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# Normobaric Hypoxia as a Cognitive Stress Test for Mild Traumatic Brain Injury: Oculometrics, Pulse Oximetry, and the Self-Report of Symptom Severity

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The present report describes research assessing the effects mild hypoxia has on individuals with a medical history of mild traumatic brain injury (mTBI). The research tests the hypothesis that individuals who have a history of mTBI but who are asymptomatic may have latent deficits that become apparent in the presence of relatively minor physiological stressors routinely encountered by military personnel or by civilians during normal daily activities. The research used a minor, altitude-referenced hypoxic challenge as a prototypical physiological stressor. The present report describes the methodology used to generate the hypoxic challenge as well as the experimental design and procedures. Two groups of 36 subjects were studied; one group with a history of mTBI and one group with no such history. The report describes the characteristics of the study volunteers who were matched on the basis of such variables as age, gender, body mass index, and smoking behavior. The response parameters included oculometric, pulse rate, pulse oximetry, a self-report inventory of subjective symptoms, and neurocognitive assessments.

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The present report provides an extensive tabulation of the oculometric, pulse rate, pulse oximetry and inventory of subjective symptoms data as well as statistical summaries of these data and initial analyses. These initial analyses suggest that the oculometric instrumentation used in this study was insufficiently sensitive to expected differences whereas the pulse rate, pulse oximetry, and symptom severity data warrant further detailed analysis. A separate report addresses the neurocognitive assessments.

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## Introduction

The present report describes research assessing the effects mild hypoxia has on individuals with a medical history of mild traumatic brain injury (mTBI). The research was designed to test the hypothesis that individuals who have experienced an mTBI but are asymptomatic may have covert deficits revealed only in the presence of physiological stressors that may be relatively minor and routinely encountered by military personnel or by civilians during their daily activities. The present study uses a minor hypoxic challenge as a prototypical physiological stressor. The response metrics of the research included self-reports of subjective symptoms, oculometrics, pulse rate, pulse oximetry, and neurocognitive assessments. The present report describes the methodology used to generate the hypoxic challenge as well as the experimental design and procedures, and the characteristics of the subject volunteers. It also presents the results of the reports of subjective symptoms, oculometrics, pulse rate, and pulse oximetry; a separate, companion report in preparation will address the neurocognitive aspects of the study.

## Background

### Mild Traumatic Brain Injury Overview

There are numerous definitions and classification schemes for mTBI. Incidence and prevalence estimates can vary enormously, some based on hospital admissions for mTBI, while others assume that most mTBI cases never reach the hospital and therefore remain undocumented. An additional complication is semantic, the confusion between the terms *mTBI* and *concussion*, which are often used interchangeably with little formal or official distinction other than the tendency to use concussion to refer to the milder end of a continuum of brain trauma.

In the absence of uniform definitions for mTBI, and in light of the variety of classification criteria and prevalence data, we primarily rely on three sources to define, describe, and characterize mTBI; sources that reflect an emphasis on the concerns of military and veterans. These sources are; firstly, the Veterans Administration (Veteran's Health Initiative, Department of Veterans Affairs [Veteran's Health Initiative Department of Veterans Affairs, VA], 2004); secondly, the VA/Department of Defense (DoD) Clinical Practice Guideline for Management of Concussion/mTBI (The Management of Concussion/mTBI Working Group, 2009); and lastly, the Centers for Disease Control and Prevention (CDC) (CDC, 2010).

a. The VA provides a traumatic brain injury (TBI) Independent Study Course through the VA Employee Education System (Veteran's Health Initiative, VA, 2004), planned and implemented in accordance with Accreditation Council for Continuing Medical Education standards for the independent study of mTBI for VA clinicians and other interested VA staff. According to this training document, approximately 80% of the patients who sustain a TBI have previously had an mTBI. The course material references the idea that an mTBI injury triggers a pathological neurochemical cascade that is insufficient to produce widespread neuronal dysfunction or axonal disruption characteristic of more severe brain injuries. For a formal definition of mTBI, the course

refers to the definition provided by the American Congress of Rehabilitation Medicine, summarizing it as:

1. Traumatically induced physiologic disruption of brain function as indicated by at least one of the following:

    A. Any period of loss of consciousness

    B. Any loss of memory for events immediately before or after the accident

    C. Any alteration in mental state at the time of the accident

    D. Focal neurologic deficits that may or may not be transient

2. Severity of the injury does not exceed:

    A. Loss of consciousness of 30 minutes (min)

    B. GCS* score of 13 to 15 after 30 min

    C. Post-traumatic amnesia of 24 hours (hr)

*The GCS referred to in this definition is the Glasgow Coma Score (Kraus & Chu, 2005), which is a 15-point scale based on the ranges of the patient's best eye opening, motor, and verbal responses. See Table 1 for more information about the GCS.

*Table 1*. Glasgow Coma Score

| Responses | Score |
|---|---|
| **Motor** | |
| **Obeys commands** | **6** |
| **Localizing responses to pain** | **5** |
| **Generalized withdrawal to pain** | **4** |
| **Flexor posturing to pain** | **3** |
| **Extensor posturing to pain** | **2** |
| **No motor response to pain** | **1** |
| | |
| **Verbal** | |
| **Oriented** | **5** |
| **Confused conversation** | **4** |
| **Inappropriate speech** | **3** |
| **Incomprehensible speech** | **2** |
| **No Speech** | **1** |
| | |
| **Eye** | |
| **Spontaneous eye opening** | **4** |
| **Eye opening to speech** | **3** |
| **Eye opening to pain** | **2** |
| **No eye opening** | **1** |
| | |
| **Total (sum of motor, verbal, and eye scores)** | _____ |

The definition provided by the VA training subsumes the spectrum of mild injuries typically referred to as concussion, explicitly extends into the mild range of TBI, and makes no reference to neuroimaging.

b. The VA/DoD Clinical Practice Guideline (The Management of Concussion/mTBI Working Group, 2009) recommends a flow-chart decision tree in which the initial determination is made that the individual presents with a head trauma resulting in alteration or loss of consciousness. Explicitly listed possible causes of the head trauma are blast or explosion, head striking or being struck by an object, and head undergoing acceleration or deceleration as may occur in a motor accident or during a fall. Following this determination and the proper referrals for emergency evaluation and treatment, the determination for concussion/mTBI is made based on the reported history. The specific criteria for concussion/mTBI include:

- Loss or a decreased level of consciousness for less than 30 min;
- Loss of memory for events immediately up to a one day after the injury;

- Alteration of consciousness/mental state for 0 to 24 hr after the injury;

- Normal structural imaging; and

- Glasgow Coma Scale score of 13 to 15 (best value determined within the first 24 hr, if available).

The VA/DoD Clinical Practice Guideline summarizes the post concussive/mTBI related symptoms that develop within 30 days of trauma as falling into the three following categories.

- Physical symptoms that include: headache, dizziness, balance disorders, nausea, fatigue, sleep disturbance, fuzzy or blurred vision, sensitivity to light, hearing difficulties/loss, sensitivity to noise, seizure, transient neurological abnormalities, and numbness tingling.

- Cognitive symptoms that include effects on: attention, concentration, memory, speed of processing, judgment, and executive control.

- Behavior/emotional symptoms that include: depression, anxiety, agitation, irritability, impulsivity, and aggression.

c. It is noteworthy that the CDC (2010) provides a listing of symptoms of concussion/mTBI that are essentially identical with the symptoms presented in the VA/DoD Clinical Practice Guideline. This CDC listing includes:

- Physical symptoms that include: headache, nausea or vomiting, balance problems, dizziness, fuzzy or blurry vision, feeling tired, having no energy, or sensitivity to light or noise;

- Symptoms effecting thinking and remembering, which include: difficulty thinking clearly, feeling slowed down, difficulty concentrating, or difficulty remembering;

- Mood and emotion related symptoms, which include: irritability, sadness, more emotional, nervousness, or anxiety; and

- Sleep disturbances, including sleeping more or less than usual and trouble falling to sleep.

To this, the CDC adds that the disturbance of brain function is typically associated with normal structural neuroimaging findings. The CDC estimates that about 1.7 million people sustain a TBI annually, with 275,000 resulting in hospitalization, 1,365,000 emergency room visits, and "about 75% of the TBIs that occur each year are concussions or some other form of mild TBI" (CDC, 2010).

Visual symptoms figure prominently in the CDC and VA/DoD discussion of TBI symptoms. The effects of TBI on the visual system is an active area of scientific research, in part due to the well-established connections among visual functions and capabilities (i.e., psychophysics), visual neurophysiology, and the known neuroanatomy of the visual system, which create the possibility that the visual system can provide a sensitive basis for the selective assessment of neurotrauma in any of the many regions of the brain known to be essential for specific functions that together comprise normal vision. One area of current research on the disruptive effects that mTBI has on vision involve eye movements, which include aspects of the coordination of the motion of the two eyes, which are essential for binocular vision. Another area of research addresses the behavior of the eyes' pupils, which are under the control of the autonomic nervous system, and has long been used as a sensitive diagnostic sign of the status of the sympathetic and parasympathetic systems. Assessments of eye movements and pupillometry are frequently referred collectively as oculometrics, which has been developed as a tool to assess the fitness for duty of personnel.

## Hypoxia and Mild Traumatic Brain Injury

The present research was motivated in part by a serendipitous observation made during previous research assessing the effects of hypoxia on simulated flight performance (Temme, Still, & Acromite, 2009; Temme, Still, & Acromite, 2010). In that study, 35 Navy, Marine, or Air Force instructor pilots executed a highly demanding flight task in a research grade, desk-top flight simulator while each of the aviator subjects breathed an oxygen partial pressure approximately equivalent to 18,000 feet (ft) (10.5% $O_2$) for 18 min. Consequently, these subjects were hypoxic in that their blood oxygen concentration was less than the blood oxygen concentration at sea level. While breathing 18,000 ft-equivalent air, the precision of the flight performance deteriorated; however, more germane to the present study is the observation that one pilot was a unique outlier. Specifically, his performance was so variable he lost control of the aircraft, although at sea level he was completely competent and his flight performance was indistinguishable from that of his peers. A subsequent interview with the pilot revealed that he was something of a hero among the group of aviators because he had the unique distinction among his squadron peers of having ejected at high speeds from a jet during a mishap; but during the ejection he lost consciousness. This event occurred more than a year prior to the study. The pilot was completely asymptomatic and returned to flight status long before his participation in this study. This anecdotal case suggested that mTBI effects may persist in individuals who are asymptomatic at sea level. This idea suggests further that at least some of these individuals who are asymptomatic at sea level may evidence reversible mTBI deficits when challenged by hypoxia.

There is an early experiment supporting this hypothesis (Ewing, McCarthy, Gronwall, & Wrightson, 1980). A group of 10 university students who experienced minor head injury 1 to 3 years prior to the study were exposed for 30 min to 3,800 meter (m) (about 12,500 ft) altitude in a low pressure chamber. Ten age and gender matched control subjects with no history of head injury were also exposed to the identical altitude stress. None of the subjects in the experimental group were symptomatic at sea level; however, at altitude, there were clear deficits in short term memory and judgment as reflected by a more lax response bias (likelihood of selecting the same wrong option over other options) in a signal detection task. This detection task permitted the

differentiation of response bias from sensitivity (accuracy of responses), which was not affected by the altitude stress. In other words, those with a minor head injury were equally as accurate as the healthy controls; however, when the experimental group made a mistake it was a consistent selection of the same wrong option while the control group's errors were randomly distributed among options. Some effects were apparent within 10 min of altitude exposure. These effects were reversible, disappearing when the subjects were returned to sea level. This early report seems to provide solid support for the ideas underlying this study: individuals with a history of mTBI may be particularly susceptible to the effects of mild or moderate hypoxia and possibly other physiological stressors. It should be noted that civilians as well as military personnel may be exposed to these provocative levels of hypoxia over the course of their normal daily activities.

## Hypoxia Exposure in Civilian and Military Aviation

### Civilian exposure to hypoxia in aviation.

Hypoxia is a physiological stressor encountered in daily life far more frequently than is commonly realized. Contrary to popular assumptions, United States commercial airline carriers do not pressurize passenger cabins to sea level. Instead, the FAA requires the cabin pressure to be no higher than 8,000 ft above sea level. The National Research Council commissioned two studies involving aspects of commercial flight addressing issues which could adversely impact passenger and crew health and safety (National Research Council, 1986; National Research Council, 2002). Both of these studies concluded that current standards of cabin pressure provide adequate oxygenation for healthy persons, but raised questions for individuals with cardiac, pulmonary, or hematological diseases; the studies did not consider mTBI.

A recent study showed that mean arterial oxygen saturation fell from 97.0% blood oxygen at preflight to 88.6% at altitude during 22 regularly scheduled commercial flights (Cottrell, Lebovitz, Fennel, & Kohn, 1995). These measurements were made in 42 aircrew, not passengers; presumably, the mean arterial oxygen saturation in the passengers would be, if anything, lower since they represent a sample of less homogeneously healthy individuals.

A recent meta-analysis of the available literature developed a set of regression models to predict arterial oxygen in commercial aircraft cabins (Muhm, 2004). The model demonstrated that sea level arterial partial pressure of oxygen ($P_aO_2$) decreases with age in individuals with normal pulmonary function. More germane to present concerns is the observation that $P_aO_2$ at sea level predicted $P_aO_2$ at altitude. This meta-analysis report concluded that "a substantial proportion of passengers may experience moderately severe hypoxia at a cabin altitude of 8,000 ft" (p. 911). The study pointed out:

> …the levels of hypoxia that this study predicts will be manifest between 6,000 and 8,000 ft may be symptomatic. Acute mountain sickness, manifest by headache, nausea, loss of appetite, fatigue, and sleep disturbance – symptoms not uncommon among passengers during or shortly after flight – has been reported within 48 h of arrival at altitudes as low as 6,300 ft (p. 911).

These ideas were evaluated in a recent study of over 500 volunteers participating in an altitude chamber flight lasting 20 hr. During the study, arterial oxygen saturation and acute mountain sickness symptoms were measured at several altitudes using a between-subjects experimental design (Muhm, Rock, McMullin, Jones, Eilers, & McMullen, 2007). At 8,000 ft, mean oxygen saturation decreased about 4.4% from baseline (with a 95% confidence interval [CI] of about 1.0), a change that may not seem meaningful; however, from the published Box and Whisker plots, it is clear that during the 20 hr flight, several of the subjects had oxygen saturations between 80% and 85% during the 20 hr flight. The participation of one (elderly) individual at 8,000 ft was terminated after 5 hr when her oxygen saturation decreased to 78%.

