

# PREDICTED RISK OF A 25% INCIDENCE OF DCS IN THE UW SHEEP MODEL OF DIVERS AND SUBMARINERS

Lehner CE, Sobakin AS<sup>1</sup>, Bates ML<sup>1</sup>, Crump PM<sup>2</sup>

<sup>1</sup>Department of Pediatrics, School of Medicine and Public Health,

<sup>2</sup>Department of Computing and Biometry, University of Wisconsin-Madison.



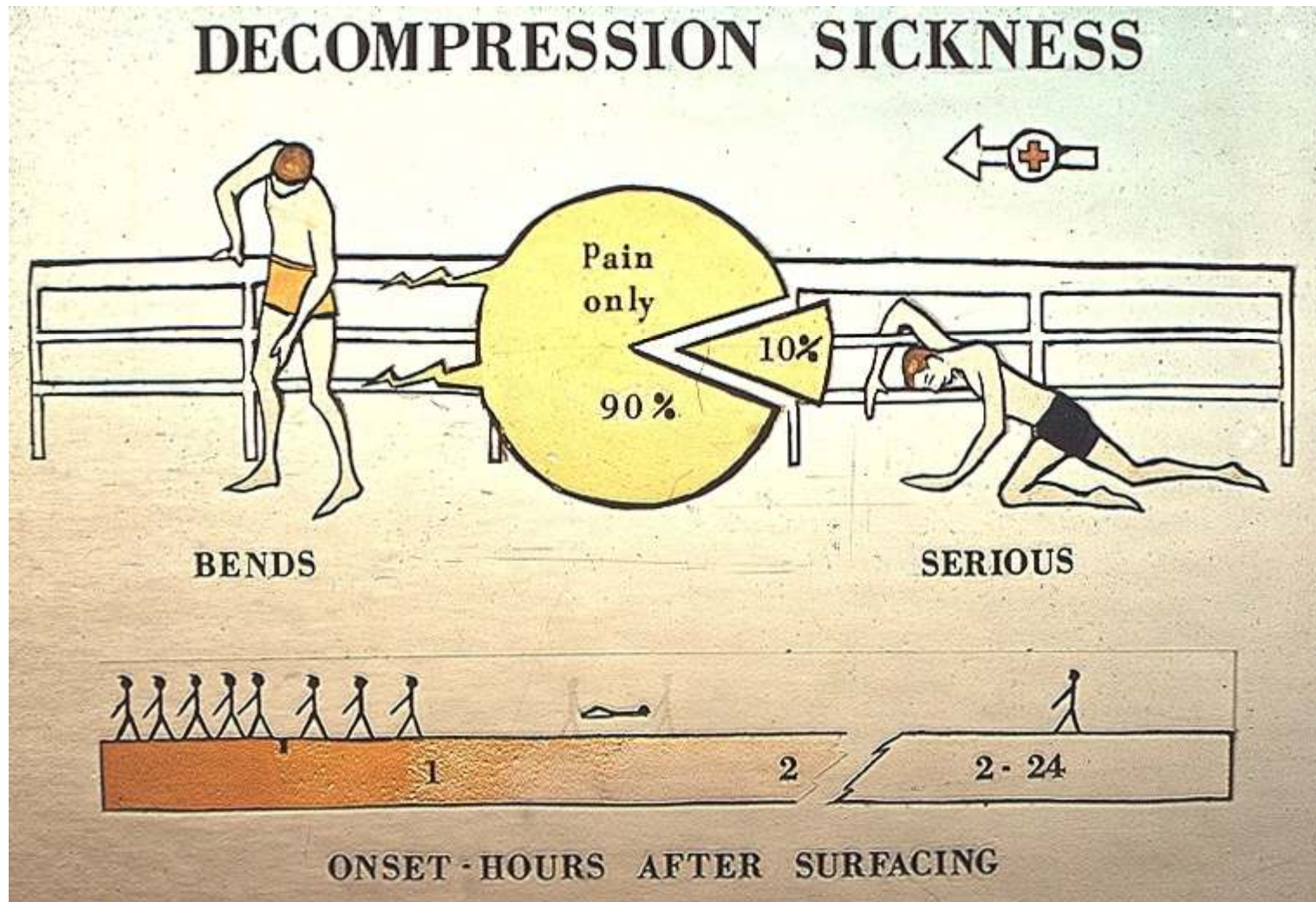
**School of Medicine  
and Public Health**

UNIVERSITY OF WISCONSIN-MADISON

# INTRODUCTION

- Scientific, recreational and operational scuba divers and submariners experiencing a saturation hyperbaric exposure and emergency decompression face the risk of decompression sickness (DCS).
- Because nitrogen is especially soluble in fatty tissue, overall body weight is also a likely determinant of DCS risk.
- We used the intact UW sheep model to test the observed risk of three clinical DCS manifestations and overall lethality after a 24-h exposure to pressure of 19 - 132 fsw (1.5 – 5.0 atm abs) and air decompression in “heavy” and “light” sheep to evaluate whether body weight is an important risk factor in decompression.

