data too small

Animal studies:
Conflicting and contradictory in their findings
May not be relevant to the human situation

Data gathered over ten years
- Retrospective data (1990/2)
- Prospective data (1996/2000)

- 129 females reported 157 pregnancies
- 1,465 dives whilst pregnant
- Mean age of 34 at 1st dived pregnancy

Retrospective
- 65% women ceased diving in 1st trimester
- 65 weeks the latest time of diving
- 65m deepest dive recorded
- 92 dives recorded during one pregnancy

Prospective
- 90% ceased diving in 1st trimester
- 26 weeks the latest time of diving
- 25m deepest dive recorded
- 72 dives recorded during one pregnancy
- 12 women made 1st dive in 2nd trimester
- 1 women made 1st dive in 3rd trimester
- 26 weeks last time reported diving
**Pregnancy & Diving**

**Retrospective**
- 65% women ceased diving in 1st trimester
- 12 women made 1st dive in 2nd trimester
- 1 woman made 1st dive in 3rd trimester

**Prospective**
- 90% ceased diving in 1st trimester
- 26 weeks last time reported diving
- Bolton Study (1980)
  - 20% women still diving in 3rd trimester

**FIG 1. Latest time of diving whilst pregnant**

- Bolton 1980
- 1st Study (M&W 1990/2)
- 2nd Study (MC 1996 to 2000)

**Pregnancy & Diving**

- 25% of 157 pregnancies failed to reach full term
  - 1 still birth
  - 16 terminations
  - 22 spontaneous abortions

- 80% of 118 live births were perceived to be problem free

**Problems reported with pregnancy or outcome** ranged from “spotting up to 26 weeks” to low birth weight.

**Underlying variables likely to influence the findings?**
- Age
- Drugs
- Alcohol
- Smoking
- Medical history
- Occupational activity
- Socio-economic grouping
- Geographical location
- Risk taking
- Other sports

**Case 1** neonatal death 18 hours after delivery
The baby was diagnosed as suffering from “severe diaphragmatic hernia.”
The respondent reported 10 dives in total,
1 > than 20 metres, the last dive being in week 21.
She also consumed alcohol during the pregnancy

**Case 2** reported that her baby was born with an extra digit on the left hand - it was successfully tied off.
She reported 13 dives, 4 in the 15 to 20 metres range between weeks 20 to 33.
She consumed the occasional glass of wine with a meal whilst pregnant.
Pregnancy & Diving

Case 3 reported that she felt extremely ill during diving. After continuing to feel unwell during the pregnancy it was decided to terminate the pregnancy at 18 weeks. It was found that although the placenta appeared to indicate a pregnancy of 18 weeks, the foetus showed a size of 8-10 weeks. The respondent was also a sky diver and in the first 6 weeks of pregnancy had been to an altitude of 10,000 feet at least 6 times. She had dived to no more than 10 to 12 metres.

Pregnancy & Diving

Case 4 reported that her baby had a seizure at three days old. A blood infection was suspected. The baby was full term and weighed 10lbs 10ozs. She reported 8 dives, 2 greater than 20 metres in the first trimester. She drank alcohol, 1 unit a day in the first trimester and thereafter 3 units per day 4 days a week. She also admitted to "occasional hashish" whilst pregnant.

Case 5 was an active horse-back rider until the sixth month of her pregnancy, when she went into labour at 33 weeks. The baby weighed 3lbs 4oz. Her 10 dives took place in the 15 to 20 metres range up to week 20. It was concluded that the placenta had torn away, resulting in premature labour, following a fall from a horse. She did not drink alcohol or smoke during pregnancy.

Pregnancy & Diving

- 8 respondents on holiday in the early stages of pregnancy
- 5 pregnancies spontaneously aborted
- 4 of the 5 had dived 5 or 6 days in a row

Pregnancy & Diving

- Women are increasingly observing the recommendations
- "Do not dive if you are pregnant"
- Safe limits to dive whilst pregnant cannot be established by studying field data
- Animal data are not a good model on which to base recommendations
- The way forward remains elusive

The future?

Scuba Diving & the Menstrual Cycle

What is the way forward? Further research?
- Studies indicate a clear correlation between the incidence of DCI or RPDD and the point in the menstrual cycle
- Data collection should include exact menstrual cycle lengths of both non-OCP and OCP users

Pregnancy and Diving

The risk of diving whilst pregnant remains unquantified. It is unlikely that the safe limits to dive whilst pregnant will ever be established.
Thank you