

INTRODUCTION

- Hypoxia, as defined in an article published by the Federal Aviation Administration (FAA) is “the lack of sufficient oxygen in the blood, tissues, and/or cells to maintain normal physiological function” (n.d.).
- According to *the AirForce Times*, “400 physiological events between 2017 and 2022 involved “hypoxia-like” symptoms across seven airframes.” Some of these events have resulted in the death of the pilot.
- Females are gradually becoming a higher percentage in military aviation, and current research has suggested sex-related differences in areas which relate to aviation safety.
- The time of useful consciousness chart (TUC) (FAA, 2023) is used to determine the amount of time individuals have to logically respond to hypoxic events. The validity of this chart is questioned (Shaw et al., 2021) and currently does not account for individual factors such as age or sex.

PURPOSE

- The purpose of this study is to examine sex-related differences in reaction time during hypoxic hypoxia in university students.
- It is hypothesized that females will exhibit both longer reaction times and a more rapid increase in reaction times during hypoxic states when compared to males.
- This hypothesis is supported by current research which has shown when comparing sexes, longer female normoxic reaction times (Ghisletta et al, 2018; Lotfi et al, 2020) and a greater decline in both physiological and cognitive response to hypoxic hypoxia in females (Archiza et al., 2021; Rice et al., 2019b).

METHODS

- Subject height and weight were assessed and recorded by the primary investigator (Table 1).
- One familiarization trial consisting of a test during normoxic states with the reduced oxygen breathing device (ROBD) set to 1200 MSL (FO₂ 20.0% ± 0.6) and completion of one simple reaction time test.
- The simple reaction time test consisted of subjects responding to a fixed position visual stimulus (a blue circle) appearing at randomized intervals on the computer screen. Reaction times were recorded from the moment the visual stimulus was presented to the time they clicked on the mousepad to respond..
- A pulse oximeter was worn during the test and values were recorded and confirmed with normal values. After the familiarization trial, participants were provided with a 15-minute rest period before beginning the testing trial. During the rest period, the subject was allowed to remain seated without the mask and pulse oximeter.
- Following the rest period, subjects were fitted again with the pulse oximeter and ROBD (Figure 1). The ROBD was set for oxygen levels of 12,000 MSL (13.2 ± .6 %) according to the manufacturer's directions (*Higher Peak*, 2020).
- At the 10-minute mark, oxygen saturation levels were recorded, and subjects performed one simple reaction time test consisting of 10 visual stimuli randomly appearing at various intervals. Subjects repeated the same testing at each of the following times: 20 minutes, 30 minutes, and 40 minutes.
- If at any point, the pulse oximeter indicated dangerous values (below 70%), or the subject showed visual signs of extreme fatigue, or verbalized they felt unsafe continuing, the testing trial was immediately terminated and conducted again after 24 hours of recovery.
- After testing, a post-test hypoxic symptoms form was given to assess current presence and degree of severity of general hypoxic symptoms: headache, dizziness/nausea, and blurred vision. Level of oxygen saturation, rate of perceived exertion, and heart rate were also recorded on the form.

Figure 1

Normobaric Hypoxic Testing Environment



Table 1

Subject Information

	Female (n = 10)	Male (n = 10)	Total (n = 20)
Height (cm)	166.12 ± 8.90	177.80 ± 10.23	171.96 ± 11.09
Weight (kg)	64.18 ± 13.17	86.98 ± 15.65	75.56 ± 18.30
Age (years)	21.30 ± 0.82	21.10 ± 1.10	21.20 ± 0.95

Table 2

Mean and Standard Deviations for Reaction Time between Sexes

	Trial 1 (10 minutes)	Trial 2 (20 minutes)	Trial 3 (30 minutes)	Trial 4 (40 minutes)
Females	0.3632 ± 0.05	0.3535 ± 0.06	0.3730 ± 0.07	0.3555 ± 0.06
Males	0.3288 ± 0.04	0.3240 ± 0.04	0.3289 ± 0.04	0.3296 ± 0.05

RESULTS

- For the Shapiro-Wilk Test, the assumption of normalcy was violated for trial three at $p = 0.008$ and trial four at $p = 0.047$. This violation was ignored in statistical analysis due to this test's sensitivity to low sample sizes" (de Souza et al., 2023). Levene's Test confirmed the assumption of equal variance (trial 1: $p = 0.371$, trial 2: $p = 0.194$, trial 3: $p = 0.210$, trial 4: $p = 0.476$).
- A repeated measures ANOVA revealed no significant difference in reaction time between male or female with $p = 0.144$. A non-significant 0.0334 second difference between male and female groups was observed. Reaction times for both groups are reported in table 2.
- No significant increase in reaction time between trials for within groups was observed. There was a non-significant increase in average reaction time between trials 2 and 4 at 0.0056 seconds for males, and between trials 2 and 3 at 0.0195 seconds for females. This trend was not consistent, as between trials 3 and 4, the female reaction time decreased by 0.0175 seconds while male reaction times increased.

CONCLUSIONS

The present study serves as a foundation for future research and indicates the need for greater control of variables and sample size when investigating sex-related differences during hypoxic hypoxia. These variables include:

- Control for female menstruation and sleep history due to the effects these variables have been shown to have on reaction time.
- Increase familiarization trials before testing to negate potential changes in reaction time during testing because of subjects' lack of familiarization with test.

PRACTICAL APPLICATION

- Future research should incorporate physical fitness testing due to the known interaction between this variable and both sex and hypoxic performance (Hunter et al., 2023; Koons et al, 2019; Kim et al., 2023).
- Study findings are not without value as the observed non-significant trends indicate the need for further investigation of this topic.

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