The above studies assessed presumably normal civilian volunteers encountering the atmospheric equivalents to the cabins of commercial airline carriers. Other general aviation environments are more extreme. The Federal Aviation Administration (FAA) permits civilian private pilots to fly at a range of substantially higher altitudes without supplemental oxygen. According to the Federal Aviation Regulations 91.211:

No person may operate a civilian aircraft of U.S. registry –

1. At cabin pressure altitudes above 12,500 ft Mean Sea Level (MSL) up to and including 14,000 ft unless the required aircrew is provided with and uses supplemental oxygen for that part of the flight at those altitudes that is of more than 30 min of duration;

2. At cabin pressure altitudes above 14,000 ft (MSL) unless the required minimum flight crew is provided with and uses supplemental oxygen during the entire flight time at these altitudes; and

3. At cabin pressure altitudes above 15,000 ft (MSL) unless each occupant of the aircraft is provided with supplemental oxygen (Department of Transportation, 2000).

According to these FAA regulations, private civilian pilots and their passengers can have unlimited exposure to 12,500 ft MSL with apparently no anticipated impact on health and no anticipated performance decrement that would jeopardize the pilot's ability to control the aircraft. Furthermore, exposing the required minimum flight crew to 14,000 ft MSL for less than 30 min would not impact health or jeopardize flight control. Civilian passengers who are not considered part of the minimum flight crew can have unlimited exposure up to 15,000 ft MSL. None of these regulations consider the possible impact of altitude-related hypoxic exposure on those with a history of mTBI.

**Military exposure to hypoxia in aviation.**

Military standards of altitude exposure differ among the Services. The crews of U.S. Army rotary-wing aircraft on operations around the world may be repeatedly exposed to altitude (up to 18,000 ft) and, although these personnel receive periodic hypoxia training, hypoxic events and mishaps do occur (Ramiccio, 1998). The current flight regulation, AR 95-1 (Department of the Army, 2014), lists in section 8-7 the following requirements for flight at altitude:

Approved oxygen systems will be used as follows:

a. Unpressurized Aircraft. Oxygen will be used by aircraft crews and occupants for flights as shown below:

1. Aircraft crews.

   a. On flights above 10,000 ft pressure altitude for more than one hr.

   b. On flights above 12,000 ft pressure altitude for more than 30 min.

2. Aircraft crews and all other occupants.

   a. On flights above 14,000 ft pressure altitude for any period of time.

   b. For flights above 18,000 ft pressure altitude, oxygen prebreathing will be accomplished by aircrew members. Prebreathing may utilize either 100% gaseous aviator's oxygen from a high pressure source, or an onboard oxygen generating system (OBOGS) that supplies at least 90% oxygen in the inspired gas. Prebreathing will be for not less than 30 minutes at ground level and will continue while en route to altitude. In those extraordinary cases where mission requirements dictate rapid ascent, commanders may authorize shorter prebreathing times on a case-by-case basis, with the realization that such practice increases the risk for developing altitude decompression illness. Return to normal oxygen (pressure demand regulator, gaseous oxygen-equipped aircraft) is authorized on descent below 18,000 ft pressure altitude, provided continued flight will not exceed this altitude (Department of the Army, 2014).

The Navy has different regulations, which are contained in OPNAVINST 3710.7T:

> In unpressurized aircraft, the pilot at the controls shall use supplemental oxygen continuously when cabin altitude exceeds 10,000 ft. When oxygen is not available to other occupants, flight between 10,000 and 13,000 ft shall not exceed 3 hr duration, and flight above 13,000 is prohibited (Department of the Navy, 2004).

Specific unpressurized military aircrafts can provide occupant exposures to the altitudes that exceed those named in standards above. The operational environment posed by the Chinook, a nonpressurized Army helicopter with an operating ceiling of up to about 18,500 ft is relevant. Forces may be exposed to hypoxic conditions and the type of supplemental oxygen available depends on the unit and the operations. It may be noted that Army forces transported by the Chinook may have little if any prior experience or formal training concerning the symptoms of hypoxia. The V-22 Osprey, which provides the U.S. Marine Corps and Air Force with the ability to conduct assault support and long-range, high-speed missions requiring vertical take-off and landing capabilities, may pose even more severe challenges since the aircraft's service ceiling is 26,000 ft; and like the Chinook, the cabin is not pressurized. This means that personnel in the cabin are exposed to severe environmental conditions, including the potential for altitude hypoxia (Department of Defense, 2001).

While the Army and Navy regulations and guidance described above provide limits for safe operations of the aircraft, it remains to be seen how these will be implemented when tactical and operational realities of theatre come into play where air speed, fuel, and range considerations may force higher altitude operations. Apparently neither the military nor civilian altitude standards considered the impact of hypoxia on individuals with a history of mTBI, the basic question of the present research.

## Methods

### Human Subject Volunteers

Two groups of subjects participated in the present study. One group, the experimental group, consisted of individuals with a history of mTBI. The second group, the control group, consisted of individuals with no such history. Each group contained 36 subjects equaling a total of 72 subjects participated in the present study.

The study was performed at Clinvest Research, Springfield, MO, U.S.A., following review and approval by the Chesapeake Institutional Review Board, the U.S. Army Aeromedical Research Laboratory Human Use Committee, and the U.S. Army Medical Research and Materiel Command Human Subjects Research Review Board. The study was conducted in accordance with all Federal laws, regulations, and standards of practice as well as those of the Department of Defense and U.S. Army. The study was determined to pose a greater than minimal risk to the subjects and included several risk mitigation techniques. One such technique was to present the normobaric hypoxic stress conditions in an ascending sequence of severity so that each subject was observed at a lower stress condition before being exposed to a greater stress.

For inclusion into the mTBI group, subjects met the following criteria, which follow closely the criteria of American Congress of Rehabilitation Medicine (McAllister, 2005):

1. a duration of a loss of consciousness of no more than 10 min at the time of the TBI;

2. a duration of post traumatic amnesia of no more than 24 hr;

3. a Glasgow Coma Scale of from 13 to 15 (Kraus & Chu, 2005); and

4. a clinical history consistent with the diagnosis of mTBI.

All volunteers were paid for travel expenses to and from the study site, up to $50 per visit. In addition, an honorarium of $100 was provided for the completion of the data collection session.

The two groups were explicitly matched on the basis of age, gender, and smoking behavior (0 to 9 cigarettes a day and greater than 10 cigarettes a day). Each member of the matched pair of mTBI and control subjects was tested within a week of each other to minimize possible inadvertent differences due to drift in instrumentation or methodology. Appendix A tabulates the

age, gender, pulse rate, systolic and diastolic blood pressures, weight, height, and body mass index for each member of the mTBI group. Appendix B tabulates the same information for each member of the control group. Table 2 provides the mean and standard deviation for these parameters (with the exception of gender) for each group. It is noted that each group contained 9 women and 27 men. An analysis of variance showed that the mTBI and control groups did not differ statistically along the dimensions of age, pulse rate, systolic and diastolic blood pressures, respiration rate, weight, height, and body mass index. The probabilities for these comparisons ranged between .817 to .180.

*Table 2*. Summary of the Characteristics of the Mild Traumatic Brain Injury and Control Groups.

| Parameter | Group | *M* | *SD* | *N* |
|---|---|---|---|---|
| Age (years) | mTBI | 25.25 | 5.416 | 36 |
| | Control | 24.89 | 4.944 | 36 |
| | Total | 25.07 | 5.152 | 72 |
| Pulse (beats/minute) | mTBI | 70.81 | 11.573 | 36 |
| | Control | 72.72 | 14.232 | 36 |
| | Total | 71.76 | 12.915 | 72 |
| Systolic (mmHg) | mTBI | 120.14 | 14.79 | 36 |
| | Control | 120.94 | 14.617 | 36 |
| | Total | 120.54 | 14.606 | 72 |
| Diastolic (mmHg) | mTBI | 73.89 | 9.789 | 36 |
| | Control | 73.36 | 7.783 | 36 |
| | Total | 73.62 | 8.784 | 72 |
| Respiration (breaths/sec) | mTBI | 14.17 | 4.178 | 36 |
| | Control | 16.92 | 11.453 | 36 |
| | Total | 15.54 | 8.671 | 72 |
| Weight (lbs) | mTBI | 200.06 | 64.885 | 36 |
| | Control | 210.99 | 85.63 | 36 |
| | Total | 205.52 | 75.633 | 72 |
| Height (inches) | mTBI | 69.5 | 4.3144 | 36 |
| | Control | 69.944 | 3.5572 | 36 |
| | Total | 69.722 | 3.9324 | 72 |
| Body Mass Index (BMI, $m/kg^2$) | mTBI | 28.325 | 7.8695 | 36 |
| | Control | 29.736 | 11.4912 | 36 |
| | Total | 29.031 | 9.8044 | 72 |

Appendix A includes three additional fields containing information pertinent only to the mTBI group: number of months since the trauma, if there was a loss of consciousness (LOC), and if there was post-traumatic amnesia. On average, the concussion occurred 37.8 ($SD$ = 33.1) months before participating in the present study, 19 resulted in a LOC, of which; 4 experienced a post-traumatic amnesia.

## Experimental Design

The present study was designed to support a between-groups comparison to evaluate the formal null hypothesis that there are no statistically significant differences between these individuals with a history of mTBI and those without such a history along the dimensions defined by the dependent variables. In addition to this between-group comparison, there is a within-group comparison in that the measurements were taken from under five conditions defined by the kind of air the subjects breathed during testing. Specifically, each subject breathed an air and nitrogen (N) mix designed to simulate the partial pressure of oxygen in the air that is encountered at five defined altitudes. The five altitude conditions were presented to every subject in the following sequence: (1) MSL (21% $O_2$), (2) 8,000 ft above MSL (15.5% $O_2$ + 84.5% N), (3) 12,000 ft above MSL (14% + 86%), (4) 14,000 ft above MSL (13% + 87%), and (5) MSL. Thus, the experimental design included a within-subject comparison, altitude, of which there were five levels.

Every subject was exposed to a MSL condition twice; once at the beginning and once at the end of the data collection. The MSL condition at the end was to ensure that there were no lingering effects of the hypoxic exposure on the subjects. The exact same altitude sequence was used for all subjects. Consequently, the design we used unavoidably confounded order effects with altitude effects. We chose this strategy for two reasons. First, subject safety; we did not know how individuals with a history of mTBI would respond to this hypoxic stressor. Although some consider the level of hypoxia posed even by a 14,000 ft above MSL altitude to be relatively minor for the normal general population, we thought it prudent to introduce the hypoxic challenge gradually. Secondly, we are more interested in whether any simulated altitude would produce evidence of lingering mTBI effects, rather than the specific impacts of specific altitudes. If such effects did show, then subsequent experimentation could target this second question. Thus, the confounding of order effects was of secondary importance for the purposes of the present study.

This study is a mixed-model experimental design in that it incorporates one between-group factor (experimental vs. control group) and one within-group factor (five levels of altitude). The response dimensions along which these comparisons were made are described below. To statistically evaluate group, altitude, and group by altitude differences two-way analyses of variance, with planned contract follow-up tests, were performed for each dependent variable. Alpha for all tests was held constant at .05. To demonstrate the magnitude of the group difference, effect sizes were determined and reported as *r* values with the interpretation ranges of .00 to .05 no effect, .10 to .23 small effect, .24 to .33 moderate effect, and greater than .34 large effect. Additionally, correlations among variables were determined (Cohen, 2013). Correlations of interest are presented in the results section and the correlation matrixes for all variables are provided in appendices G and H.

## Apparatus

The present study required three pieces of equipment, the Reduced Oxygen Breathing Device (ROBD), the Functional Impairment Tester (FIT), and a hand-held personal digital assistant (PDA). The ROBD was used to induce hypoxia in the volunteers, the FIT recorded oculometrics, and the PDA was used to administer the neurocognitive testing. Of these, only the ROBD and the FIT are discussed here; the PDA is described in a companion report that is in preparation and that will address neurocognitive testing.

### Reduced Oxygen Breathing Device.

The ROBD (Environics, Tollande, CT), a commercial, off-the-shelf device, is a portable, computerized, gas-blending instrument that produces normobaric hypoxia, hypoxia without changes in atmospheric pressure. Figure 1 shows the ROBD in the bottom right and the tanked gasses on the left. It uses thermal mass flow controllers (MFC) to mix breathable air and medical nitrogen to produce the equivalent atmospheric oxygen partial pressures for altitudes up to 34,000 ft. The MFCs are calibrated on a primary flow standard traceable to the National Institutes of Standards and Technology. The system is equipped with an emergency dump switch that, if needed, will instantaneously supply to subjects 100% oxygen (Temme et al., 2009; Temme et al., 2010; Sausen, Bower, Stiney, Feigl, Wartman, & Clark, 2003; Sausen et al., 2001).

Several features are built into the ROBD to prevent over pressurization of the mask and to prevent partial pressures of oxygen below those being requested for a particular altitude. Additionally, built-in self-tests verify all system component functionality before the operation of the system can begin. If any self-test fails, the system does not operate. The ROBD also includes a built-in pulse oximeter sensor that can be attached to the subject's index finder or to the earlobe during device use.

*Figure 1.* The reduced oxygen breathing device and tanked gases used to generate normobaric hypoxia.

The ROBD was developed by the Naval Aerospace Medical Research Laboratory (NAMRL) and is now marketed commercially (Environics, Tollande, CT) for aviation training and for research purposes. The ROBD enables individuals to be safely made hypoxic, without

risk of barotrauma and decompression sickness under controlled conditions in such a way that these individuals can engage in the vision and performance-based testing procedures.

**Functional Impairment Tester.**

The FIT (PMI, Inc, Rockville, MD)is a commercial, off-the-shelf device designed to assess fitness for duty in an objective, quick, and efficient fashion using oculometrics as a sign of neurological changes caused by drugs, alcohol, sleepiness, or other neurological deficits that express themselves in the reflexive ocular motor responses of the eye (Rothberg, Cornsweet, & Rafal, 1995; LeDuc, Greig, & Dumond, 2005a; LeDuc, Greig, & Dumond, 2005b; Cymerman et al., 2003; Cymerman, Muza, Friedlander, Fulco, & Rock, 2005). Figure 2 is an image of the FIT testing apparatus.

