



The impact of antidepressants on hypoxia tolerance in Gulf toadfish, *Opsanus beta*

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Filming Florida

Background

- Severely hypoxic or anoxic aquatic environments are found worldwide and have been on the rise¹
- In August 2020, due to a hypoxia event in Biscayne Bay, FL, fish died, and most were Gulf toadfish²
- This was unexpected as toadfish are believed to be able to withstand hypoxia^{3,4}
- The neurochemical serotonin (5-HT, 5-hydroxytryptamine) plays a role in the cardiovascular response to hypoxia^{4,5}

Objectives & Hypotheses

Objective 1: Determine the time it takes for toadfish to lose equilibrium (tLOE) when in severe hypoxia and compare them to sheepshead minnow, *Cyprinodon variegatus variegatus*.⁶

- Hypothesis 1:** Toadfish will have a significantly higher tLOE than the sheepshead minnow

Objective 2: Assess if tLOE in toadfish is affected by blocking 5-HT uptake or degradation.

- Hypothesis 2:** Toadfish will have a significantly shorter tLOE when 5-HT uptake or degradation is inhibited

Methods

- A tLOE apparatus was built that minimized movement
- Oxygen saturation was maintained at 0.4% throughout trials
- tLOE was recorded when the fish was unable to maintain dorsoventral orientation
- Sheepshead minnow:** tLOE was reported for male and female minnows as males are easily distinguishable



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- Gulf toadfish:** 24 h before tLOE trials, toadfish were intraperitoneally injected with coconut oil (control), coconut oil overlaid with fluoxetine, bupropion and decynium-22 (FBD-treated), or coconut oil overlaid with clorgyline (M-treated)
- Statistics:** Welch's t-tests and one-way ANOVAs were used to determine significant differences for data analysis in R ($P < 0.05$ considered statistically significant)

