THE RELATIONSHIP OF AGE AND BODY MASS INDEX TO DOPPLER-DETECTED BUBBLE GRADES

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INTRODUCTION

The US Navy reported on 2,491 dive trials in 1985.[1] They describe profiles by time-depth intervals, dive conditions and personal characteristics. Doppler monitoring was carried out on these dives but not reported. This study analyzes the Doppler results for dives using nitrogen and helium diluents.

METHODS

Trials were experimental dives conducted in a wet pot chamber environment for the purpose of developing decompression procedures. Included in this study are decompression and no-decompression profiles using helium-oxygen (n=1,508) and nitrogen-oxygen (n=707) for which Doppler detected venous gas emboli (VGE) data were collected. Ascent rates for helium dives were 60 fpm to the first stop as well as between stops where as nitrogen dives were 30 and 60 fpm respectively. Doppler results were obtained according to the DCIEM protocol at 30-60 and 60-90 minutes post-surfacing.

We analyzed the associations of age, body mass index (BMI; kg/m2) and breathing gas on Doppler bubble levels. Highest score for any site was converted to a binary variable for high bubble grade (HBG) defined as HBG=0 for Spencer Grades 0-II or HBG=1 for Grades III-IV. Decompression stress was represented by the conditional probability of DCS ($\%P_{DCS}$) estimated by the U.S. Navy multi-gas exponential-linear model (LEM).[2] The LEM calibration database included, but was not limited to, the dives we investigated. Associations of the dependent variable (HBG) with the dichotomous age and BMI (<median, >=median), breathing gas and continuous $\%P_{DCS}$ were assessed by logistic regression using a level of significance at $p<0.05$.

RESULTS

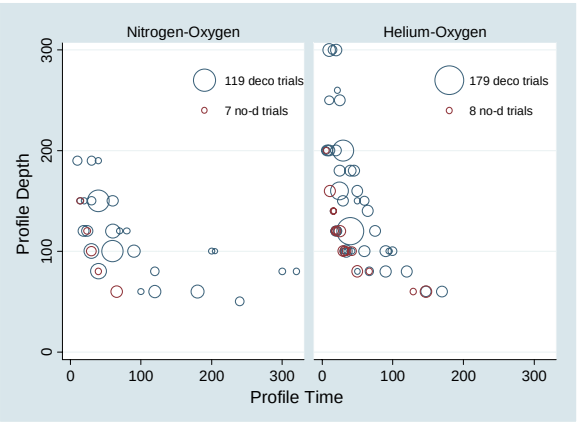

Figure 1. Frequency of dive exposures by nitrogen-oxygen and helium-oxygen breathing gases and by decompression and no-decompression profiles.

Table 1. Estimated odds ratio, p-values and 95% CI for multiple logistic regression model using dichotomous variables of age, BMI, breathing gas and continuous variable $\%P_{DCS}$.

HBG	OR	95% Conf. Interval
$\%P_{DCS}$	1.22	1.14 - 1.30
Age	1.48	1.24 - 1.77
BMI	2.06	1.72 - 2.47
He (vs. N_2)	1.91	1.57 - 2.33

Odds ratios indicate significance for all independent variables tested ($p<0.05$).

Table 2. Summary statistics for plotted values of logistic regression analysis. N_2 (n=707) and He (n=1,502) profiles.

	Inert Gas	Median	Range
Age	N_2	26	20 - 46
	He	28	20 - 44
BMI	N_2	24.7	20.4 - 32.4
	He	24.5	20.3 - 32.4
$\%P_{DCS}$	N_2	4.3	1.7 - 7.1
	He	4.6	1.4 - 8.2

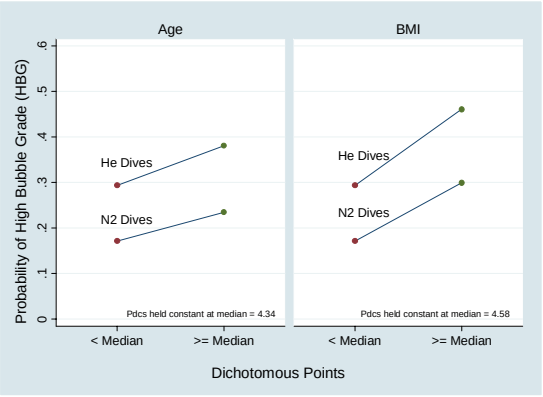

Figure 2. Probability of HBG for dichotomized variables age and BMI by breathing gas. Trials include decompression and no-decompression profiles.

DISCUSSION

There were 861 incidents of HBG in 2,215 trials (39% of exposures)**.** Nitrogen dives had 27.7% HBG and helium 42.8%. Despite similar $\%P_{DCS}$ for helium and nitrogen dives, the probability of HBG was higher in helium dives for both age and BMI. This observed difference is un-explained but may be influenced in part by higher rates of ascent to the first stop and somewhat deeper dives for helium.

Divers with higher levels of BMI had more HBG than divers with lower levels. BMI does not discriminate fatness from muscularity. An assessment of body fat (three site skinfold measures on 78% of dataset) was included in a restricted model but found not significant. The effect of BMI on the probability of HGB is unexplained.

Older divers had more HBG than younger divers. Because measures of fat were found not significant, the effect of age on HBG may represent other changes possibly related to micro-vascular changes.

LIMITATIONS

This study takes into account neither the thermal status nor the exercise load of exposed divers.

Using skinfolds as a measure of body fat may have influenced the finding of non-significance.

CONCLUSIONS

There were significantly more HBG with helium-oxygen than with nitrogen-oxygen, and the HBG incidence increased with age and BMI.

REFERENCES

1. Thalmann, NEDU Reports 1-85 & 8-85
2. Parker, NEDU Technical Report 92-73