*Figure 2.* Functional impairment tester used to evaluate eye movements.

## Dependent Variables and Response Measurements

The present report limits its discussion to the data derived from the ROBD, FIT, and the subject's subjective reports of the hypoxic symptoms. The companion report in preparation addresses the impact of hypoxia on the cognitive functions.

**Reduced Oxygen Breathing Device.**

The ROBD includes a pulse oximeter, which provides a display readout of the volunteer's pulse rate in beats per minute and percent hemoglobin oxygen concentration ($SpO_2$). These values were recorded by hand every minute during altitude exposures.

**Functional Impairment Tester.**

The FIT software automatically records pupil diameter in the dark, the latency of the pupil's response to a flash of light, the amplitude of that response, which is the difference between the diameter in the dark and the diameter in the light, and the saccadic velocity of the eye moving between a pair of alternately flashing lights. These four measurements are made one after the other, without any break and represent a complete trial requiring about 1 min to complete. The FIT makes these measurements using image analysis algorithms of reflections from the eye's optical surfaces. Completing these four measurements requires careful

cooperation of the volunteer so that sometimes the trial is aborted or incomplete in that not all four measurements were successfully made. The FIT database contained every trial, even the trials that were incomplete. Consequently, the FIT dataset includes a measure of the number of completed and incomplete trials as well as the specific oculometrics.

**Subjective reports of hypoxic symptoms.**

The subjective reports were measured using a paper and pencil questionnaire that assessed the level of agreement of the following statements:

1. I felt light headed.
2. I had a headache.
3. I felt dizzy.
4. I felt faint.
5. My vision was dim.
6. My coordination was off.
7. I felt weak.
8. I felt sick to my stomach (nauseous).
9. I lost my appetite.
10. I felt sick.
11. I felt hung-over.

For each of these brief simple declarative statements, the volunteer reported the extent to which the statement was accurate using the 6-point Likert rating scale with the options: 0 (*not at all*), 1 (*slight*), 2 (*somewhat*), 3 (*moderate*), 4 (*quite a bit*), 5 (*extreme*).

These response items were drawn from the literature reporting a standardized questionnaire developed to assess the symptoms associated with Environmental Stress Questionnaire (ESQ) (Muhm et al., 2007; Sampson, Cymerman, Burse, Maher, & Rock, 2005). This standardized questionnaire originally contained 68 items. The responses to this 68-item questionnaire were factor analyzed producing the following set of nine factors.

- Acute mountain sickness – cerebral (AMS – C): symptoms appear to reflect altered cerebral or cerebellar functioning in conjunction with malaise.

- Acute mountain sickness – respiratory (AMS – R): symptoms apparently indicate shortness of breath, and other mask issues.

- Ear, nose, and throat discomfort.

- Cold stress reflects the symptoms of cold feet, cold hands.

- A relatively generalized distress that includes mood as well.

- Alertness reflecting positive affective arousal states rather than factor 9, fatigue.

- Exertion stress, which was evident in those volunteers who were exercising during these studies.

- Muscular discomfort, a factor which reflects residual muscle fatigue from exercise.

- Fatigue, symptoms loading here are tired, sleepy, weak, faint, etc.

The 11 items that were used in the questionnaire for the present study were the items that comprised the AMS – C and the items reflecting cerebral and cerebellar issues. Of course, since the items used in the present study are isolated from the full questionnaire, we do not consider the responses to the 11 items recorded in the present study as a measure of the AMS – C factor that would be measured with the complete 68 item questionnaire.

In summary, the database we report includes the two measures from the ROBD (pulse rate and $SpO_2$), the four measures from the FIT (pupil diameter, pupil response latency, pupil response amplitude, saccadic velocity), including the number of incomplete FIT trials, the 11 subjective ESQ AMS – C responses, as well as the individual volunteer's physical parameters tabulated in Appendices A and B and summarized in Table 2.

**Procedures**

Subject recruitment flyers were placed in several locations throughout the local community where people with a history of head injury would likely see them. These locations included academic athletic departments, bicycle shops, fitness and health centers as well as such clubs and organizations as roller derby teams, rodeo clubs, rugby teams, ice hockey teams, and rock climbing groups. The posted announcements provided contact phone numbers.

During initial phone screening, the study and the inclusion criteria for participation were described. Specific additional exclusion criteria included pregnancy; history of drug or alcohol abuse; depression; bipolar disorder; schizophrenia; problems with the heart, kidney, or liver; asthma; strokes; mini-stroke; poor leg circulation; any ongoing medical problems; current or past neurological problems such as seizures, epilepsy or dementia; post-traumatic headache; current concentration and/or memory problems because of the head injury; LOC greater than 10 min at time of injury; and post-traumatic amnesia greater than 24 hr at time of injury.

For prospective mTBI subjects, appointments were arranged as soon as convenient following the phone screening. For prospective control subjects, names, demographics and contact information were filed so that these prospective subjects could be matched appropriately with mTBI subjects on the basis of age, gender, and smoking behavior.

After an appointment was scheduled, prospective subjects were told how much they would be compensated for their participation in the study; they were also asked to bring documentation of their injury for the study records, if appropriate. Also, if the prospective subjects wore contact lenses, the individual was told to wear glasses on the day of testing. The individual was told to abstain from any alcohol 12 hr before testing. A copy of the informed consent document (ICD) was mailed or e-mailed to the individual so the prospective subjects could review it at their convenience beforehand.

When the prospective subject arrived for testing, a hardcopy of the previously mailed ICD was provided. The consenting individual went through the ICD with the prospective subject. The consenting individual described the study in detail and answered any questions the prospective subject had in order to ensure that the individual understood all aspects of the experimental procedures and was fully informed and completely comfortable with all procedures. The prospective subject read the ICD, initialed the bottom of each page, and signed the document at the end. All procedures were documented with an ICD checklist. All subjects were given a copy of the ICD for their own records.

After the ICD was signed, a study intake form was completed, which documented such information as sitting blood pressure, heart rate, respiration, height, and weight. The inclusion/exclusion criteria were again reviewed to ensure consistency with the study. Female subjects provided a urine sample to test for pregnancy. The study physician reviewed this information and examined the subject to ensure compliance with all inclusion/exclusion criteria and that the individual was medically qualified to participate in the study. The physician also asked questions of the subject to ensure that the subject understood all procedures and to determine whether the subject had any history of altitude sickness or wheezing. Once the study physician was sure that the subject was healthy and qualified to participate, the physician signed the intake forms.

The subject was then introduced to the testing facility, including the test apparatus. The technician described the FIT and completed five trials with it to ensure the subject understood how it worked. If it took more than 10 attempts for the subject to complete five trials, the technician realigned the subject in the FIT and repeated the measurements.

The first three of these five FIT warm-up trials were completed without the subject being connected to the ROBD. For the last two FIT warm-up trials, the technician fitted the subject's finger with the pulse oximeter. The technician also fitted the ROBD mask (Gentex HyperMed Oxygen Mask) on the subject's face to introduce the individual to the task of making the FIT measurements with the mask. It may be noted there were four different sizes of masks from which the correct size mask was selected based on the size of the subject's face.

Once the mask was securely attached to the face, the technician had the subject close off both of the valves in the mask (one for inhalation and one for exhalation) to ensure that there was no leakage. If there was leakage or if the mask did not fit tightly or was uncomfortable, adjustments were made to fit the mask securely. On occasion a different size mask was substituted. The fifth and last FIT warm-up trial was conducted with the ROBD turned on but not connected to the mask so that the subject would know what noises to expect during testing. During these steps any questions the subject had about the ROBD and FIT were answered.

Once the subject was comfortable with the FIT, cognitive testing was introduced. During this familiarization process, the subject wore the mask and the pulse oximeter finger sensor so that the subject would become accustomed to them. After the subject reported being comfortable with all the testing procedures, the subject was encouraged to take a break before formal testing began.

Subjects were instructed to breathe normally and were watched to ensure that they did breathe normally to guard against hypocapnia. Every subject went through the same sequence of altitudes: MSL, 8,000 ft, 12,000 ft, 14,000 ft and MSL again. At the beginning of each altitude, the volunteer acclimated to that altitude for 1 min before beginning the following sequence of testing: (1) FIT test; (2) cognitive testing, results reported elsewhere; (3) ESQ subjective questionnaire; and (4) a second FIT test.

When this testing sequence was completed, the subject was returned to MSL and asked whether s/he wanted to take off the mask and take a break. If the subject opted for a break, the mask was removed and the airflow through the ROBD was turned off. When the subject was ready to continue, ROBD airflow was begun and the subject donned the mask and checked to make sure the seal was tight. If the subject opted to continue testing without a break, the volunteer rested at MSL for at least 1 minute before exposure to the next altitude. This procedure was repeated for each of the five altitudes.

After the subject completed the five altitudes, s/he removed the mask and remained under observation in the laboratory for at least 30 min to ensure that there were no signs of any after effects of the hypoxic exposures.

## Results

### Duration of Normobaric Hypoxic Exposures

The duration of the altitude (i.e., normobaric hypoxic exposures for each subject) was determined ultimately by the time each subject needed to complete the scheduled measurements at that altitude. Table 3 presents the average time, in minutes, needed to complete the measurements at each of the five altitude conditions for each of the two groups of subjects and for all subjects combined. Note that MSL-1 refers to the measurements made at sea level at the beginning of the data collection and MSL-2 refers to the measurements made at sea level at the end of the data collection. The column named *Total* refers to the duration of the whole data collection session, which included any rest breaks between tested altitudes, so that the total durations all are longer than the sum of the durations of the five altitudes.

*Table 3.* Mean Time (min) to Complete Measurements at Each Altitude Condition

| Group | Altitude | | | | | Total |
|---|---|---|---|---|---|---|
| | MSL-1 | 8,000 ft | 12,000 | 14,000 | MSL-2 | |
| mTBI | 14.11 | 13.7 | 14.2 | 13.9 | 13.9 | 84.7 |
| Control | 13.86 | 14.5 | 14.2 | 13.4 | 13.6 | 83.1 |
| Mean | 13.9 | 14.1 | 14.2 | 13.7 | 13.8 | 83.9 |

*Note.* The times in the *Total* column refer to the total duration of the data collection session, including rests and breaks between altitudes.

A mixed model analysis of variance (ANOVA) showed no significant differences among these durations. Thus, times needed to complete the measurements for each of the five altitude conditions were not significantly different nor were there significant differences between the two groups of subjects, and none of the interaction terms were significant. Consequently, the exposure times for the two groups were not statistically different.

## Reduced Oxygen Breathing Device Measurements

The ROBD produced two measures, $SpO_2$ and pulse rate. Appendix C tabulates these measurements for each of the mTBI subjects at each of the five altitudes and Appendix D tabulates these measurements for each of the control subjects at each of the five altitudes.

### Pulse oximetry: Percent blood oxygen

The $SpO_2$ for each altitude is presented in Table 4 separately for the mTBI and the control subjects. An ANOVA showed that the two groups of subjects differed significantly in their $SpO_2$, $F(1,70) = 13.247$, $p < .001$. With an $r = .399$, the effect size is conventionally considered to be moderate.

As expected, there was a main effect of altitude on $SpO_2$, $F(1.639,114.762) = 702.133$, $p < .001$, which, with an $r = .9271$, is quite large. More importantly, there was a significant interaction between group and altitude. Specifically, since Mauchly's test indicated that the main effect of altitude violated the assumption of sphericity ($\chi^2 = 299.616$, $p < .001$), the degrees of freedom (*df*) for the interaction ANOVA were corrected using Greenhouse-Geisser estimates ($\varepsilon = .410$) to produce $F(1.639,114.762) = 9.087$, $p < .001$, with an $r = .709$, a value generally taken to indicate a large effect. Contrasts were performed to examine further this interaction. Contrasts showed there were no statistical differences between the mTBI and control subjects at MSL-1 and MSL-2; however, with respect to the MSL-2 condition, the $SpO_2$ response of the mTBI subjects differed from the $SpO_2$ response of the control subjects at 8,000 ft ($p < .004$), $r = .333$; 12,000 ft ($p < .001$), $r = .403$; and 14,000 ft ($p < .003$), $r = .341$. The respective $r$ values show these differences to be of moderate statistical size. These comparisons are illustrated in Figure 3, which includes the 95% CI around the average $SpO_2$ for the mTBI and control groups.

*Table 4.* Mean Percent Hemoglobin Oxygen Concentration at Each Altitude Condition

| Group | Altitude | | | | |
|---|---|---|---|---|---|
| | MSL-1 | 8,000 ft | 12,000 | 14,000 | MSL-2 |
| mTBI | 97.05 | 93.58 | 88.49 | 85.12 | 97.09 |
| Control | 96.92 | 92.53 | 85.72 | 82.22 | 96.94 |
| Mean | 96.99 | 93.06 | 87.11 | 83.67 | 97.03 |

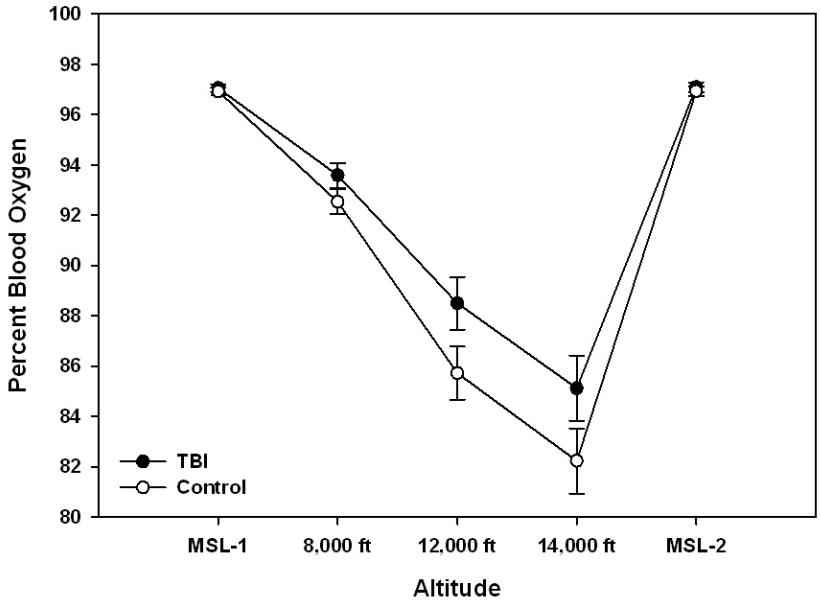


*Figure 3.* Average percent hemoglobin oxygen concentration as a function of the altitude condition for the mild traumatic brain injury (closed circles) and control (open circles). Error bars show the ±95% CI.