# INTRODUCTION



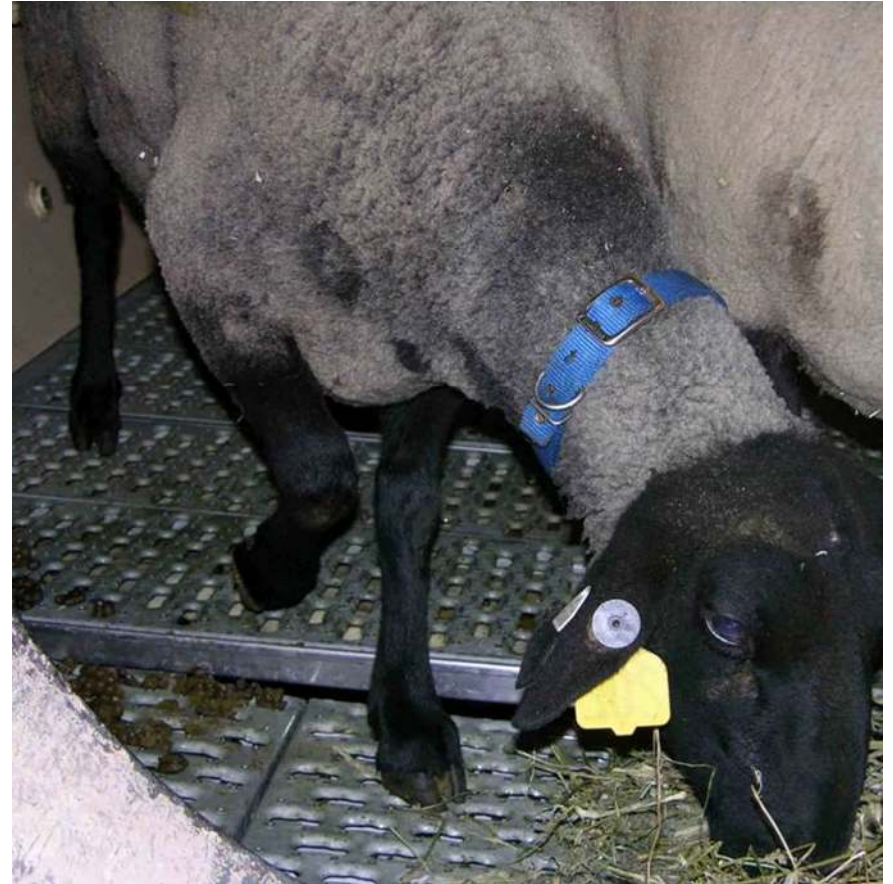
# MATERIALS AND METHODS

- Sheep (22-129 kg  $\pm$ 10.85 SD) underwent air exposure to 19 -132 fsw for 24-h followed by rapid decompression “dropout” (30 fsw/min).
- We analyzed decompression events observed in all ewes subjected to this protocol (n=1120) over a 28-year cumulative series by logistic regression.
- Four outcome variables were evaluated for each sheep: limb DCS (LDCS), respiratory DCS (RDCS), central nervous system DCS (CNS-DCS) and mortality
- Sheep were subdivided into two groups based on weight as “light” sheep  $\leq$ 90 kg (n=456 events) and “heavy” sheep >90 kg (n=664 events).