Results

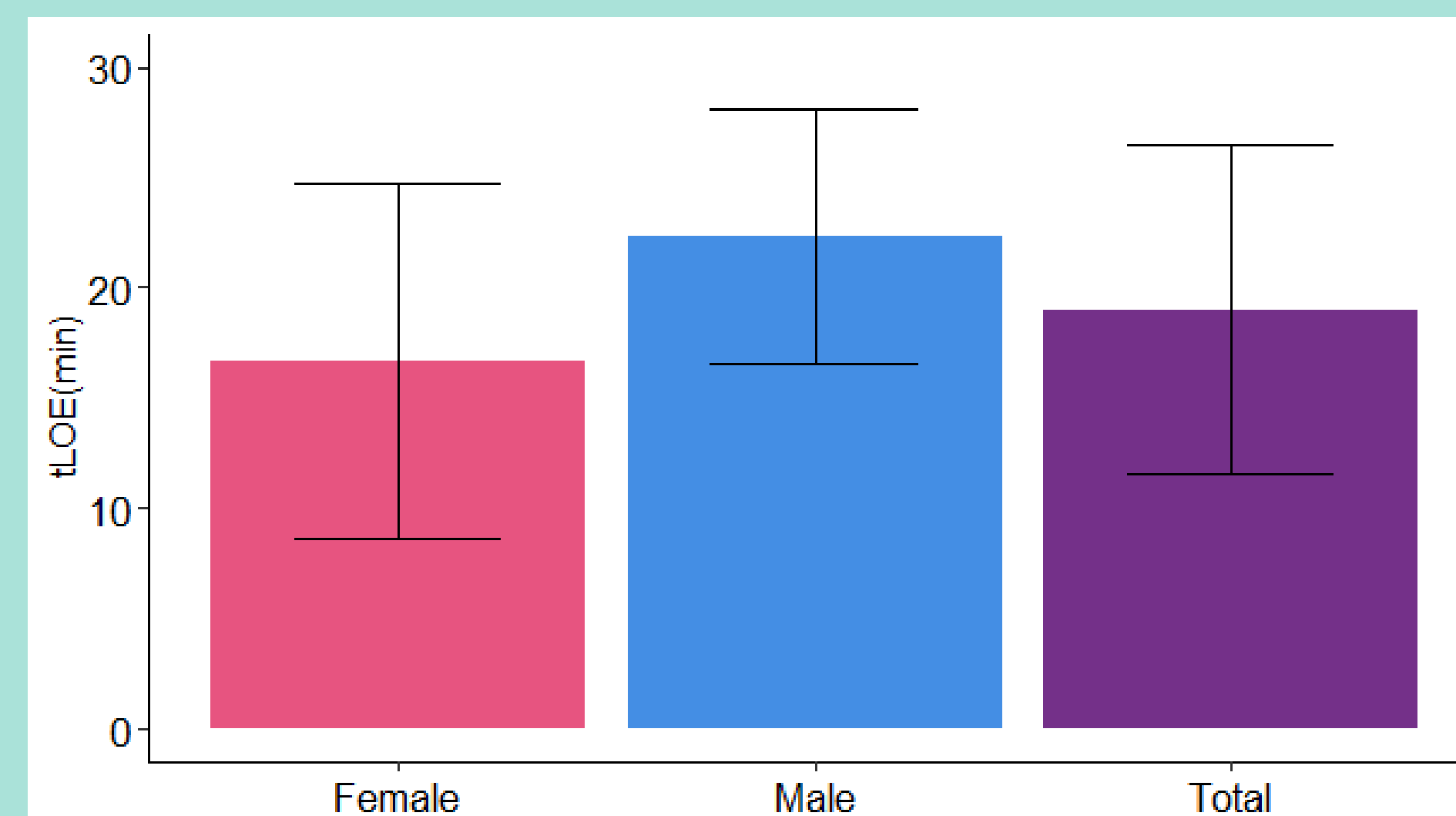


Figure 1. Bar graph demonstrating mean \pm standard deviation of tLOE in female, male, and total sheepshead minnow. There was no significant difference between males and females ($p=0.19$).