*Correlations*

Since each individual was exposed to five different altitude conditions; it is possible to question the extent to which the $SpO_2$ at one altitude predicts the $SpO_2$ at the other altitudes. To address this question, the Pearson product moment correlations of the $SpO_2$ measurements made at each of the five altitudes were correlated with each other. With five altitudes, there are ten possible altitude pairs and therefore ten correlations. This correlation matrix was calculated for the mTBI subjects and is presented in Table 5, while the matrix calculated for the control subjects is presented in Table 6.

*Table 5*. Pearson Product Moment Correlation Matrix of Percent Hemoglobin Oxygen Concentration for the Mild Traumatic Brain Injury Group at Each Altitude Condition ($n$ = 36).

| | | MSL-1 | 8,000 ft MSL | 12,000 ft MSL | 14,000 ft MSL | MSL-2 |
|---|---|---|---|---|---|---|
| MSL-1 | Pearson Correlation | 1 | 0.671 | 0.506 | 0.265 | 0.554 |
| | Significance | | 0.000 | 0.002 | 0.119 | 0.000 |
| 8,000 ft MSL | Pearson Correlation | | 1 | 0.845 | 0.685 | 0.563 |
| | Significance | | | 0.000 | 0.000 | 0.000 |
| 12,000 ft MSL | Pearson Correlation | | | 1 | 0.859 | 0.347 |
| | Significance | | | | 0.000 | 0.038 |
| 14,000 ft MSL | Pearson Correlation | | | | 1 | 0.182 |
| | Significance | | | | | 0.233 |
| MSL-2 | Pearson Correlation | | | | | 1 |
| | Significance | | | | | |

The matrices in Tables 5 and 6 can be used to compare further the responses of the two groups of subjects. Two of the correlations in Table 5 were not statistically significant (14,000 ft with the MSL-1 or with MSL-2) whereas four of the correlations in Table 6 were not statistically significant (MSL-1 and MSL-2 with 12,000 ft and with 14,000 ft). Furthermore, the average correlation for the mTBI group was .547 ($SD$ = .230) and the average correlation for the control group was .433 ($SD$ = .198), a difference that was statistically significant by $t$-test ($p < .001$) evaluation. These differences suggest that the $SpO_2$ under one altitude condition was more predictive of the $SpO_2$ under other altitude conditions for the mTBI subjects than for the control subjects. It may be noted further that there were only two correlations in Table 5 that were smaller than the corresponding correlations in Table 6. One of these correlations was the MSL-2 with 14,000 ft, which was not significant in either matrix. The other one of these two correlations was between MSL-1 with MSL-2.

*Table 6*. Pearson Product Moment Correlation Matrix of Percent Hemoglobin Oxygen Concentration for Control Group at Each Altitude Condition ($n$ = 36).

| | | MSL-1 | 8,000 ft MSL | 12,000 ft MSL | 14,000 ft MSL | MSL-2 |
|---|---|---|---|---|---|---|
| MSL-1 | Pearson Correlation | 1 | 0.480 | 0.211 | 0.154 | 0.580 |
| | Significance | | 0.003 | 0.216 | 0.369 | 0.000 |
| 8,000 ft MSL | Pearson Correlation | | 1 | 0.618 | 0.651 | 0.440 |
| | Significance | | | 0.000 | 0.000 | 0.007 |
| 12,000 ft MSL | Pearson Correlation | | | 1 | 0.668 | 0.322 |
| | Significance | | | | 0.000 | 0.055 |
| 14,000 ft MSL | Pearson Correlation | | | | 1 | 0.204 |
| | Significance | | | | | 0.233 |
| MSL-2 | Pearson Correlation | | | | | 1 |
| | Significance | | | | | |

**Pulse rate**

The average pulse rate in beats per minute (bpm) for each altitude is presented in Table 7 separately for the mTBI and the control subjects. These data are also shown in Figure 4, which includes the 95% CI around the average pulse rate for the mTBI and control groups. An ANOVA showed that the overall average pulse rate response of the mTBI (74.732 bpm) and the control subjects (78.77 bpm) did not differ statistically, $F(1,70) = 2.417$, $p < .125$. On the other hand, the five different altitude conditions did affect overall average pulse rate response, $F(2.323,162.584) = 142.519$, $p < .001$, but more importantly, the different altitude conditions had different effects on the pulse rate responses of the mTBI and the control subjects, an interaction effect that was examined in further detail. Specifically, since Mauchly's test indicated that the main effect of altitude violated the assumption of sphericity ($\chi^2 = 110.013$, $p < .001$), the *df* for the interaction ANOVA were corrected using Greenhouse-Geisser estimates ($\varepsilon = .581$) to produce an $F(2.323,162.584) = 3.752$, $p < .020$, with an $r = .150$, which indicated a significant but relatively modest interaction effect.

*Table 7*. Mean Pulse Rate of the Two Groups of Subjects Measured at Each Altitude Condition.

| Group | Altitude | | | | |
|---|---|---|---|---|---|
| | MSL-1 | 8,000 ft | 12,000 ft | 14000 ft | MSL-2 |
| mTBI | 73.72 | 75.6 | 77.11 | 78.04 | 69.18 |
| Control | 76.6 | 79.74 | 82.46 | 83.38 | 71.66 |
| Mean | 75.16 | 77.67 | 79.78 | 80.71 | 70.42 |

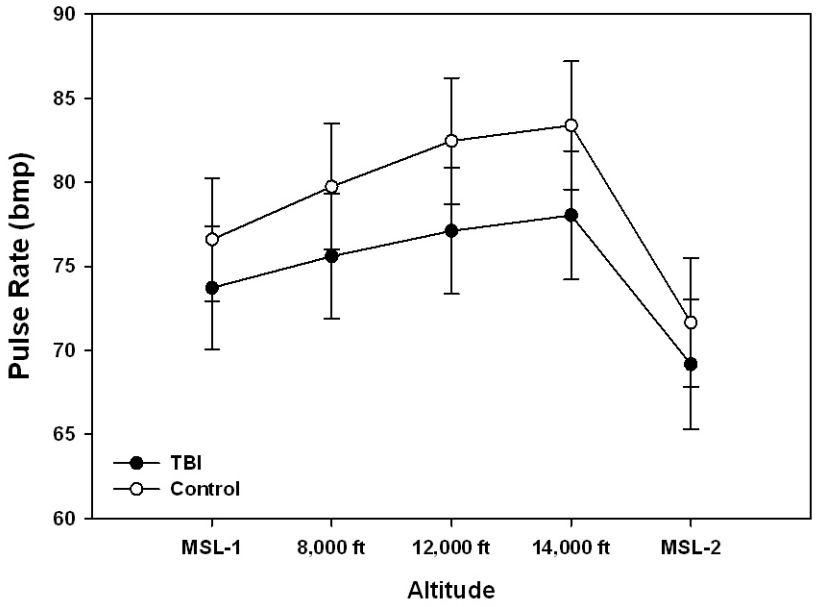


*Figure 4.* Mean pulse rate as a function of altitude for the mTBI (closed circles) and control (open circles). Error bars show the ±95% CI.

To examine further this interaction, contrasts were calculated comparing the pulse rate of the mTBI and control groups at different altitude, see Table 7. These contrasts showed that while there were statistically significant differences in pulse rate between the MSL-1 (75.16 bpm) and MSL-2 (70.42 bpm), $F(1,70) = 124.945$, $p < .001$, the difference between the mTBI and control subjects at MSL-1 (2.88 bpm) and MSL-2 (2.48 bpm) was not significant, $F(1,70) = .209$, $p < .649$. Similarly, the difference between the mTBI and control subjects at 8,000 ft (4.14 bpm) and MSL-2 (2.48 bpm) was not significant, $F(1,70) = 2.974$, $p < .089$. The situation was different at the 12,000 ft and 14,000 ft altitudes. The difference in pulse rate between the mTBI and control subjects at the 12,000 ft (5.35 bpm) and at MSL-2 (2.48 bpm) was significant, $F(1,70) = 5.381$, $p < .023$, $r = .267$ as was the difference between the groups at 14,000 ft, (5.43 bpm), $F(1,70) = 6.102$, $p < .016$, $r = .283$. Effect sizes were in the moderate range.

*Correlations*

Since each individual was exposed to five different altitude conditions; it is possible to question the extent to which pulse rate at one altitude predicts the pulse rate at the other altitudes. To address this question, the Pearson product moment correlations of the pulse rate measurements made at each of the five altitudes were correlated with each other. With five altitudes, there are 10 possible altitude pairs and therefore 10 correlations. This correlation matrix was calculated for the mTBI group; and is presented in Table 8 while the matrix calculated for the control subjects is presented in Table 9.

Together, the matrix in Tables 8 and 9 can be used to compare further the responses of the two groups of subjects. All ten correlations calculated for both the mTBI and the control

subjects (tables 8 and 9, respectively) were significant. The average of these ten correlations for the group of mTBI subjects was .932 (*SD* = .034). The average of these 10 correlations for the control subjects was .934 (*SD* = .028). There was no evidence of any systematic or statistically significant patterns of differences in correlations of Tables 8 and 9 as there was in Tables 5 and 6.

*Table 8*. Pearson Product Moment Correlation Matrix of Pulse Rate for Mild Traumatic Brain Injury Group at Each Altitude Condition (*n* = 36).

| | | MSL-1 | 8,000 ft MSL | 12,000 ft MSL | 14,000 ft MSL | MSL-2 |
|---|---|---|---|---|---|---|
| MSL-1 | Pearson Correlation | 1 | 0.974 | 0.899 | 0.892 | 0.957 |
| | Significance | | 0.000 | 0.000 | 0.000 | 0.000 |
| 8,000 ft MSL | Pearson Correlation | | 1 | 0.943 | 0.935 | 0.944 |
| | Significance | | | 0.000 | 0.000 | 0.000 |
| 12,000 ft MSL | Pearson Correlation | | | 1 | 0.981 | 0.892 |
| | Significance | | | | 0.000 | 0.000 |
| 14,000 ft MSL | Pearson Correlation | | | | 1 | 0.899 |
| | Significance | | | | | 0.000 |
| MSL-2 | Pearson Correlation | | | | | 1 |
| | Significance | | | | | |

*Table 9*. Pearson Product Moment Correlation Matrix of Pulse Rate for Control Group at Each Altitude Condition (n = 36).

| | | MSL-1 | 8,000 ft MSL | 12,000 ft MSL | 14,000 ft MSL | MSL-2 |
|---|---|---|---|---|---|---|
| MSL-1 | Pearson Correlation | 1 | 0.963 | 0.916 | 0.894 | 0.947 |
| | Significance | | 0.000 | 0.000 | 0.000 | 0.000 |
| 8,000 ft MSL | Pearson Correlation | | 1 | 0.971 | 0.942 | 0.933 |
| | Significance | | | 0.000 | 0.000 | 0.000 |
| 12,000 ft MSL | Pearson Correlation | | | 1 | 0.967 | 0.899 |
| | Significance | | | | 0.000 | 0.000 |
| 14,000 ft MSL | Pearson Correlation | | | | 1 | 0.915 |
| | Significance | | | | | 0.000 |
| MSL-2 | Pearson Correlation | | | | | 1 |
| | Significance | | | | | |

**Oculometrics, Functional Impairment Tester Measurements**

The FIT device measured ocular motility along four dimensions: pupil diameter, pupil response latency, pupil response amplitude, and saccadic velocity. These four oculometrics were recorded for each subject under each of the altitude conditions. Appendix E presents these oculometric measurements from the individual subjects in the mTBI group and Appendix F presents these oculometric measurements from the individual subjects in the control group for each of the five different altitude conditions. The means of the mTBI and the control group responses for the four response parameters over the five altitude conditions are listed in Table 10.

*Table 10*. Mean Responses of the Mild Traumatic Brain Injury and the Control Subjects for Each of the Four Oculometric Response Parameters at Each Altitude Condition.

| Response Parameter | Group | Altitude | | | | |
|---|---|---|---|---|---|---|
| | | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 |
| Pupil Diameter | mTBI | 5.425 | 5.289 | 5.171 | 5.083 | 5.189 |
| | Control | 5.873 | 5.681 | 5.589 | 5.433 | 5.665 |
| | Mean | 5.642 | 5.471 | 5.373 | 5.523 | 5.419 |
| Pupil Response Amplitude | mTBI | 1.134 | 1.126 | 1.094 | 1.062 | 1.113 |
| | Control | 1.194 | 1.143 | 1.109 | 1.063 | 1.159 |
| | Mean | 1.163 | 1.134 | 1.102 | 1.062 | 1.135 |
| Pupil Latency | mTBI | 299.98 | 298.28 | 301.27 | 299.85 | 303.02 |
| | Control | 294.23 | 293.71 | 295.24 | 293.57 | 294.44 |
| | Mean | 297.19 | 296.07 | 298.35 | 296.81 | 298.87 |
| Saccadic Velocity | mTBI | 74.25 | 72.47 | 72.96 | 72.06 | 71.67 |
| | Control | 72.32 | 73.64 | 71.99 | 71.01 | 71.02 |
| | Mean | 73.31 | 73.04 | 72.49 | 71.55 | 71.36 |

Multivariate statistical analysis showed that hypoxic stress significantly affected the oculometric responses, (Pillai's Trace, V = 0.636, $F(16,59) = 5.123$, $p < .001$); however there was no statistically significant evidence that the hypoxic stress affected the oculometric responses of the mTBI group differently than the control group (Pillai's Trace, V = 0.107, $F(4,59) = 1.761$, $p < .149$) nor was there any statistically significant evidence of an interaction between the two groups of volunteers and the hypoxic stress (Pillai's Trace, V = 0.270, $F(16,47) = 1.088$, $p < .392$). Consequently, for the statistical analysis of the effects of the hypoxic stress on the different oculometric responses, the responses of the two groups of volunteers are combined.