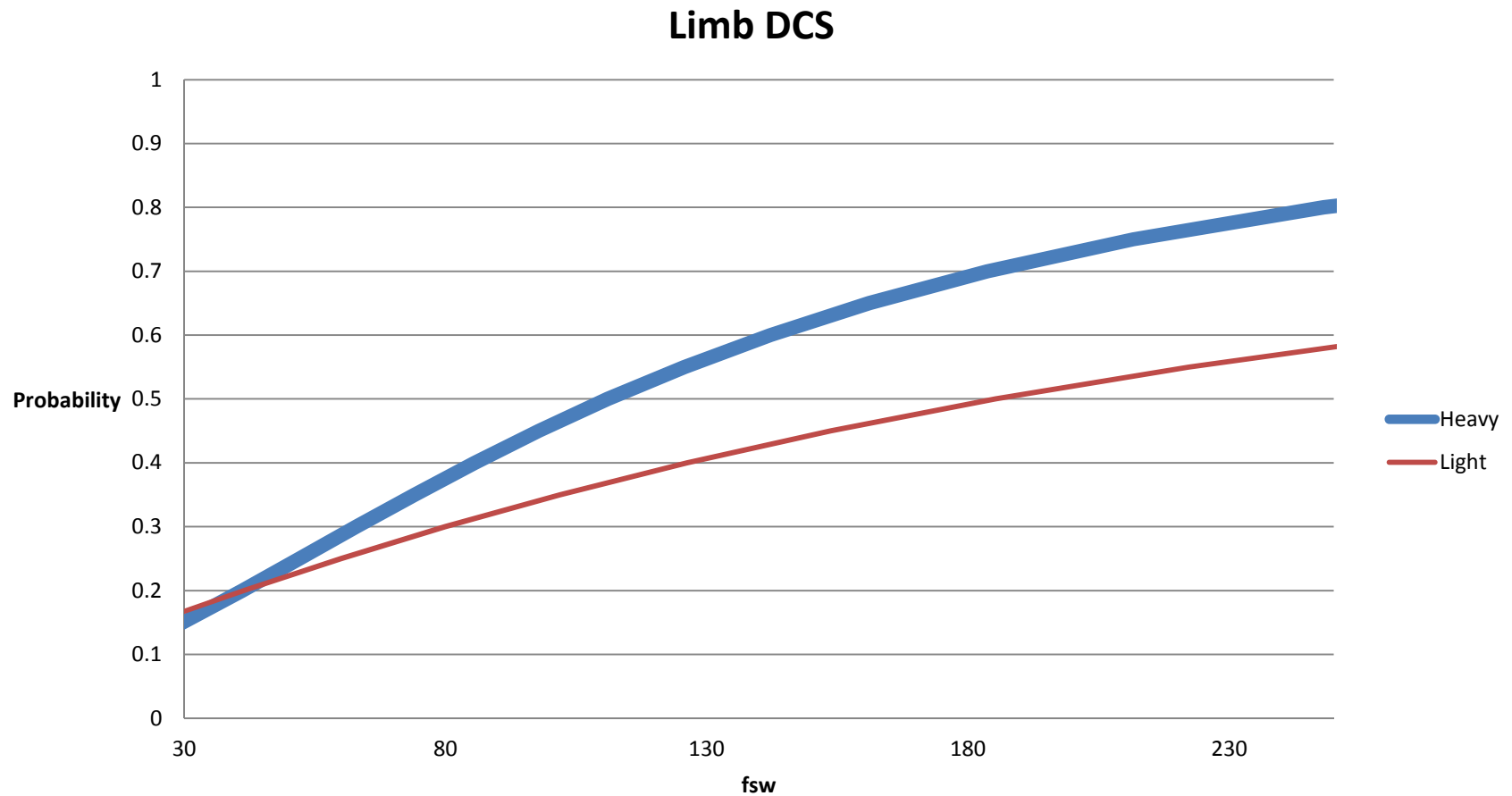


# Grade of Limb Lifting (Counts per 10 min)

- grade 1 - short lifts, resting behavior (duration  $< 1$  sec),  $< 5$  lifts per 10 min
- grade 2 - full lifts (duration approx. 1 sec), 5 - 10 lifts per 10 min
- grade 3 - sustained lifts (duration  $> 1$  sec),  $> 10$  lifts per 10 min