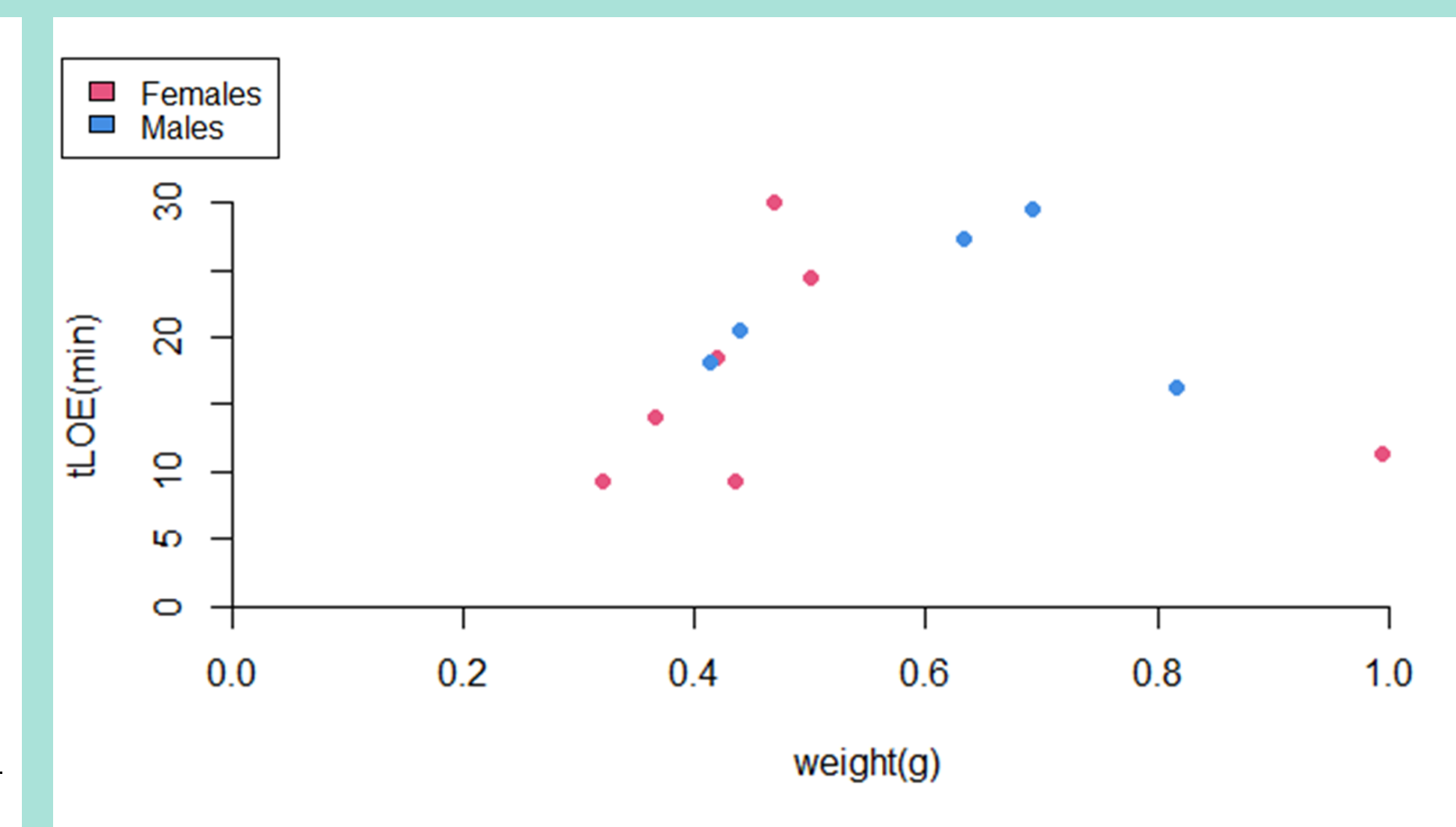


Figure 2. Scatter plot of weight versus tLOE in sheepshead minnow females and males. A polynomial trendline to the second order revealed an R^2 value of 0.62. When standardizing for weight, female and male tLOE per gram were not significantly different ($p=0.76$).

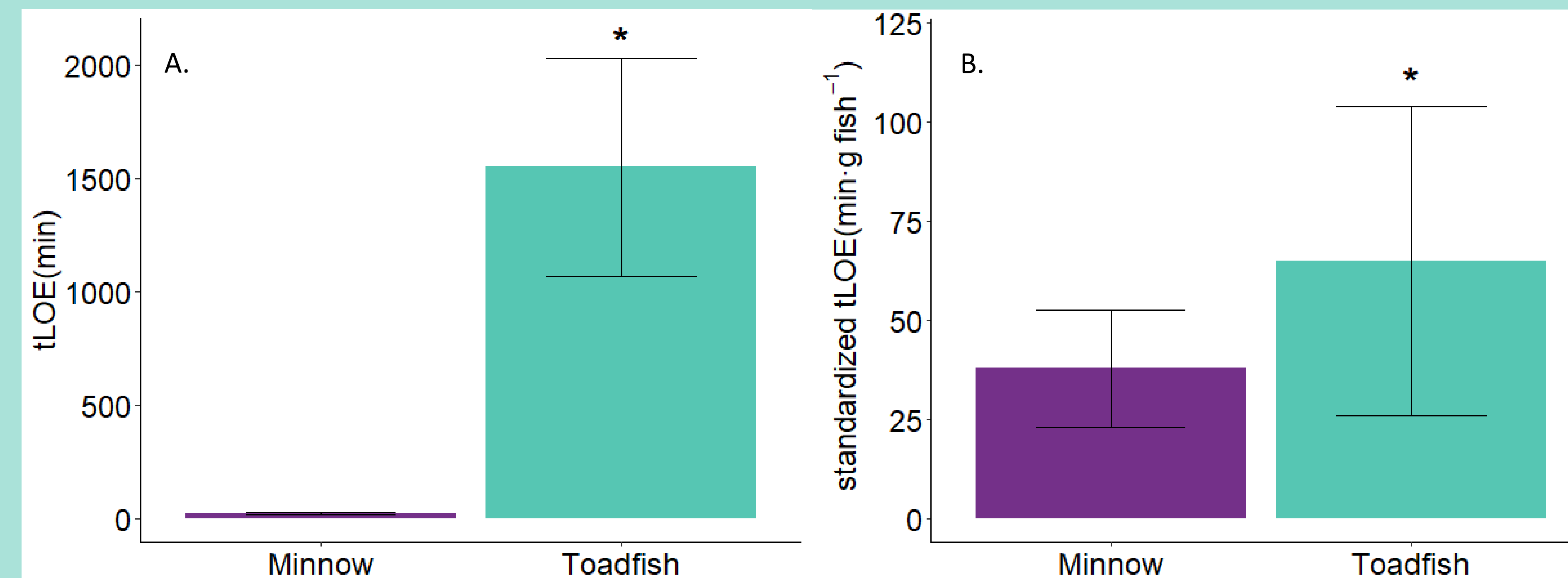


Figure 3. Bar graphs comparing mean \pm standard deviation of A) tLOE and B) weight standardized tLOE between total sheepshead minnow and control toadfish. * indicates significant difference ($p < 0.05$). Control toadfish tLOE was 81.5 times greater than sheepshead minnow tLOE ($p=2.7 \times 10^{-7}$). The difference between sheepshead minnow and control toadfish tLOE after standardizing for weight was also statistically significant ($p=0.04$).