For these comparisons, Mauchly's test indicated that the assumption of sphericity was violated for pupil diameter ($\chi^2 = 30.850$, $df = 9$, $p < .001$), pupil response amplitude ($\chi^2 = 22.876$, df = 9, p < .001), and saccadic velocity ($\chi^2 = 17.053$, $df = 9$, $p < .048$), so Greenhouse-Geisser *df* corrections of 0.800, 0.847, and 0.886, respectively, were used for the univariate evaluation these response parameters. It should be noted that Mauchly's test showed no statistical evidence that pupil response latency violated the assumption of sphericity ($\chi^2 = 14.892$, $df = 9$, $p < .094$) so no Greenhouse-Geisser correction was used for evaluating the pupil response latency.

Hypoxic stress affected pupil diameter, $F(3.201, 198.4810) = 22.145$, $p < .001$, pupil response amplitude, $F(3.388, 210.028) = 10.134$, $p < .001$, and saccadic velocity, $F(3.544, 219.723) = 4.929$, $p < .001$; however, there was no evidence that the hypoxic stress altered the latency of the pupil response, $F(3.565, 221.006) = 1.291$, $p < .276$. Contrasts were calculated for pupil diameter, pupil response amplitude, and saccadic velocity in order to identify the hypoxic stress comparisons that were responsible for the significant differences. All contrasts were calculated with respect to the MSL-2 condition.

Concerning pupil diameter, the MSL-2 pupil diameter was 5.419 millimeters (mm), which was significantly smaller than the 5.642 mm pupil diameter measured at MSL-1, $F(1,62) = 20.620$, $p < .001$, but the MSL-2 pupil diameter of 5.419 mm was significantly larger than the 5.253 mm diameter pupil measured at 14,000 ft MSL, $F(1,62) = 13.564$, $p < .001$. The pupil diameters measured at the two other hypoxic stress conditions were not different from the MSL-2 comparison. These differences can be seen in Figure 5, which separately plots average pupil diameter and the 95% CI calculated for the mTBI and the control groups for each of the five altitude conditions. Although there are no statistically significant differences between the two subject groups, showing them separately in Figure 5 is informative, illustrating a statistically insignificant but consistent difference between the groups that may be worth further investigation.

Concerning pupil response amplitude, the MSL-2 amplitude was 1.135 mm, which was significantly larger than the 1.102 mm response amplitude measured 12,000 ft MSL, $F(1,62) = 4.578$, $p < .036$, as well as the 1.062 mm pupil response amplitude measured at 14,000 ft MSL, $F(1,62) = 19.086$, $p < .001$. The pupil response amplitudes measured at the other two hypoxic stress conditions were not different from the MSL-2 comparison. These differences can be seen in Figure 6, which plots average pupil response amplitude and the 95% CI calculated for the mTBI and the control groups separately for each of the five altitude conditions. Although there were no statistically significant differences between the two subject groups, showing them separately in Figure 6 is informative, possibly suggestive of a systematic albeit small and statistically insignificant difference between the groups that may be worth further investigation.

Concerning pupil response latency, as mentioned earlier, there were no statistical justifications for pursuing additional statistical comparisons, yet the data in Figure 7, plotting average pupil response latency and the 95% CI calculated for the mTBI and the control groups separately for each of the five altitude conditions are intriguing. Although there are no statistically significant differences between the two subject groups, showing them separately in Figure 7 is informative, illustrating a statistically insignificant but consistent difference between the groups that may be worth further investigation, a pattern consistent with the data in Figure 5.

Concerning saccadic velocity, the MSL-2 velocity was 71.36 degrees per second (deg/sec), which was significantly slower than the velocities of: 73.31 deg/sec recorded at the MSL-1, $F(1,62) = 8.539$, $p < .005$, and the 73.04 deg/sec velocity recorded at 8,000 ft MSL, $F(1,62) = 7.570$, $p < .008$. Neither the 72.49 deg/sec nor the 71.55 deg/sec velocities recorded respectively at 12,000 ft MSL, $F(1,62) = 3.756$, $p < .057$ and 14,000 ft MSL, $F(1,62) = 0.102$, $p < .751$, differed from the velocity recorded at MSL-2. The average saccadic velocity and the 95%

CI calculated for the mTBI and the control groups are plotted separately in Figure 8, which plots average pupil response amplitude, and the 95% CI calculated for the mTBI and the control groups separately for each of the five altitude conditions. Although there are no statistically significant differences between the two subject groups, the graph is informative; by itself, it shows little evidence for any consistent pattern of differences between the subject groups.

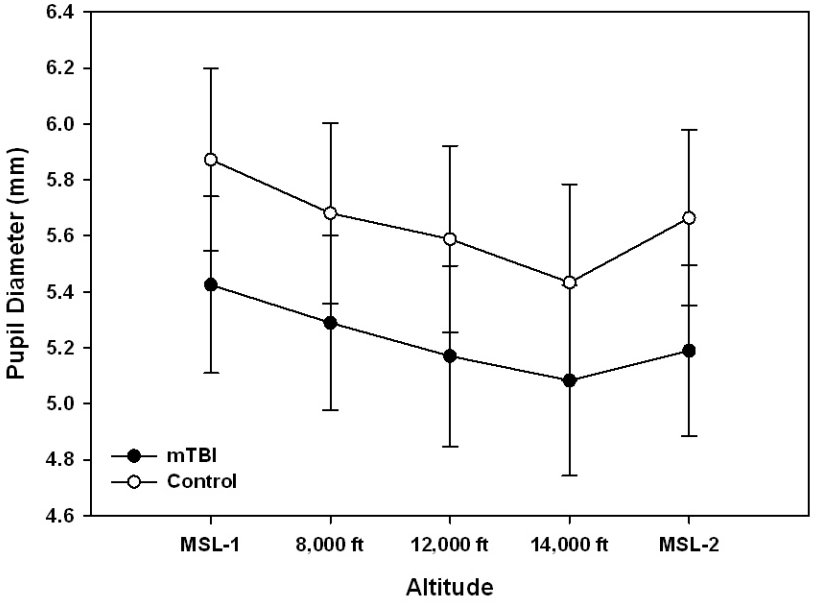


*Figure 5.* Pupil diameter as a function of hypoxic condition averaged for the group of mild traumatic brain injury subjects (closed circles) and for the group of control subjects (open circles). The error bars show the ±95% CI.

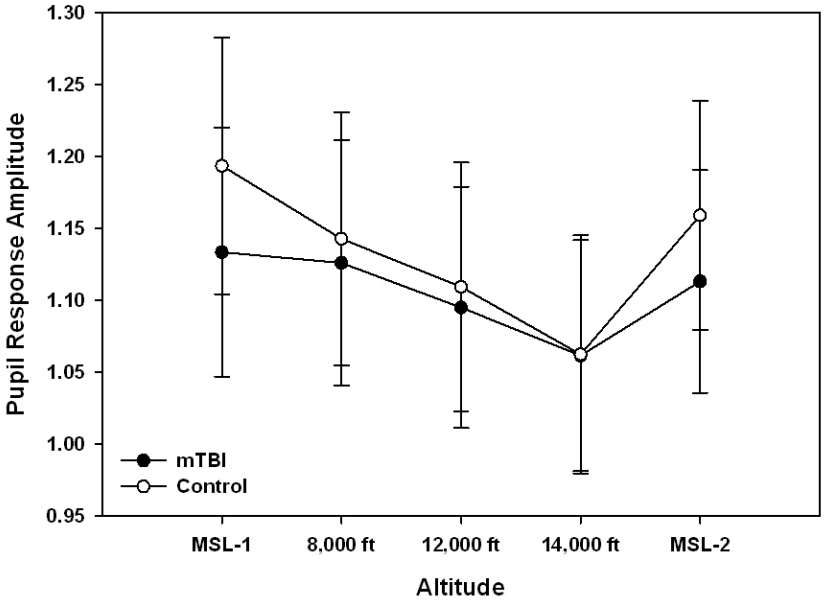


*Figure 6.* Pupil response amplitude as a function of hypoxic condition averaged for the group of mild traumatic brain injury subjects (closed circles) and for the group of control subjects (open circles). The error bars show the ±95% CI.

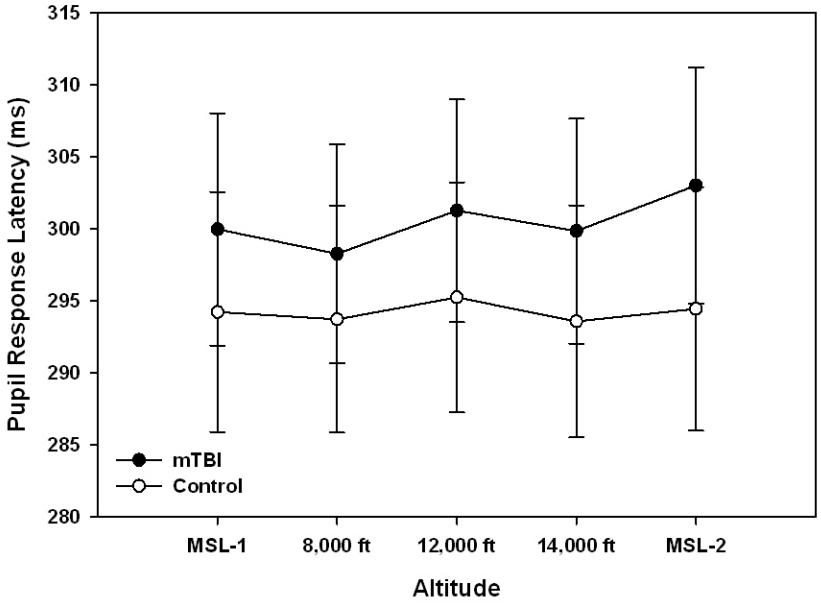


*Figure 7.* Pupil response latency as a function of hypoxic condition averaged for the group of mild traumatic brain injury subjects (closed circles) and for the group of control subjects (open circles). The error bars show the ±95% CI.

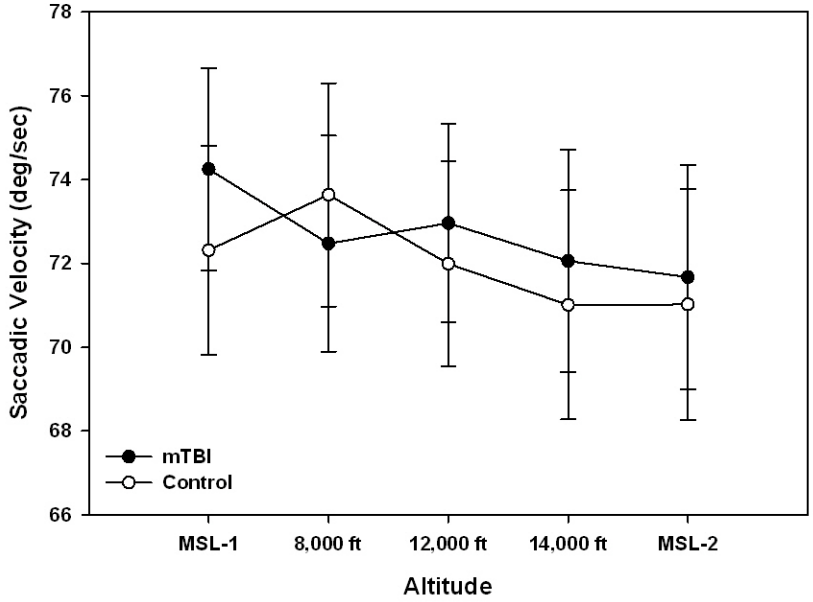


*Figure 8.* Saccadic velocity as a function of hypoxic condition averaged for the group of mild traumatic brain injury subjects (closed circles) and for the group of control subjects (open circles). The error bars show the ±95% CI.

### Environmental Stress Questionnaire: Acute Mountain Sickness-Cognitive

The results of the Environmental Stress Questionnaire: Acute Mountain Sickness-Cognitive (ESQ AMS-C) self-report are presented in Table 11, which tabulates the sum of the rating for each question for each of the five altitudes separately for the two groups of subjects. The sum of ratings was established by adding all Likert scale response values together; for

example, if one subject reported a 3 (*somewhat*), another a 2 (*moderate*), and the rest reported 0 (*not at all*), the sum value would be 5. Scores per item could range from 0 to 180 (36 subjects by 5 *extreme*). These ESQ AMS-C data are displayed in Figure 9, which shows for the mTBI and the control groups the sum of the ESQ AMS-C responses as a function of altitude.

