AEROBIC FITNESS OF CERTIFIED DIVERS VOLUNTEERING FOR LABORATORY DIVING RESEARCH STUDIES

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Introduction

- Physical fitness is necessary to ensure that both normal and emergent needs of diving can be met
  - reserves of both strength and aerobic capacity are important
- Aerobic capacity ($VO_{2\ max}$) is a good overall measure of physical fitness
  - defined as the maximum amount of oxygen that can be consumed per unit time
  - inter-individual comparability is facilitated by indexing $VO_{2\ max}$ to body mass instead of reporting whole-body consumption
    - i.e., mL of O_2 consumed per kg body mass per min
  - ease of discussion is facilitated by converting $VO_{2\ max}$ into dimensionless metabolic equivalents (MET)
    - i.e., dividing $VO_{2\ max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$) by assumed resting metabolic rate ($3.5\ mL \cdot kg^{-1} \cdot min^{-1}$)
- A 13 MET capacity has been recommended for diving readiness (Bove, 1996) but it is not clear that this is a realistic requirement
- Aerobic fitness testing is conducted in some of our environmental physiology laboratory studies
  - we reviewed the aerobic capacities of our recent subject-divers

Methods

- Lab data from subjects identifying themselves as certified divers were studied
- Standard techniques were used to assess habitus
  - body mass index (BMI)
    - BMI = weight in kg / [height in m]^2
  - body fat via skinfold thickness
    - seven site measures with a Harpenden caliper
      - Siri (1956); Schutte et al. (1984); Jackson & Pollock (1985)
  - waist-to-hip ratio (WHR)
    - WHR = circumference of narrowest waist/widest hip
- $VO_{2\ max}$ was determined with progressive tests to exhaustion during stationary cycling
  - expired gases analyzed with a ParvoMedics TrueOne 2400 metabolic cart
- Data are presented as mean±SD with ranges
- Pearson product moment correlations were computed to assess relationships between descriptive measures

Results

- A total of 132 certified divers were tested (Table 1)

Table 1. Subject characteristics

Gender	Count	Age (y)	Weight (kg)	Height (m)	BMI ($kg \cdot m^{-2}$)	WHR	Body Fat (%)	$VO_{2\ max}$ ($mL \cdot kg^{-1} \cdot min^{-1}$)	MET_{max}
Male	103	34.5±9.0 [18.6-54.8]	83.6±10.7 [59.6-120.5]	1.80±0.07 [1.68-1.98]	25.8±3.0 [19.5-33.7]	0.86±0.06 [0.76-1.06]	15.6±4.9 [5.1-23.9]	44.0±9.6 [24.7-71.2]	12.6±2.7 [7.1-20.3]
Female	29	32.8±10.3 [21.0-59.3]	61.1±6.9 [46.4-73.8]	1.66±0.07 [1.49-1.78]	22.1±2.3 [18.5-28.4]	0.75±0.05 [0.66-0.89]	22.6±4.7 [14.6-35.1]	39.9±8.4 [24.7-60.5]	11.4±2.4 [7.1-17.3]
ALL	132	34.1±9.3 [18.6-59.3]			24.9±3.2 [18.5-33.7]			43.1±9.5 [24.7-71.2]	12.3±2.7 [7.1-20.3]

- Only 32% of subjects (35% of males and 21% of females) met or exceeded a 13 MET_{max} threshold (Figure 1)

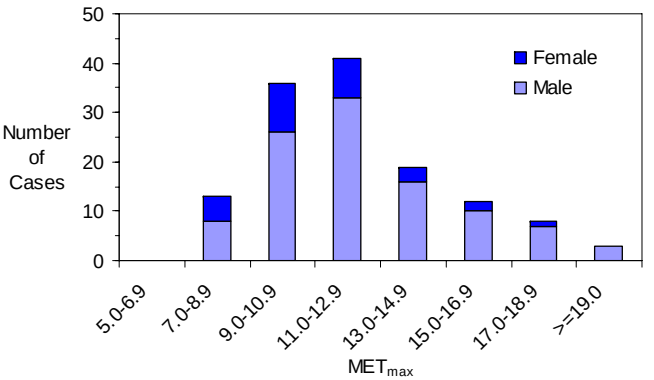

Figure 1. Aerobic fitness of 132 laboratory research subject-divers

- The strongest correlations (modest inverse) were between
  - $VO_{2\ max}$ and body fat (-0.562 males; -0.448 females)
- Correlations were substantially stronger in males than females between
  - age and body fat (0.522 males; 0.235 females)
  - age and $VO_{2\ max}$ (-0.475 males; -0.136 females)

Discussion

- Our results are consistent with a recent review of published reports which found a weighted mean $VO_{2\ max}$ of 41.9 $mL \cdot kg^{-1} \cdot min^{-1}$ (11.9 MET) in 358 diver-subjects
  - individual study means ranged from 37-57 $mL \cdot kg^{-1} \cdot min^{-1}$ (10.6-16.3 MET)
  - lowest individual scores were 16.0 & 16.4 $mL \cdot kg^{-1} \cdot min^{-1}$ (4.6 and 4.7 MET)
    - Pollock (2007)
- Any laboratory study likely overestimates typical fitness since less fit individuals may be less likely to volunteer
- The relative rarity of serious fitness-related diving incidents suggests that wholesale disqualification of divers based on sub-optimal aerobic fitness is not warranted

Conclusions

- While high levels of aerobic fitness ensure substantial reserves to manage emergent events, threshold targets must be reasonable
- Given the physical fitness patterns that we (and others) have found and the relative rarity of serious fitness-related incidents in diving, a 13 MET capacity is unrealistically high as a general requirement

Future Initiatives

- Collect additional normative data on
  - diver fitness
  - diving activity-specific energetic demands
- Develop appropriate diver fitness guidelines/standards

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