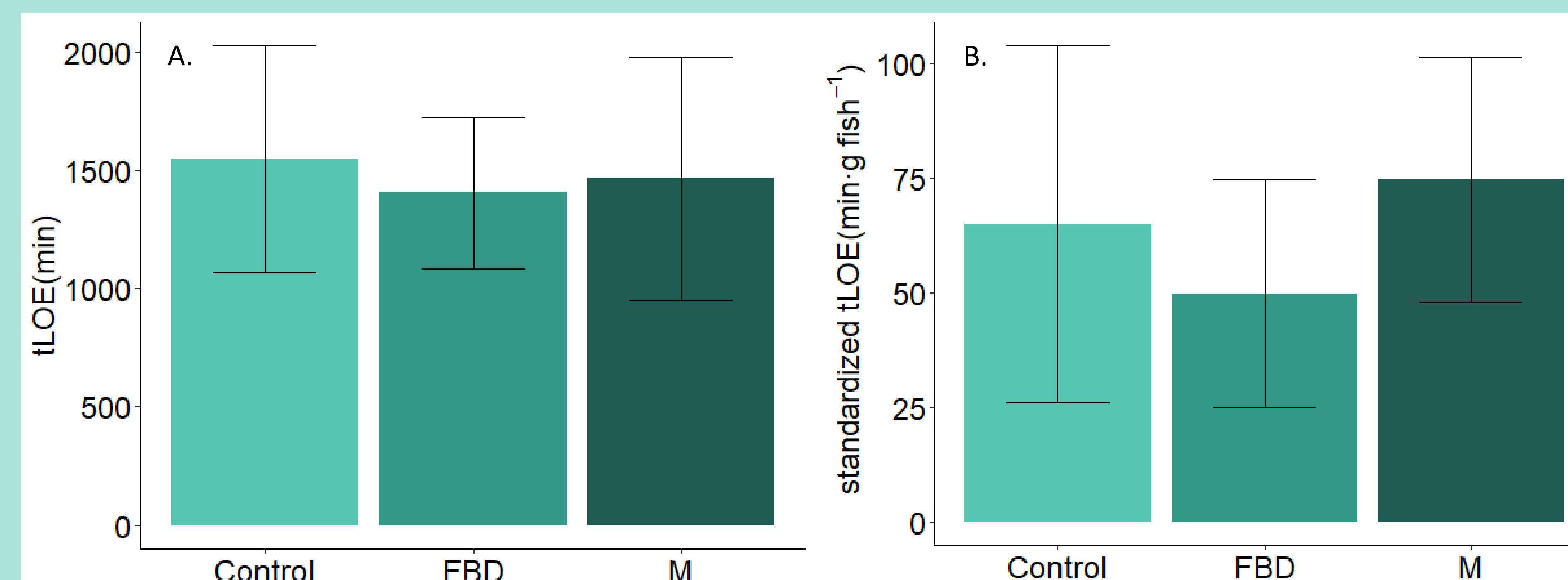


Figure 4. Bar graphs comparing mean \pm standard deviation of A) tLOE and B) weight standardized tLOE in control, FBD-, and M-treated toadfish. There was no significant difference in tLOE between control and treatment groups ($p=0.74$). No comparisons of tLOE with standardized weight were significantly different ($p=0.24$).

Discussion

Hypothesis 1 was supported

- Toadfish are more hypoxia tolerant independent of size
- tLOE presents the toadfish as being highly tolerant to hypoxic conditions
- Further investigation of the physiological mechanisms conferring hypoxia tolerance in both species is needed

Hypothesis 2 was not supported

- Hypothesized that the medications were metabolized during the trials
- A single intraperitoneal injection may not be sufficient in hindering the hypoxia responses mediated by 5-HT

Sheepshead minnow sex and weight investigation

- Average tLOE was lower than expected
- Fish were lab-reared while the previous study collected their fish from a tidal pond⁶
- Potential implications of using lab-reared versus wild-caught
- No change in hypoxia tolerance due to sex
- Likely a species-specific trait as other species exhibit superior hypoxia tolerance in one sex^{7,8}

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