*Table 11*. Environmental Stress Questionnaire: Acute Mountain Sickness-Cognitive Sum of the Ratings for Each Question Item for the Mild Traumatic Brain Injury and Control Groups Over Each Altitude Condition.

| ESQ Question | MSL-1 | | 8,000 ft | | 12,000 ft | | 14,000 ft | | MSL-2 | | Total | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | mTBI | Control | mTBI | Control | mTBI | Control | mTBI | Control | mTBI | Control | mTBI | Control |
| I felt light headed | 5 | 5 | 10 | 11 | 19 | 18 | 32 | 29 | 6 | 15 | 72 | 78 |
| I had a headache | 2 | 2 | 6 | 7 | 10 | 13 | 16 | 13 | 12 | 13 | 46 | 48 |
| I felt dizzy | 2 | 0 | 6 | 3 | 9 | 9 | 18 | 19 | 1 | 7 | 36 | 38 |
| I felt faint | 1 | 2 | 7 | 5 | 10 | 13 | 18 | 17 | 4 | 5 | 40 | 42 |
| My vision was dim | 4 | 3 | 9 | 6 | 14 | 7 | 22 | 10 | 3 | 5 | 52 | 31 |
| My coordination was off | 9 | 8 | 20 | 10 | 29 | 14 | 42 | 23 | 12 | 8 | 112 | 63 |
| I felt weak | 2 | 4 | 5 | 4 | 12 | 7 | 22 | 10 | 3 | 4 | 44 | 29 |
| I felt sick to my stomach (nauseous) | 0 | 0 | 4 | 0 | 6 | 2 | 6 | 2 | 1 | 1 | 17 | 5 |
| I lost my appetite | 0 | 0 | 1 | 0 | 1 | 0 | 1 | 0 | 0 | 0 | 3 | 0 |
| I felt sick | 0 | 0 | 1 | 0 | 2 | 2 | 4 | 2 | 0 | 1 | 7 | 5 |
| I felt hung-over. | 0 | 0 | 1 | 0 | 1 | 1 | 5 | 3 | 0 | 1 | 7 | 5 |
| Total | 25 | 24 | 70 | 46 | 113 | 86 | 186 | 128 | 42 | 60 | 436 | 344 |

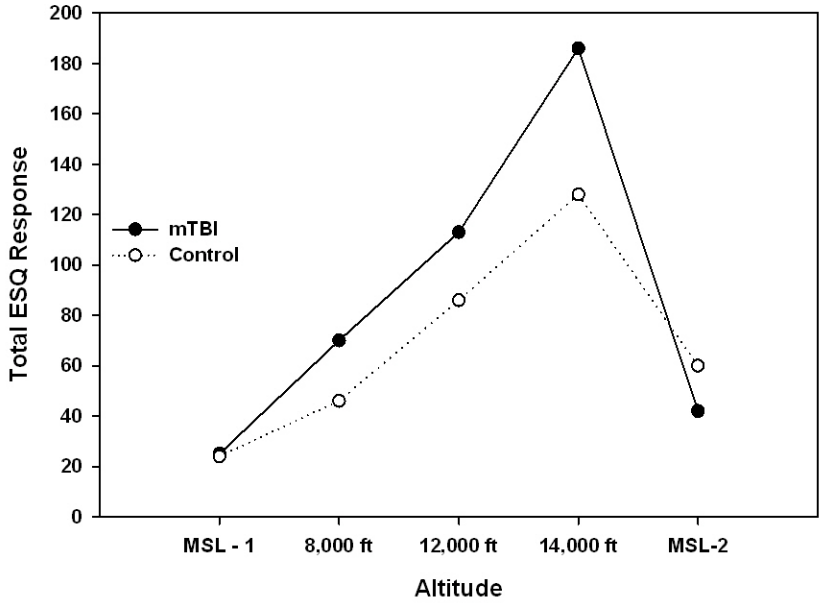


*Figure 9.* Environmental Stress Questionnaire responses recorded for the two groups of subjects (mild traumatic brain injury and control) separately as a function of altitude condition. Note that the ordinate is the sum over the 11 ESQ items for the specific group for the altitude indicated on the abscissa.

These effects were evaluated using a three-factor, mixed model ANOVA with one between-subject variable and two within-subject repeated measure variables. The one between subject variable was the group to which the subject belonged, either the mTBI or control group. One within-subject repeated measures variable was altitude, of which there were five levels (MSL-1, 8,000 ft, 12,000 ft, 14,000 ft, and MSL-2). The other within-subject repeated measures variable was ESQ question, of which there were 11 levels, where each level was one of the ESQ

questions. As mentioned, the response was the subject's Likert scale self-report of the magnitude of the symptom.

Mauchly's test indicated that both within-subject variables violated the assumption of sphericity (altitude, $\chi^2$ (9) = 129.65, $p < .001$, $\varepsilon = .579$; and ESQ, $\chi^2$ (54) = 503.989, $p < .001$, $\varepsilon = .579$). The results showed that the responses were significantly affected by altitude, V = .439, $F(4,65) = 12.702$, $p < 001$; ESQ, V = .604, $F(10,59) = 8.988$, $p < 001$; and the interaction of altitude with ESQ, V = .712, $F(38,31) = 2.016$, $p < 024$. The between-subject variable, group, was not significant, $F(1,68) = .592$, $p < .444$, nor was the interaction of group with altitude, ESQ, or the altitude by ESQ interaction.

Tests of within-subject contrasts compared the altitudes with respect to MSL-2 and showed that MSL-1, $F(1,68) = 7.002$, $p < .01$, $r = .306$; 12,000 ft, $F(1,68) = 13.325$, $p < .001$, $r = .405$; and 14,000 ft, $F(1,68) = 37.398$, $p < .001$, $r = .596$, each differed from the MSL-2 reference. The significant difference between MSL-1 and MSL-2 indicates that lingering hypoxic sensations were experienced immediately after the conclusion of the three hypoxic stress conditions. The time necessary for these sensations to fully dissipate is worth exploring in future investigations.

While the statistical interactions of altitude with the ESQ question item are extremely complex and lengthy to describe, the last column of Table 11 suggests some generalities that illustrate the significant finds that did emerge. Specifically, the subjective report of the effect of hypoxia on coordination was most severe followed by feeling light-headed, headache, feeling faint, dizziness, a dimness of vision, and weakness. There were negligible reports of feeling sick to the stomach (nervous), a loss of appetite, sick, or hung-over.

### Overall correlation among variables

All variables were entered into a single correlation matrix for the mTBI group (Appendix G) and for the control group (Appendix H). These two exploratory analyses were conducted to identify meaningful relationships between variables. It was anticipated that inter-variable correlations would reveal consistent trends between demographic variables and dependent variables and that these trends would be maintained across the levels of the independent variable. However, meaningful relationships did not emerge beyond those reported throughout this results section. These matrixes do contain relationships that would be expected for all human subjects. For example, systolic and diastolic blood pressures were correlated with BMI and pulse rate for both groups; but none of these variables were consistently associated with FIT or ESQ measures in either group.

## Discussion

The specific research goal of the present study was to evaluate the possibility that mTBI may have lingering effects that are not evident unless the individual is confronted with stressful situations or challenges that could have a greater than normal effect on the individual with mTBI. More specifically, individuals with a history of mTBI who appear asymptomatic under normal environmental conditions may have lingering or hidden deficits or other consequences of mTBI

that only become apparent when confronting environmental or physiological stressors that may be relatively minor and routinely encountered by military personnel or by civilians during their daily activities. This possibility would suggest that mTBI could have covert or occult (not accompanied by readily discernable signs or symptoms) affects that may not be evident unless the individual is compromised in some further way. This notion was formalized for experimental evaluation by formulating the null hypothesis that no statistically significant differences in selected measures would be found between a sample of individuals with a history of mTBI, who appeared asymptomatic under sea level conditions, and a sample of individuals without such a history, the mTBI and the control groups, when the two groups were stressed by normobaric hypoxia. Normobaric hypoxia is a prototypical physiological stress for this type of research paradigm. While the volunteers were exposed to three moderate levels of the hypoxia stress conditions, four general response categories were measured:

a. Pulse oximetry, which included percent blood oxygen saturation, ($SpO_2$) and pulse rate (bpm);

b. Oculometric (FIT measures), which included measurements of the size of the eye's pupil at rest, the pupil's response latency, the pupil's response amplitude, and the eye's saccadic velocity;

c. The subjective, self-reported (ESQ AMS-C) severity of symptoms associated with normobaric hypoxic stressor as rated along 11 response dimensions; and

d. Neurocognitive assessment, to be discussed in a separate report.

The experiment incorporated a design that exposed the mTBI and control volunteers to three different levels of the normobaric hypoxic stress using the ROBD that manipulated the concentration of oxygen in the air breathed by the research volunteers and two control conditions in which oxygen concentration was not manipulated. Five oxygen concentrations (and corresponding $PO_2$ values) are most easily indexed to altitude in that the magnitude of the hypoxic stress was defined as the $PO_2$ typically encountered at defined altitudes (Gradwell, 2006). The specific altitude equivalents were: (1) Sea level at the start of the study, which imposed no increment in stress whatsoever for any of the volunteers and is referred to as MSL-1; (2) 8,000 ft MSL, which may be considered to impose a very imposed a low stress, (3) 12,000 ft MSL, which may be considered to impose a moderate stress; (4) 14,000 ft MSL, which may be considered to impose a moderately high stress; and (5) Sea level at the completion of the study, which is referred to as MSL-2 and is a condition used to ensure that the volunteer did not display any lingering effects from the preceding hypoxic exposures. Thus, there were five altitude conditions in the study and all subjects experienced all altitudes so that the study was designed to compare the responses of the two groups of subjects (mTBI vs. controls) across the five altitude conditions. This experimental design is typically referred to as a mixed design since it incorporates between-group (mTBI vs. controls) as well as within-group comparisons (across the hypoxic/altitude conditions) (Field, 2009).

The mTBI and controls were matched for gender, age, resting pulse rate, systolic and diastolic blood pressures, resting respiration rate, weight, and height to reduce the likelihood that

these variables or factors associated with them might predispose one or the other group to the effects of normobaric hypoxia, thereby confusing the experimental results. Height and weight were used to estimate BMI. A simple between-subject multiple analysis of variance (MANOVA) showed that the mTBI and control groups did not differ significantly along any of these dimensions. Each control subject was tested within a week of the mTBI subject to which the control subject was paired, ensuring that any systematic but inadvertent drifts in instrumentation and/or experimental procedures would have essentially simultaneous and therefore equivalent impact on both the mTBI and control groups.

The present report documents the results of this study, excluding discussion of the neurocognitive results, which are presented in a companion report. The present report provides summary statistics and comparisons of the two study groups, while providing a first order analysis of the major findings derived from all subjects of the two groups.

As expected, the hypoxic stress had significant effects on arterial oxygen saturation recorded with the pulse oximeter such that the greater the hypoxia (i.e., the higher the altitude or equivalently, the lower the partial pressure of oxygen) the less the arterial oxygen saturation. Thus the physiological stress, hypoxia, had a strong effect on $SpO_2$. More surprising, however, was the unanticipated discovery of a difference in $SpO_2$ between the mTBI and the control subjects. Specifically, while the $SpO_2$ of the mTBI and control groups was indistinguishable at MSL-1 and at MSL-2, at altitudes of 8,000, 12,000, and 14,000 ft MSL not only was the $SpO_2$ of the mTBI group significantly higher than the $SpO_2$ of the control group, but the greater the hypoxia, the greater the difference in $SpO_2$. These completely unanticipated differential effects of the altitude on the $SpO_2$ of the mTBI group and the control group were of a moderate statistical size.

The effects of decreasing $PO_2$ (increasing altitude) were reflected systematically in the pulse rate that was recorded simultaneously with $SpO_2$. Hypoxia affected pulse rate in that the greater the hypoxia (i.e., the lower the $PO_2$ or equivalently, the higher the altitude), the higher the pulse rate. It should be noted that the pulse rate recorded at MSL-1 was statistically significantly greater than the pulse rate recorded at MSL-2 whereas there was no such statistically significant difference in $SpO_2$ between these two conditions. This would seem to indicate that at the conclusion of the hypoxic condition, the pulse rate was lower than at the start of the study and may simply reflect the relief the subjects experienced that the stressful situation had come to an end. A comprehensive literature review did not identify descriptive information of this depressed pulse rate response to breathing sea level oxygenated (normal air) immediately following short duration exposures to hypoxia.

The pulse rate showed an unanticipated finding that was consistent with the unanticipated finding of the $SpO_2$ data, the pulse rate of the mTBI group was statistically significantly less than the pulse rate for the control group at the two greatest hypoxic stress levels. In summary, there was strong evidence that the hypoxic stress affected both the pulse rate and the $SpO_2$ of the control (normal) subjects more than both the pulse rate and $SpO_2$ of the mTBI subjects, a very surprising and counterintuitive finding.

There was another difference that should be noted between the mTBI and control subjects' SpO2 and pulse rate response to hypoxic stress. Specifically, this was the difference between the mTBI and the control subjects' pattern of correlations over altitude among $SpO_2$ and among pulse rate. In effect the difference was reflected in the size of the correlation coefficient calculated among the different hypoxic stress levels for the mTBI subjects and for the control subjects separately for $SpO_2$ and for pulse rate. The pattern was clear, those subjects who had a high pulse rate for one stress level had a high pulse rate for another stress level. Conversely, those with a low pulse rate for one stress level had a low pulse rate for another stress level so that the correlation coefficients provide a measure of the relative consistency of the response across subjects. The same was true for the $SpO_2$ response: those with a high $SpO_2$ for one hypoxic stress tended to have a high $SpO_2$ under another hypoxic stress and so forth. A statistically significant difference was apparent between the mTBI and control subjects in the pattern of correlations such that the correlations are statistically significantly stronger for the mTBI subjects than for the control subjects. In other words, there was more consistency among the mTBI subjects than there was among the control subjects.

None of these differences between the two groups was expected, and to a great extent they seem counterintuitive. One possible explanation is that they simply reflect a random error (i.e., a false positive); an explanation that seems unlikely in light of the size the effect, the probability levels involved, and the care that was exercised in matching the two groups of volunteers along a number of apparently relevant physical parameters. Another possible explanation concerns the nature of the two groups of volunteers. It is possible that the mTBI volunteers tended to be more physically active than are the control volunteers. In fact it may be argued that the extent of physical activity was a risk factor for mTBI in that these individuals regularly engaged in physically demanding activities more frequently than did the control volunteers. This could mean that the mTBI group would have been more physically fit that the control group, which could account for the fact that as a group, the mTBI volunteers had lower heart rates and higher $SpO_2$ when confronted with the hypoxic stress conditions; a difference completely consistent with being more physically fit. This would mean that the effort to control for such predisposing factors by matching along the dimensions of smoking history, age, gender, weight, and height was insufficient to overcome the other effects of physical conditions for the analyses reported here.

Another possibility is that the difference between the two groups does reflect a systematic difference resulting from the trauma history. For example, it is known that exercise is associated with the contraction of the spleen and the release of substantial quantities of red blood cells into the circulation resulting in an increased oxygen transport capacity. It has recently been demonstrated that the type of hypoxic stress used in the present study is similarly associated with the contraction of the spleen and the release of substantial quantities of red blood cells into the blood stream within minutes of exposure to hypoxia, a time course that is relevant to the present study (Lodin-Sundstrom & Schagatay, 2010). The stimulus mechanisms signaling this response in the human body have yet to be fully demonstrated, but current evidence suggests more of a hormonal basis than a strictly neural innovation. Regardless of the stimulus mechanisms controlling this response, it is possible that the trauma history might impact the release of red blood cells or similar mechanisms that control the vascular system.

