Letters to the editors

High-fat diets and decompression stress revisited

Dear editors:

The authors Kaczerska, *et al.* conclude in their paper "The influence of high-fat diets on the occurrence of decompression stress after air dives" [1], that a high-fat diet significantly increases the severity of DCS stress. Unfortunately, the term "symptoms of DCS stress," as used in their paper, is confusing, as they apparently mean the risk of DCS. Since the paper considers bubble grades, not occurrence of DCS itself, it would have been more clear to label the horizontal axis of the legendless Figures 3-9 with "bubble grade" and with "low" and "high."

Despite this, it is disputable whether the diet can be seen as a causal factor as they suggest. To date, several demographic characteristics are considered as DCS stressors, such as age, and VO_{2max} (see Ref 2, also for references). A stressor has an underlying mechanism enhancing the amount of venous gas bubbles (VGB) and consequently increasing the DCS risk. For a century, body fat (BF) and BMI have often been considered as a stressor. In the introduction the authors adopt the classical assumed mechanism, the five-time higher solubility of N_2 in fat compared to water. Then with increasing BF, total body N_2-load increases. However, in a recent paper this load was modeled for a lean diver and fat diver; the difference appeared to be so small that a notable difference in VGB can be excluded [2].

Although some studies found a (cor)relation between DCS risk or VGB with BF or BMI, this does not at all imply causality. The problem with BMI and BF is that they are strongly mutually correlated with age and VO_{2max}; the problem of multicollinearity. In two studies the BF (or BMI) correlation with VGB was significant [3,4], but when the correlation was corrected for the correlation with age and VO_{2max} by calculating partial correlation coefficients, any correlation with VGB vanishes.

Also, another study with very small ranges of age and VO_{2max} showed no correlation between BF and VGB [2]. Studies claiming BMI or BF as a stressor, according to our definition, have in fact a disputable or inappropriate study design since multicollinearity was not examined.

In the study discussed, the multicollinearity (*i.e.*, calculating the partial correlations) between BMI, age, recommended daily fat intake (RDI), total cholesterol (CHOL) and triglycerides (TG) were not examined. It seems quite likely that daily RDI, TG and CHOL are mutually highly correlated and that these variables are also correlated with BMI. BMI is in turn correlated with VGB (via its negative correlation with the stressor VO_{2max}).

Surprisingly, this study examines BMI, not BF, whereas the correlation between BF and VO_{2max} is much higher than between BMI and VO_{2max}. Although BMI and BF are well correlated, many, especially young subjects with high BMIs, have unexpected low BFs and high VO_{2max} values (e.g., rowers, weight-lifters).

In addition to statistical concerns, there is also a physiological one.

In the discussion the authors implicitly indicate that the difference in dissolved N_2 in serum due to the diet would be the cause for the difference in VGB. From the authors' data it can be calculated directly that the difference in volume% of fatty molecules in the serum between the low bubblers (KM<2) and the high bubblers is 0.8 mL/L. This is a serum load difference of only 3%. It is highly unlikely that this difference will result in the large observed differences in KM. (Unfortunately, detailed information about the distribution of KM grades and scoring methods are lacking.)

In conclusion, from experimental findings and theoretical considerations it seems likely that RDI, TG, and CHOL are indicators for bubble stress, but with the present study design and statistical analysis the question cannot be answered whether they are stressors.

To date, BMI is an indicator, poorer than BF; according to new insights they have lost their status as stressor.

Nico A.M. Schellart, Ph.D., M.Sc., Biomedical Engineering and Physics, Academic Medical Center, University of Amsterdam, Amsterdam, The Netherlands, and Foundation for Dive Research (SDR), Amsterdam, The Netherlands

Wouter Sterk, Ph.D., M.D., Dadcodat, Zuidwolde, The Netherlands

References

1. Kaczerska D, Siermontowski P, Olszański R et al. The influence of high-fat diets on the occurrence of decompression stress after air dives," Undersea Hyperb Med 2013;40-6:487-497.
2. Schellart NA, van Rees Vellinga TP, van Hulst RA. Body fat does not affect venous bubble formation after air dives of moderate severity: theory and experiment. J Appl Physiol 2013;114:602-610
3. Schellart NAM, van Rees Vellinga TP, van Dijk FH, Sterk W. Doppler bubble grades after diving and relevance of body fat. Aviat Space Environ Med 2012;83:951-957.
4. Carturan D, Boussuges A, Vanuxem P, et al. Ascent rate, age, maximal oxygen uptake, adiposity, and circulating venous bubbles after diving. J Appl Physiol 2002;93:1349-1356.

Response: High-fat diets and decompression stress revisited

Dear editors:

According to the theory, decompression stress without symptoms always carries the risk of decompression sickness (DCS). But even if it does not lead to the onset of DCS, it can lead to the so-called late sequelae of diving. In our study decompression stress or lack thereof was observed. Results were divided into two groups and the signatures of the charts indicate the group: without stress and with stress. Changing of signatures into "low stress" and "high stress" could suggest that stress was observed in both groups, but in varying degrees.

For years, the research on the impact of age, body weight, fat mass, maximal oxygen uptake went on, but no one paid attention to the factor as obvious as nutrition. This is why in our research we focus our attention on diet and its influence on the level of cholesterol and triglycerides and presence of decompression stress. Many times it has been proven that a high-fat diet with a predominance of animal products causes an increase in cholesterol and triglyceride levels in the blood. It should also be stressed in the mechanism of fat digestion and absorption and a long half-life in the blood, from a few hours to a few days depending on the type of the fat fraction. The results indicate a strong causal relationship between the studied parameters. Just highlighting the effects of diet was the aim of our research

The influence of BMI on the risk of decompression stress has been investigated in the past as "by the way," with researchers having results, analyzing them and drawing conclusions. Even statistically BMI influences on stress are not reliable indicators of risk. This is evident particularly among young people who are well trained with highly developed muscle tissue: A relatively high body weight has nothing to do with being overweight.

In such cases, in fact it is better to examine the body fat mass or perform measurements of the thickness of skin folds.

The question arises in reference to research conducted by the authors of the letter as to whether it would not be worthwhile to do your research including evaluation of food preferences and maximal oxygen absorption.

As we know, a high-fat diet with a majority of products of animal origin is an acidic diet. During metabolic acidosis an increase in oxygen uptake caused by hyperventilation is observed. There is a high probability that a high-fat diet increases the maximal oxygen uptake, not the mass of adipose tissue.

Dorota Kaczerska MSc[1], Piotr Siermontowski M.D., Ph.D.[2], Romuald Olszański M.D., Ph.D.[2], Karolina Krefft M.Sc.[3], Sylwia Małgorzewicz M.D., Ph.D.[1]

[1]Department of Clinical Nutrition, Medical University of Gdańsk Poland. [2]Department Maritime & Hyperbaric Medicine Military Institute of Medicine Gdynia Poland; [3]Department of Physics and Biophysics, Medical University of Gdansk