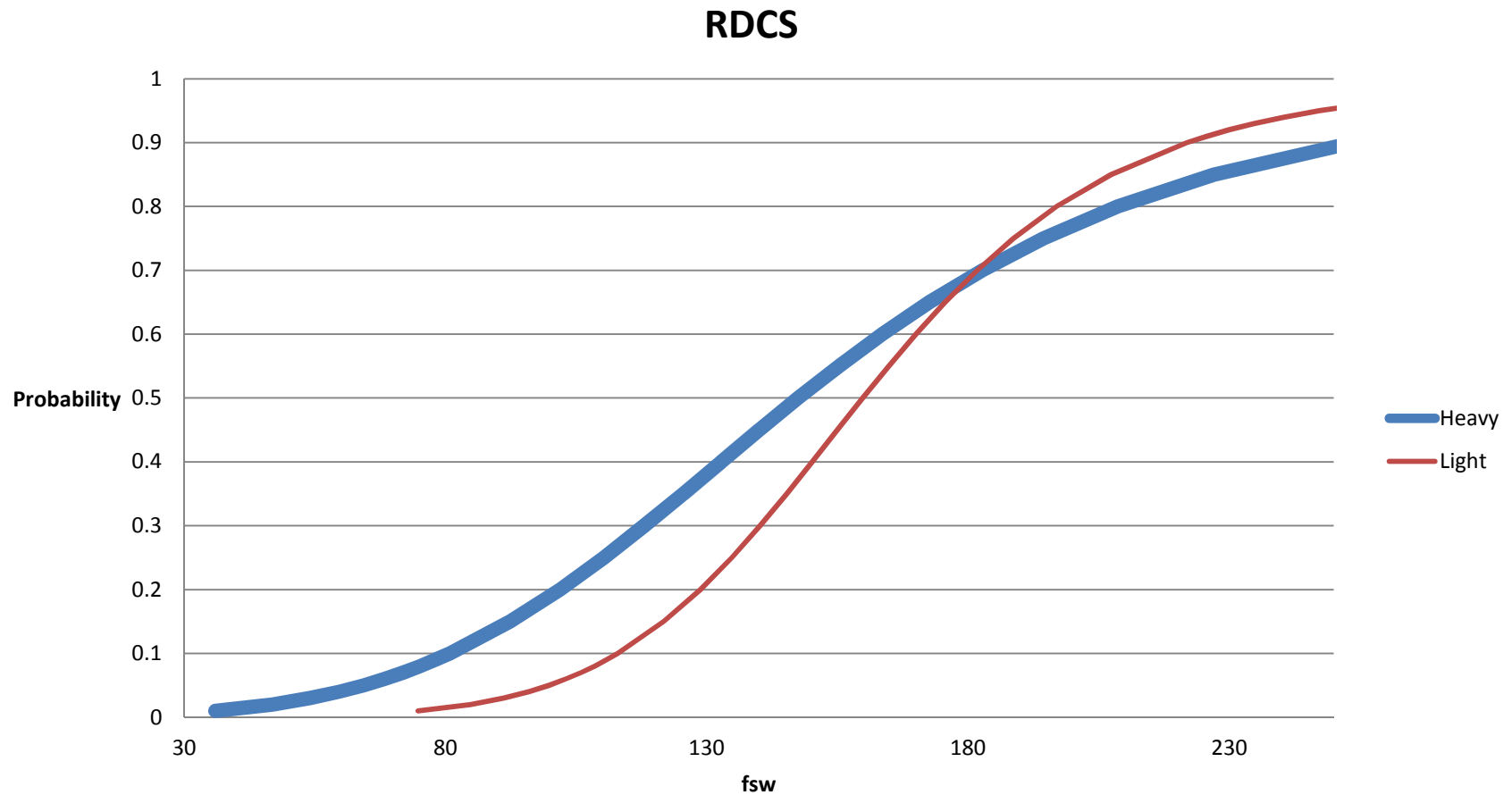
# Limb DCS Results



# **Grade of Respiratory Decompression Sickness, the Chokes**

- grade 0 – normal
- grade 1 - tachypnea, mild labored breathing
- grade 2 - restlessness, sporadic apnea, labored breathing
- grade 3 - severely labored breathing, neck extended, recumbent
- grade 4 - collapse, stupor, death