One of the aspects of the difference between the mTBI and control volunteers was the implication that the higher $SpO_2$ and lower heart rate of the mTBI group would seem to imply the group was healthier or the cardiovascular system more fit. On the other hand, since heart rate and $SpO_2$ were recorded using a finger pulse oximeter, they reflect only the peripheral circulation and do not reflect any local differences in cerebral circulation. There are many local mechanisms that control the distribution of blood and oxygen throughout the body, with particular emphasis on ensuring that the supply of oxygen to the brain is stable. Thus, a peripheral pulse oximeter at the finger, which can easily be influenced by peripheral vasoconstriction, anemia, hypotension, etc., may not only be a poor indicator of the cerebral oxygenation, but a misleading one. It is possible that if the circulatory system was functioning accurately, ensuring that oxygen would be preferentially delivered to the brain, one would expect the peripheral oximetry measured at the finger to drop. The present results could be completely consistent with this idea, in that the greater $SpO_2$ of the mTBI group might indicate a failure of the system to adjust correctly; a failure that could be due to any of a large number of mechanisms, ranging from local capillary control through pH regulation to changes in receptor dynamics. This idea is consistent with the intuitive expectation that the trauma would decrease rather than an increase a physiological capability.

The hypoxic stress had a statistically significant effect on the oculometric responses but without any evidence of a difference between the mTBI and control volunteers, a finding that seems to contradict the underlying hypothesis of the presence of lingering, covert, or occult effects of mTBI in otherwise asymptomatic individuals. It should be emphasized that the oculometric battery chosen here is extremely rudimentary, and while it was quickly administered and available with commercial off-the-shelf instrumentation, with the expectation that essentially all the volunteers would be able to complete testing, there was no expectation the battery provides anything but a very rudimentary oculometric assessment. The negative results found here do not provide any guarantee that the oculo-motor system of these individuals was necessarily normal. For example, there was no assessment of smooth pursuit tracking of the eyes, conjugate eye movements, accommodation, or the interconnection among accommodation, convergence, and pupillary constriction. It may be that this study's most important contribution concerning the use of hypoxic stress for the evaluation of oculometrics in mTBI is that the procedures were well tolerated by all the volunteers, and more sophisticated assessment of oculometrics is worth exploring before concluding that oculometric measures are not sensitive to mTBI and control differences when exposed to hypoxic stress.

Pupil diameter was altered by hypoxia. The magnitude of this effect was evaluated with respect to the MSL-2 condition, which was the condition of breathing sea level oxygen at the completion of the study after being exposed to all four of the other conditions: the MSL-1 condition and the three hypoxic conditions simulating 8,000 ft, 12,000, and 14,000 ft MSL. It may be noted that the comparisons with MSL-2 were simply a statistical expediency; the comparison with MSL-1 led to the same conclusions, in several instances with greater significance. Pupillary diameter decreased with increased hypoxia, although the difference was statistically significant between MSL-2 and the 12,000 ft and the 14,000 ft MSL conditions it was not at the 8,000 ft condition. While the change in pupil diameter due to hypoxia was statistically significant, the magnitude of the effect was quite small, as can be seen from Table 10. The pupil diameter measured at MSL-2 was 5.419 mm, while the pupil diameter measured at

14,000 ft MSL was 5.523 mm, a difference of 0.104 mm, which was less than a 4% decrease in pupil area. While the pupil and pupil diameter are important factors affecting characteristics of the optical imagine forming on the retina, this small change in pupil area in all probability has essentially no impact on the retinal image; as far as the image on the retina is concerned, the effect is completely unimportant. On the other hand, the more important aspect of this finding may lie in the suggestion that the change in pupil diameter reflect a change in the balance between the sympathetic and parasympathetic systems due to hypoxia. It may be noted that the literature on the pupil's response to hypoxia, reviewed in 1988 by Dyer (Dyer, 1988), contains conflicting reports showing that hypoxia can increase, decrease, or have no effect on pupil diameter, differences that may be due as much to with the specifics of the experimental procedures as to the fact that the pupil's response to hypoxia seems to be so small.

Similarly, the results showed a systematic decrease in the amplitude of the pupil's response to a flash of light as a function of hypoxia. At 12,000 ft MSL the 1.102 mm response to light was about 94.3% of the area measured at MSL-2, and the area at 14,000 ft MSL was 87.6%. It may be noted that the latency of the pupil's response was unaffected by hypoxia. Since the autonomic nervous system clearly can have large effects on the pupil's diameter, response amplitude, and response latency, it is only to be expected that emotion, arousal, anxiety, etc. would impact these oculometrics. For example, the difference in the measurements made under MSL-1 and MSL-2 could well reflect the fact the MSL-1 condition incorporates any emotional component arising from the imminent hypoxic stress while the MSL-2 condition incorporates the emotional component associated with the completion of hypoxic stress conditions and the near completion of the study period.

There was some evidence that hypoxia systematically reduced saccadic velocity, since the velocities measured for the 12,000 ft, 14,000 ft, and MSL-2 conditions were not different from each other but the MSL-2 velocity was significantly slower than the MSL-1 condition. The *t*-test comparison of the saccadic velocity at MSL-1 with 8,000 ft MSL was not statistically significant ($t = .584$, $p < .561$) but the MSL-1 was significantly faster than the velocity measured at 12,000 ($t = 2.05$, $p < .044$), 14,000 ft MSL ($t = 3.233$, $p < .002$), and at MSL-2 ($t = 3.088$, $p < .003$). While the MSL-2 condition might have incorporated hypoxia effects that may have accumulated over the successive altitude exposures, the finding of a decrease in saccadic velocity is consistent with the literature (Cymerman et al., 2005).

Analysis failed to show a significant difference between the groups of mTBI and control volunteers in their responses to the ESQ AMS-C, the self-report questionnaire of physical symptoms associated with hypoxia. Although the differences between the mTBI and control groups were not statistically significant, the mTBI group had a greater symptom rating than did the control volunteers for 8,000, 12,000, and 14,000 ft MSL (Table 11 and Figure 9). This negative finding shows that the hypoxia was well tolerated by the subjects. The time course relationship between time since trauma, magnitude of trauma, and physical symptoms associated with hypoxia is currently unavailable in the literature, and future work should use sound scientific methods to provide descriptive responses.

The relation between symptom severity and hypoxic condition was explored further. Since there were no statistically significant differences between the two groups of volunteers, the

symptom ratings for the two groups shown in Table 11 were combined as follows. In each of the two groups, there were 36 individuals and each individual rated the 11 questionnaire items on a scale with a maximum value of 5, so that for a group, at an altitude, the maximum rating for a questionnaire item was 180; specifically, the product of the maximum rating (5) and the number of subjects in the group (36). The 11 ratings for the mTBI group were summed separately from the 11 ratings of the control group at each altitude. Thus, at an altitude, there were 11 ratings for each group so that combining the two groups entailed averaging the 22 ratings for each hypoxic condition, to produce an average symptom (±SEM) rating for each altitude, as shown in Figure 10. Simple *t*-tests compared the mean symptom severity scores across the five hypoxic conditions and showed that the mean symptom ratings were statistically different with the exception of the ratings at 8,000 ft MSL and the MSL-2 conditions. While there was no hypoxic stress posed under MSL-1, the symptoms were appreciably different from zero, suggesting a form of tonic or background level of symptom to which the hypoxic effects were added or compounded. Also, the magnitude of the symptoms reported during the MSL-2 condition were significantly greater than MSL-1 and in fact were statistically indistinguishable ($t = 0.834$, $df = 21$, $p < .414$) from the magnitude of the symptoms reported during the 8,000 ft MSL exposure, suggesting the continued effects of the previous hypoxic exposures. With the exclusion of the MSL-2 condition, the symptoms increased with increasing hypoxic stress.

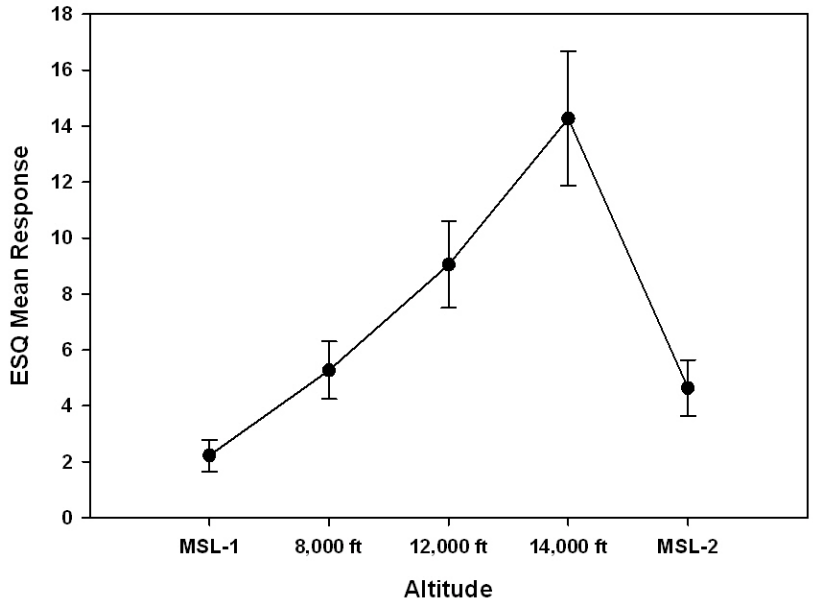


*Figure 10.* Average (± Standard Error of the Mean) Environmental Stress Questionnaire responses as a function of hypoxic condition. The average was calculated by summing over the 11 question items for both the mild traumatic brain injury and control groups for each altitude.

A sense of the relative severity of these symptoms may be gained by considering the method by which the rating scores were summarized. The maximum rating possible at each altitude was the product of 11 items rated 5 by 72 volunteers, or 3960. The average response ratings in Figure 10 were all a fraction of the maximum possible; the 14,000 ft MSL rating, which was the largest, was less than 0.4% of the maximum. Thus, in general, the data suggest that the severity of the hypoxic symptoms reported by the volunteers was extremely small.

On the other hand as mentioned in association with the symptom severity summarized in Table 11, the 11 ESQ AMS-C items do seem to show differences in response severity to hypoxia even though all the 11 items were selected to reflect the symptoms that defined the cerebral factor of Acute Mountain Sickness. In general, the 11 questionnaire items may be grouped into three general classes based on the relative ranking of the total symptom severity, granting that the magnitude of the symptoms were slight. Summing over all 72 volunteers over the five altitude conditions with a maximum severity of 5 produced a maximum possible symptom rating of 1800. The different symptoms can be compared to this maximum value. The slightest symptoms involved a loss of appetite (0.167 % of maximum), a feeling of hangover (0.667%), a feeling of sickness (0.667%), and feeling nauseous (1.222%). The slightly more severe symptoms involved feeling weak (4.056%), feeling dizzy (4.111%), feeling faint (4.556%), having dim vision (4.611%), having a headache (5.222%). The most severe symptoms involved feeling light headed (8.333%) and reporting that the coordination was off (9.722%). Thus it would seem that even though symptom severity was quite modest in general, there was evidence that the hypoxic stress had a spectrum of effects with the most severe affecting coordination and light headedness. It would be important to extend the analysis of the present dataset to examine the relationships among symptom severity, oculometrics, and pulse oximetry.

## Conclusion

The present analysis is intended to provide a description and summary of the complete dataset for the study described above. While it provides a description of the main trends of the complete dataset, it is not intended to be an exhaustive treatment of the data analysis; consequently, it does not take into account a number of other factors that can reasonably be expected to affect the results and that need to be examined before definitive conclusions are drawn from these data. For example, the most obvious such factor concerns the range in the length of time between the trauma and volunteer's test participation, an interval that ranges from 1.7 to 119.7 months. In addition, attention should be paid to physical conditioning indices such as BMI, blood pressures, and more careful consideration of the magnitude of the hypoxic responses.

In summary, the results showed that $SpO_2$ and pulse rate responses differed between individuals with a history of mTBI who were asymptomatic at the time of the study and matched healthy controls when exposed to the normobaric hypoxic stress conditions equivalent to 8,000, 12,000, and 14,000 ft MSL. FIT measures and subject measures (ESQ AMS-C) showed responses to the within subjects variable of hypoxia level but did not show significant differences between the two groups. Overall, this set of findings did not fully support all *a priori* hypotheses and moreover the $SpO_2$ and pulse rate responses were counter intuitive in that they were expected to be depressed in the mTBI group compared to controls but were found to be elevated above the control group values.

## References


Centers for Disease Control and Prevention. (2010). *Injury Prevention and Control: Traumatic Brain Injury*. Retrieved from http://www.cdc.gov/ncipc/tbi/

Department of Defense, *Panel to Review the V-22 Program*. (2001). Report of the Panel to Review the V-22 Program. Retrieved from http://www.fas.org/man/dod-101/sys/ac/v22-report.pdf

Department of the Army, *Flight Regulations*. Army Regulation 95-1. Washington, DC: U.S. Department of the Army, March 11, 2014.

Department of the Navy, Office of the Chief of Naval Operations, *Natops General Flight and Operating Instructions*. OPNAV Instruction 3710.7T 8.2.4.1. Washington, DC: U.S. Department of the Navy, March 1, 2004.

Department of Transportation. (2000). Federal Aviation Regulations and Aeronautical Information Manual.

Department of Veterans Affairs and Department of Defense, *The Management of Concussion/mTBI Working Group*. (2009). VA/DoD Clinical Practice Guideline for Management of Concussion / Mild Traumatic Brain Injury Version 1.0. Retrieved from http://www.healthquality.va.gov/management_of_concussion_mtbi.asp

Department of Veterans Affairs, Employee Education System. (2004). *Veterans Health Initiative: Traumatic Brain Injury, Independent Study Course*. Retrieved from http://www.publichealth.va.gov/docs/vhi/traumatic_brain_injury.pdf

Cohen, J. (2013). *Statistical power analysis for the behavioral sciences*. Academic press.

Cottrell, J. J., Lebovitz, B. L., Fennell, R. G., & Kohn G. M. (1995). Inflight arterial saturation: Continuous monitoring by pulse oximetery. *Aviation, Space, and Environmental Medicine*, *66*(2), 126-130.

Cymerman, A., Muza, S. R., Ditzer, D., Friedlander, A. L., Hagobian, T., Subudhi, A., Jacobs, K, Stone, K., & Fulco, C. S. (2003). *Oculomotor and pupillary reflexes during acute exposure to hypobaric hypoxia* (Report No. T03-04). Aberdeen Proving Ground, MD: U.S. Army Research Institute of Environmental Medicine.

