

## HEART RATE CHANGE OF HEALTHY VOLUNTEERS IN A SIMULATED DIVE EXPERIMENT

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### ABSTRACT

**Background:** Key components of the diving response (apnoea, bradycardia, peripheral vasoconstriction, redistribution of cardiac output etc.) were found in essentially all species analyzed, and were generally taken to be biological adaptations.

**Aims & Objective:** To determine change in the heart rate (HR) in a simulated dive experiment in human volunteers.

**Materials and Methods:** In this study, 30 healthy adult male volunteers without cardio-respiratory illness participated. They held their breath in air and then in water at around 15°C in a plastic tub for 30 seconds at our laboratory. Their HR was measured using an automated instrument (Schiller's multipara monitor).

**Results:** 1<sup>st</sup> part of experiment (breath holding in air) has shown no significant change in HR during 30 sec, while in the 2<sup>nd</sup> part (breath holding in water) has shown a significant change in the heart rate – on an average, from 108.97 to 70.8; with a difference of 38.17 (p <0.0001). The comparison of the difference in HR at 0 and 30 seconds of the 1<sup>st</sup> and 2<sup>nd</sup> part of the experiment has shown that an average difference in HR was 3.2 in breath holding in air and 38.17 in breath holding in water, with a difference of 34.97 (p<0.01) between the two parts of the experiment at the 30s.

**Conclusion:** The study indicated that a significant decrease in HR can occur during a dive.

**Key Words:** Heart Rate; Diving; Breath Holding; Under Water

### Introduction

Studies of diving physiology and biochemistry made a great progress in explaining the basic diving response of aquatic mammals and birds. Key components of the diving response (apnoea, bradycardia, peripheral vasoconstriction, redistribution of cardiac output etc.) were found in essentially all species analyzed, and were generally taken to be biological adaptations.

By eliciting this physiological response in the laboratory, we can understand this diverse response in our close approximation and can devise a helpful aid in the adaptive response in rescue operation or in other related health concerns.

### Materials and Methods

In this study, 30 healthy adult male volunteers without cardio-respiratory illness participated. They held their breath in air and then in water at around 15°C in a plastic tub for 30 seconds at our laboratory. Their heart rate (HR) was measured using an automated instrument (Schiller's multipara monitor).

**Setting:** Research Room, Department of Physiology, Baroda Medical College, Gujarat

**Design:** A cross sectional study

### Equipment and Setup:

- 1 plastic tub - for facial immersion
- Tap water - to fill the tubs
- Ice - for adjusting water temperature at 15oC
- 1 thermometer - to measure water and room temperature
- Schiller's multipara monitor-monitoring device
- Electrodes -to be pasted on the participant's chest
- nasal clip - to prevent accidental inhalation/ snuffing of water
- Swimming goggles - to prevent oculo-cardiac reflex
- 1 stopwatch - for accurately measuring duration of experiment
- 1 handkerchief - to wipe face
- Software set up - for statistical analysis
- Inclusion Criteria
- Adult male volunteers who were willing to participate and have no any cardio-respiratory illness.

### Exclusion Criteria:

- Those who were not willing to participate or
- Those who have any cardio-respiratory illness.

## Methodology

Breath holding in air was done at room temperature with timer visible to the participant. Nasal clip was used and absence of respiration was reassured by absence of abdomino-thoracic movements. Before conducting the test using water, temperature of the water was measured and it was adjusted to the desired temperature of 15°C by adding warm tap water or ice.

To measure the heart rate (HR), Schiller's multipara monitor was used. Electrodes were attached on its leads and were applied on the participant's chest at the appropriate place. Participant wore swimming goggle and had nose clip before the experiment started. Diving was simulated by leaning over the lab platform with elbows resting on the lab platform and the head down.<sup>[1]</sup>

For immersion tests, participant immersed the face up to both the temples. Each experiment lasted for 30secs. Several minutes of rest was taken for the HR to return to normal between experiments. Most participants were able to hold their breath this long without much trouble but participants were free to discontinue the experiment as soon as they experienced discomfort.

As it was easy for the subject to lose track of time during the test, participants were being tapped on the back every 10 s by the timer when being asked to hold their breath. Tapping helped the participant to remain calm during the test because they had a better idea of completion of the 30-s test period.

In our study, thirty healthy male participants with mean age of 18.77 years were enrolled. The physical components of our study were also kept in a close range before starting an experiment.

We can get from chart that HR was 104, 101 & 101 during 0sec, 15 sec & 30 sec respectively during breathing in air. During simulated dive HR was 109, 82 & 71 during 0 sec, 15 sec & 30 sec respectively.

## Discussion

The first part of experiment i.e. breathing in air has shown no significant change in HR during 1st & 2nd 15 second. The second part of experiment i.e. holding breath in cold water has shown a strong significant change in heart rate during 1st 15 second from an average of 108.97 to 81.77 with a difference of 27.2 and  $p < 0.01$ . During the next 15 seconds i.e. from 15 to 30 seconds HR has reduced even more from an average of 81.77 to 70.8 with a difference of 10.97 and  $p = 0.004$ . Considering the overall time changes i.e. from 0 to 30 seconds HR was reduced from 108.97 to 70.8 with a difference of 38.17 and  $p < 0.0001$ . This experiment shows that diving reflex exists in human which becomes more pronounced with time.

The comparison of the difference in HR from 0 to 30 seconds of 1st and 2nd part of the experiment has shown that an average of difference in HR from 0-30secs of 1st part was 3.2 and of 2nd part was 38.17 with difference in HR of 34.97 ( $p < 0.01$ ). It indicates a significant decrease in HR occurs in simulating dive as compared with breathing in air.

There is evidence in literature that the decrease in HR results from increased parasympathetic stimulus to the cardiac pacemaker.<sup>[2,3]</sup> The elicitation of the diving response by cold stimulation is derived from the upper part of the face innervated by the ophthalmic part of the trigeminal nerve (forehead and eye area).<sup>[4]</sup> We can use these physiological responses to increase the effectiveness of self-rescue efforts, required by anyone who participates in recreational, commercial or military activities in the oceans, lakes, and streams.

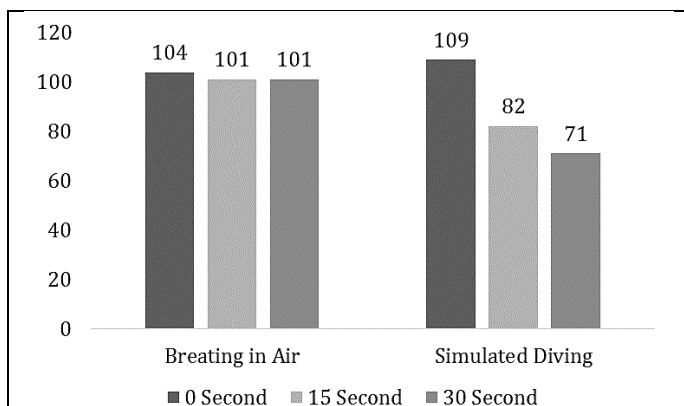
## Conclusion

The experiment established that heart rate changes by breath holding is not significant if done in air but becomes significant if done in simulated diving. The outcome may be extrapolated to mean that diving

## Results

**Table-1: Age and ambience of the study population**

	Mean	SD
Age (Years)	18.77	0.57
Room temperature (°C)	33.75	0.67
Cold water temperature (°C)	17.92	0.96



**Figure-1: Change in Heart Rate during breathing in air and simulated diving**

induced changes in heart rate are significantly more than simple breath holding outside in the air.

## References

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