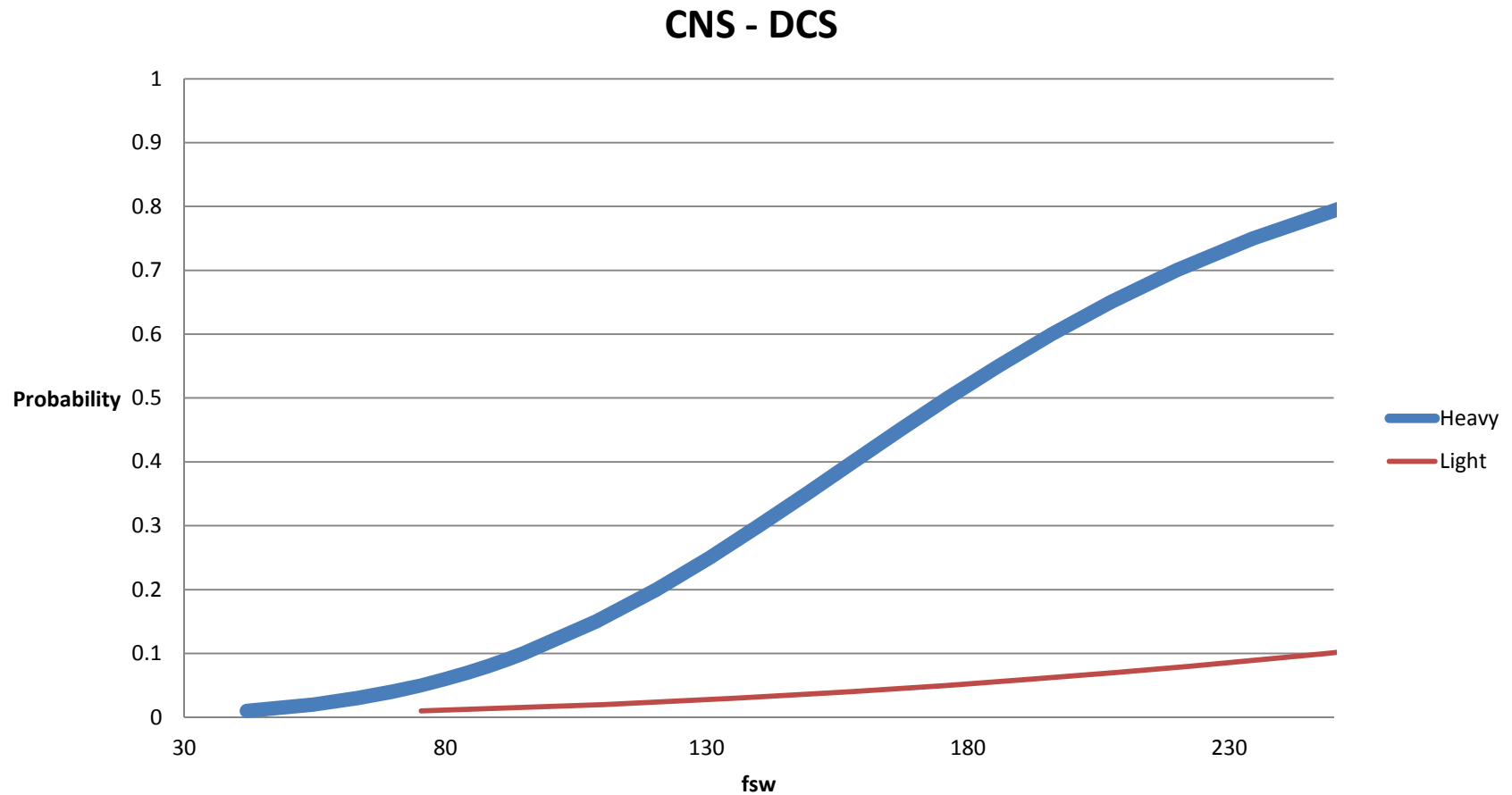
# Respiratory DCS Results



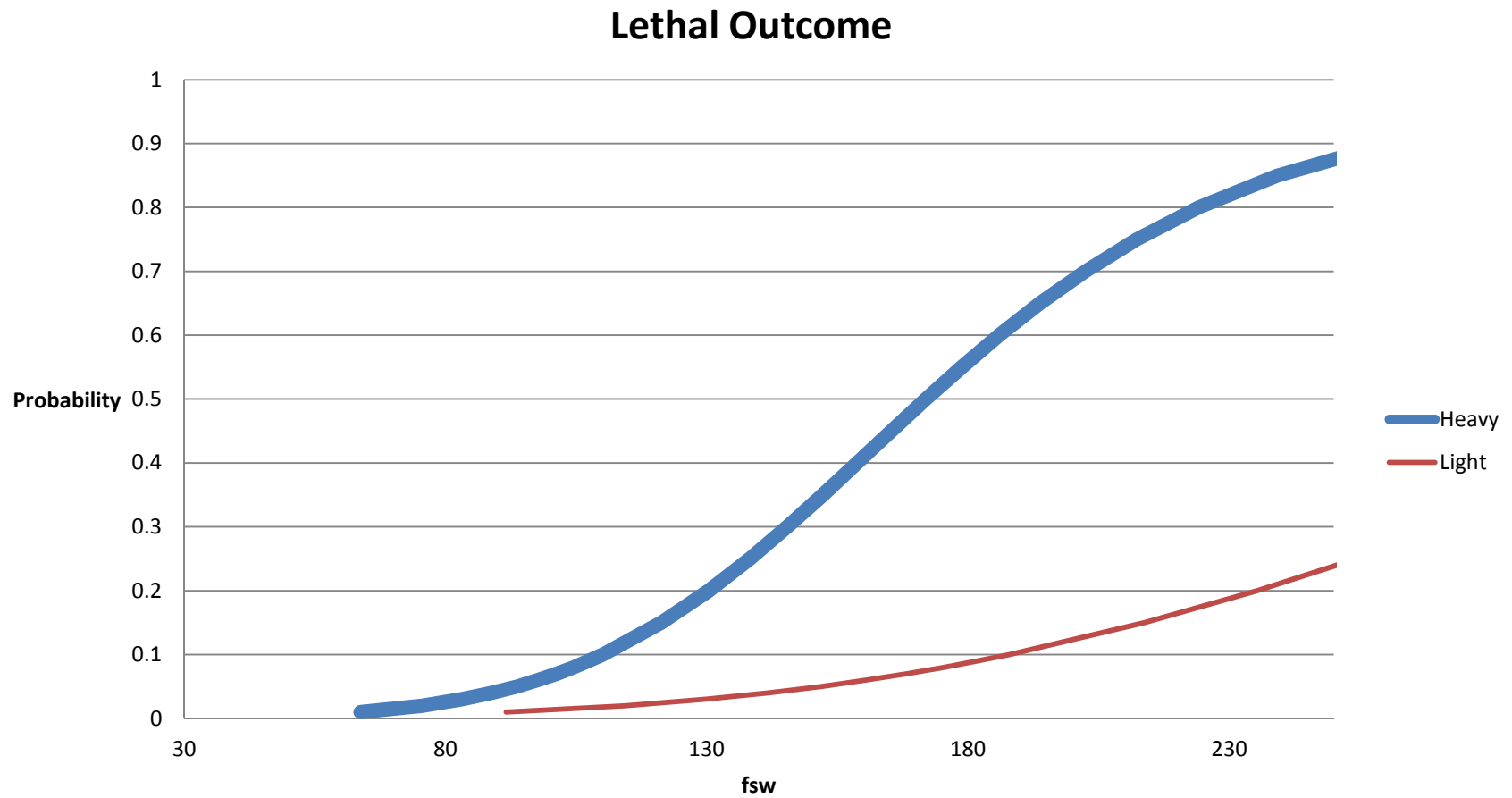
# **Grade of Central Nervous System Decompression Sickness**

- grade 0 - no signs
- grade 1 - placement of the limbs together
- grade 2 - craning (stretching) of the neck
- grade 3 - mild paralysis
- grade 4 - moderate paralysis
- grade 5 - severe paralysis

# Central Nervous System DCS Results

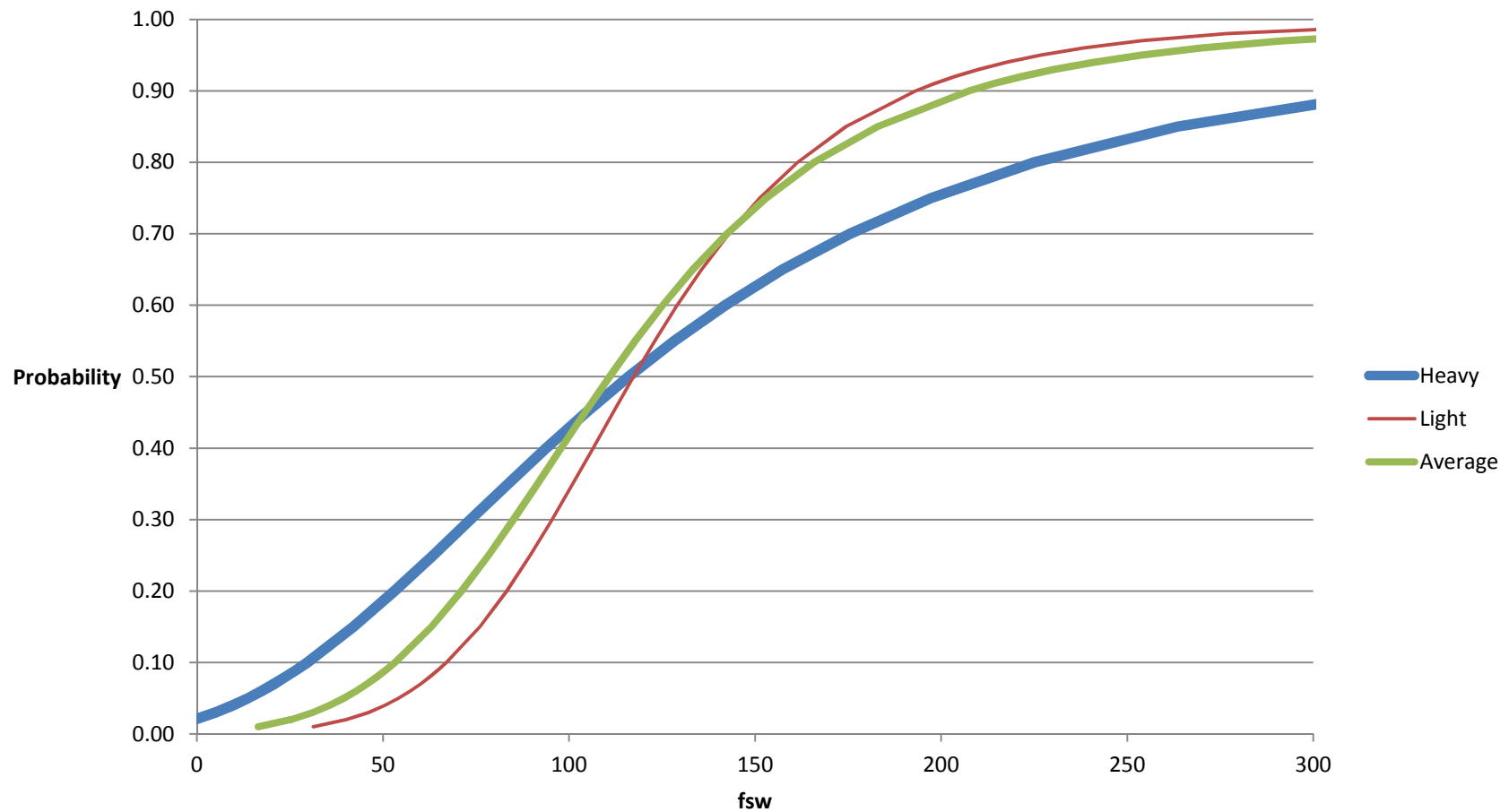


# Mortality Results

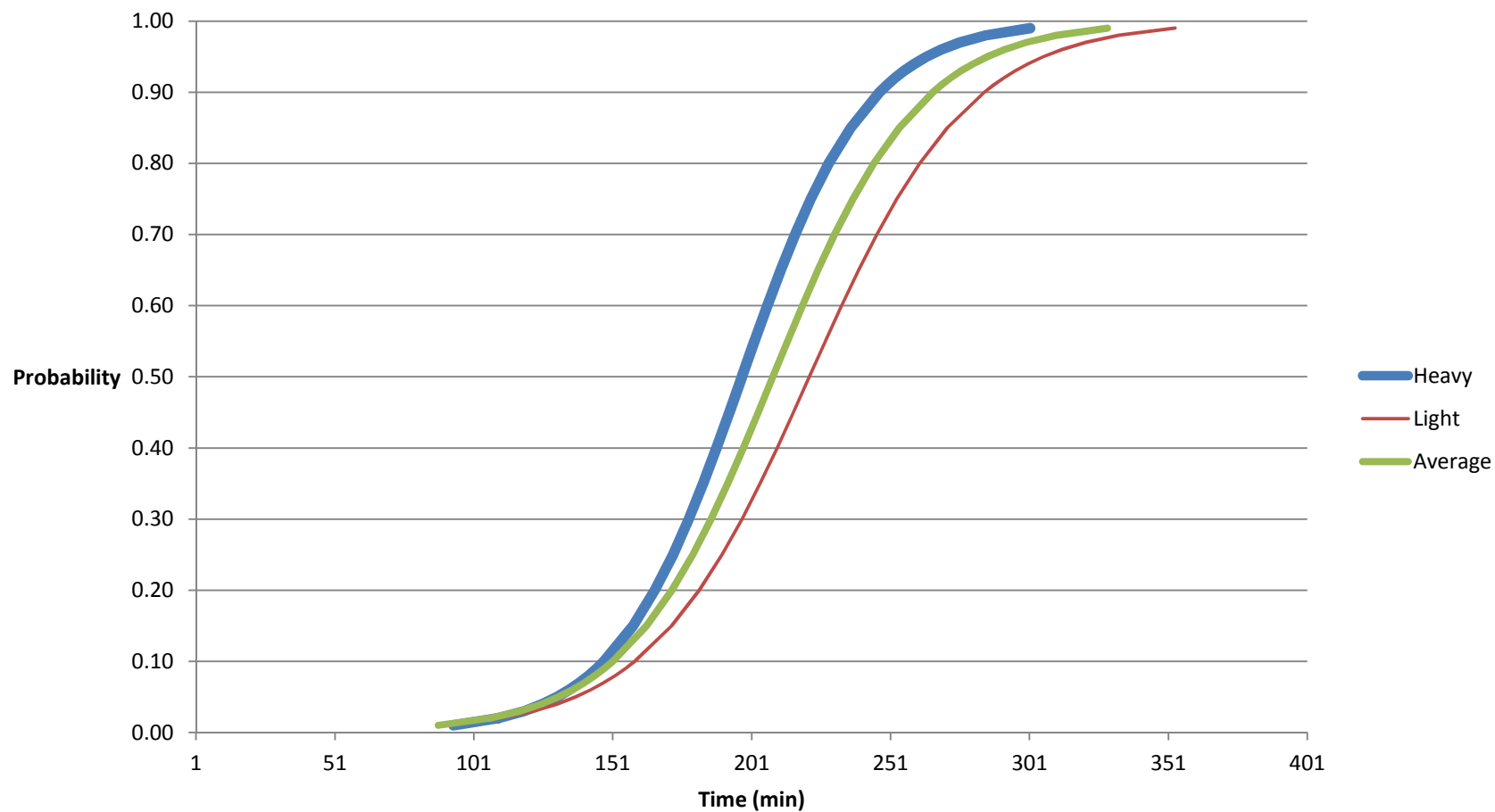


# First dives mortality results

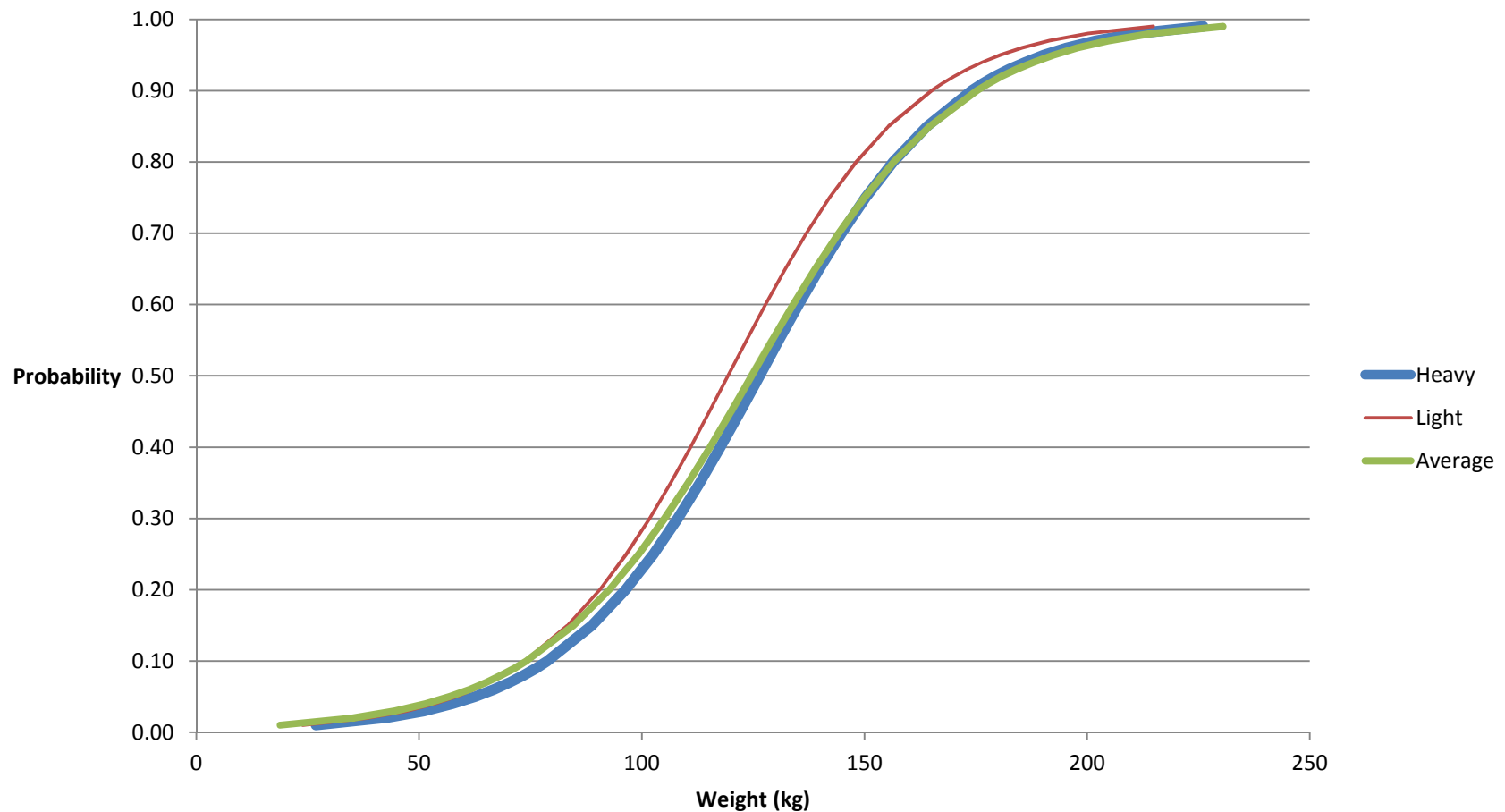
## Probability vs. Pressure



# Probability vs. Time



# Probability vs. Body Weight



# RESULTS

**Depth that creates a 25% likelihood of DCS outcomes for UW sheep model after a 24-h hyperbaric air exposure and drop-out decompression**

Clinical signs	“HEAVY” SHEEP	“LIGHT” SHEEP
Limb DCS	52	60
Respiratory DCS	110	135
CNS - DCS	131	>132
Mortality	>132	>132

# CONCLUSION

- Increased exposure pressure showed a strong dose-response for all manifestations of DCS and lethal outcomes with provocative decompression potentially faced in “drop-out” escapes from a disabled submarine and saturation habitat.
- Increased body weight resulted in a greater risk of RDCS, limb bends, and lethal outcomes, but not CNS-DCS.
- The UW sheep model findings implicate obesity as an important risk factor in RDCS (the chokes) and lethal outcomes in submarine and saturation habitat escape.

# ***ACKNOWLEDGMENT***

Research was funded by the Deep Submergence and Biomedical Development Program, NAVSEA, U.S. Navy, and by the University of Wisconsin Sea Grant Institute.