Cymerman, A., Muza, S. R., Friedlander, A. L., Fulco, C. S., & Rock, P. B. (2005). Saccadic velocity and papillary reflexes during acclimatization to altitude (4300 m). *Aviation, Space, and Environmental Medicine*, *76*, 627-634.

Dyer, F. N. (1988). *Effects of low and high oxygen tensions and related respiratory conditions on visual performance: A literature review* (USAARL Technical Report No. 88-7). Fort Rucker, AL: U. S. Army Aeromedical Research Laboratory.

Ewing, R., McCarthy, D., Gronwall, D., & Wrightson, P. (1980). Persisting effect of minor head injury observable during hypoxic stress. *Journal of Clinical Neuropsychology*, *2*, 147-155.

Field, A. (2009). *Discovering Statistics Using SPSS*. Thousand Oaks, CA: SAGE Publications, Ltd.

Gradwell, D.P. (2006). Hypoxia and hyperventilation. In D. J. Rainford & D. P. Gradwell (Eds.), *Ernsting's Aviation Medicine* (pp. 41-56). London: Hodder Arnold.

Kraus, J. F., & Chu, L. D. (2005). Epidemiology. In J. M. Silver, T. W. McAllister, & S. C. Yudofsky (Eds.), *Textbook of Traumatic Brain Injury* (pp. 3-26). Arlington, VA: American Psychiatric Publishing, Inc.

LeDuc, P. A., Greig, J. L., & Dumond, S. L. (2005). Involuntary eye responses as measures of fatigue in U.S. Army Apache aviators. *Aviation, Space, and Environmental Medicine*, *76*(7, Suppl.), C86-91.

LeDuc, P. A., Greig, J. L., & Dumond, S. L. (2005). *Self-reported and ocular measures of fatigue in U. S. Army Apache aviators following flight*. (USAARL Technical Report No. 2005-10). Fort Rucker, AL: U. S. Army Aeromedical Research Laboratory.

McAllister, T. W. (2005). Mild brain injury and the post-concussive syndrome. In J. M. Silver, T. W. McAllister, and S. C. Yudofsky (Eds.), *Textbook of Traumatic Brain Injury* (pp. 279-308). Arlington, VA: American Psychiatric Publishing, Inc.

Muhm J. M. (2004). Predicted arterial oxygenation at commercial aircraft cabin altitudes *Aviation, Space, and Environmental Medicine*, *75*, 905-912.

Muhm J. M., Rock, P. B., McMullin, D. L., Jones, S. P., Eilers, K. D., & McMullen, A. (2007). Effects of aircraft-cabin altitude on passenger discomfort. *New England Journal of Medicine*, *357*, 18-27.

National Research Council, Committee on Air Quality in Passenger Cabins of Commercial Aircraft, Board on Environmental Studies and Toxicology, Division on Earth and Life Science. (1986). *The airliner cabin environment and the heath of passengers and crew*. Washington, DC: National Academy Press.

National Research Council, Committee on Air Quality in Passenger Cabins of Commercial Aircraft, Board on Environmental Studies and Toxicology, Division on Earth and Life Science. (2002). *The airliner cabin environment and the heath of passengers and crew*. Washington, DC: National Academy Press.

Ramiccio, J. (1998). Hypoxic hypoxia in a Hawk? *FlightFax*, *26*(9), 6-7.

Rothberg, M., Cornsweet, T., & Rafal, M. D. (1995). U.S. Patent Number 5422690. Washington, DC: U.S. Patent and Trademark Office.

Sampson, J. B., Cymerman, A., Burse, R. L., Maher, J. T., & Rock, P. B. (1983). Procedures for the measurement of acute mountain sickness. *Aviation, Space, and Environmental Medicine*, *54*, 1063-1073.

Sausen K. P., Bower, E. A., Stiney, M. E., Feigl, C., Wartman, R., & Clark, J. B. (2003). A closed-loop reduced oxygen breathing device for inducing hypoxia in humans. *Aviation, Space, and Environmental Medicine*, *74*(11), 1190-1197.

Sausen, K. P., Wallick, M. T., Slobodnik, B., Chimiak, J. M., Bower, E. A., Stiney, M. E., & Clark, J. B. (2001). The reduced oxygen breathing paradigm for hypoxia training: physiological, cognitive, and subjective effects. *Aviation, Space, and Environmental Medicine*, *72*, 539-545

Lodin-Sundstrom A. & Schagatay E. (2010). Spleen contraction during 20 min normobaric hypoxia and 2 min apnea in humans. *Aviation, Space, and Environmental Medicine*, *81*(6), 545-549.

Temme, L. A., Still, D. L., & Acromite, M. T. (2009). The effects of hypoxia on the flight performance of active duty, instructor pilots in fixed wing flight simulator (abstract). *Aviation, Space, and Environmental Medicine*, *80*(3), 314.

Temme, L. A., Still, D. L., & Acromite, M. T. (2010). Hypoxia and flight performance of military instructor pilots in a flight simulator. *Aviation, Space, and Environmental Medicine*, *81*(7), 654-659.

## Appendix A. Mild Traumatic Brain Injury Group Description.

| Subject Number | Gender | Age | Pulse | BP Systolic | BP Diastolic | Respiration | Weight (lbs) | Height (in) | BMI | Months Since Trauma | LOC | Amnesia |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 1101 | M | 24 | 43 | 111 | 63 | 12 | 190 | 70.5 | 27.3 | 23.6 | 1 | 0 |
| 1102 | M | 20 | 60 | 117 | 67 | 20 | 164 | 71.5 | 22.9 | 16.7 | 0 | 0 |
| 1103 | F | 21 | 75 | 108 | 74 | 12 | 124 | 61 | 22 | 18.0 | 0 | 0 |
| 1104 | M | 23 | 69 | 108 | 67 | 16 | 162 | 68 | 24 | 20.1 | 1 | 0 |
| 1105 | F | 20 | 83 | 122 | 81 | 16 | 145 | 68 | 21 | 19.1 | 1 | 0 |
| 1106 | M | 29 | 80 | 110 | 70 | 16 | 349 | 71 | 48.7 | 17.2 | 0 | 0 |
| 1107 | F | 26 | 79 | 120 | 80 | 10 | 116 | 63 | 21 | 25.0 | 0 | 0 |
| 1109 | M | 20 | 52 | 127 | 52 | 9 | 210 | 71 | 30 | 105.8 | 1 | 0 |
| 1111 | M | 20 | 54 | 111 | 56 | 8 | 176 | 74 | 22 | 33.8 | 0 | 0 |
| 1112 | M | 24 | 72 | 126 | 80 | 6 | 172 | 69 | 25 | 34.9 | 1 | 0 |
| 1113 | M | 26 | 64 | 127 | 87 | 11 | 238 | 73 | 31 | 76.6 | 1 | 0 |
| 1114 | M | 20 | 70 | 122 | 79 | 12 | 162 | 72 | 22 | 17.8 | 1 | 0 |
| 1116 | M | 19 | 56 | 86 | 49 | 12 | 142 | 70 | 20 | 23.9 | 1 | 0 |
| 1117 | M | 29 | 96 | 125 | 80 | 12 | 315 | 72 | 42 | 1.7 | 1 | 0 |
| 1118 | M | 38 | 79 | 149 | 84 | 20 | 267 | 72 | 36.2 | 15.0 | 1 | 1 |
| 1119 | M | 30 | 76 | 135 | 79 | 16 | 327 | 79 | 36.8 | 7.9 | 0 | 0 |
| 1120 | M | 32 | 86 | 145 | 90 | 16 | 279 | 76 | 34 | 63.8 | 1 | 1 |
| 1121 | F | 21 | 68 | 111 | 76 | 10 | 129 | 66 | 20 | 7.4 | 1 | 1 |
| 1122 | M | 33 | 71 | 125 | 86 | 24 | 193 | 67 | 30 | 13.2 | 0 | 0 |
| 1123 | F | 29 | 63 | 105 | 73 | 16 | 255 | 64 | 43.8 | 119.7 | 0 | 0 |
| 1124 | F | 21 | 80 | 100 | 69 | 12 | 140 | 64 | 24 | 17.3 | 0 | 0 |
| 1125 | M | 36 | 79 | 105 | 69 | 20 | 153 | 68 | 23 | 55.9 | 0 | 0 |
| 1126 | M | 18 | 76 | 130 | 76 | 20 | 165 | 70 | 23 | 14.5 | 0 | 0 |
| 1127 | M | 21 | 74 | 108 | 65 | 12 | 134 | 70 | 19 | 29.0 | 0 | 0 |
| 1129 | F | 20 | 72 | 106 | 73 | 12 | 204 | 68 | 31 | 76.4 | 1 | 0 |
| 1130 | M | 26 | 77 | 148 | 90 | 15 | 364 | 71 | 48 | 109.9 | 0 | 0 |
| 1132 | F | 24 | 62 | 105 | 64 | 12 | 154 | 66 | 25 | 51.2 | 1 | 0 |
| 1133 | M | 25 | 69 | 137 | 83 | 10 | 199 | 69 | 29 | 16.7 | 0 | 0 |
| 1134 | M | 26 | 73 | 124 | 79 | 15 | 233 | 69 | 34 | 66.6 | 1 | 0 |
| 1135 | M | 33 | 72 | 114 | 81 | 20 | 208 | 59 | 31 | 34.2 | 1 | 1 |
| 1136 | M | 35 | 59 | 107 | 65 | 12 | 146 | 68 | 22 | 106.2 | 1 | 0 |
| 1137 | M | 22 | 52 | 120 | 74 | 20 | 171 | 76 | 21 | 35.3 | 0 | 0 |
| 1138 | M | 27 | 86 | 144 | 70 | 12 | 194 | 71 | 27 | 8.0 | 0 | 0 |
| 1139 | M | 24 | 57 | 124 | 78 | 12 | 204 | 74 | 26 | 62.8 | 1 | 0 |
| 1140 | F | 18 | 78 | 119 | 71 | 20 | 159 | 65 | 26 | 7.1 | 0 | 0 |
| 1141 | M | 29 | 87 | 144 | 80 | 12 | 259 | 76 | 31 | 7.8 | 1 | 0 |

*Note.* BMI = Body Mass Index; BP = Blood Pressure LOC = Loss of Consciousness, 1 = Yes, 0 = No; Amnesia, 1 = Yes, 0 = No; Respiration in breaths per minute

## Appendix B. Control Group Description.

| Subject Number | Gender | Age | Pulse | BP Systolic | BP Diastolic | Respiration | Weight (lbs) | Height (in) | BMI |
|---|---|---|---|---|---|---|---|---|---|
| 1201 | M | 24 | 59 | 119 | 82 | 12 | 211 | 75 | 26.4 |
| 1202 | M | 21 | 71 | 130 | 75 | 16 | 211 | 76.5 | 26 |
| 1203 | F | 22 | 59 | 101 | 69 | 18 | 135.4 | 68 | 21 |
| 1204 | M | 24 | 76 | 108 | 64 | 14 | 142.4 | 64.5 | 24 |
| 1205 | F | 20 | 76 | 106 | 65 | 8 | 142 | 71.5 | 20 |
| 1206 | M | 28 | 61 | 116 | 80 | 14 | 164 | 72 | 22 |
| 1207 | F | 23 | 83 | 110 | 74 | 12 | 156 | 65.5 | 24 |
| 1209 | M | 20 | 69 | 137 | 81 | 12 | 202 | 72 | 27 |
| 1211 | M | 20 | 54 | 134 | 85 | 12 | 191 | 69 | 28 |
| 1212 | M | 20 | 93 | 103 | 65 | 20 | 203 | 73 | 26 |
| 1213 | M | 27 | 86 | 118 | 66 | 12 | 157 | 75 | 20 |
| 1215 | M | 19 | 63 | 108 | 66 | 10 | 127 | 70 | 18 |
| 1216 | M | 18 | 73 | 130 | 78 | 15 | 388 | 73 | 51.2 |
| 1217 | M | 30 | 95 | 138 | 93 | 20 | 455 | 67 | 71.3 |
| 1218 | M | 34 | 91 | 122 | 76 | 20 | 199 | 71 | 27.8 |
| 1219 | M | 32 | 73 | 132 | 78 | 16 | 194 | 70 | 28 |
| 1220 | M | 30 | 77 | 148 | 88 | 16 | 517 | 70 | 31 |
| 1221 | F | 21 | 95 | 104 | 71 | 20 | 129 | 66 | 21 |
| 1222 | M | 33 | 90 | 125 | 79 | 10 | 189 | 71 | 26 |
| 1223 | F | 28 | 84 | 101 | 69 | 20 | 250 | 63 | 44 |
| 1224 | F | 21 | 69 | 102 | 70 | 20 | 156 | 64 | 26.8 |
| 1225 | M | 34 | 74 | 143 | 86 | 8 | 239 | 63 | 60 |
| 1226 | M | 21 | 69 | 121 | 68 | 20 | 238 | 71 | 33 |
| 1227 | M | 20 | 69 | 115 | 60 | 80 | 212 | 77 | 25 |
| 1229 | F | 23 | 81 | 105 | 65 | 20 | 140 | 68 | 21 |
| 1231 | M | 23 | 52 | 114 | 63 | 12 | 186 | 68 | 28 |
| 1232 | F | 25 | 85 | 129 | 77 | 12 | 266 | 68 | 40 |
| 1233 | M | 27 | 70 | 126 | 71 | 14 | 143 | 71 | 20 |
| 1234 | M | 27 | 66 | 138 | 68 | 12 | 208 | 72 | 29 |
| 1235 | M | 32 | 65 | 110 | 76 | 12 | 150 | 71 | 21 |
| 1236 | M | 33 | 69 | 116 | 70 | 14 | 204 | 73 | 27 |
| 1237 | M | 20 | 45 | 128 | 71 | 16 | 174 | 70 | 25 |
| 1238 | M | 27 | 56 | 125 | 72 | 20 | 268 | 74 | 34 |
| 1239 | M | 23 | 51 | 121 | 70 | 16 | 200 | 70 | 29 |
| 1240 | F | 18 | 62 | 109 | 68 | 16 | 173 | 68 | 26 |
| 1241 | M | 28 | 107 | 162 | 82 | 20 | 276 | 67 | 43 |

*Note.* BP = Blood pressure mmHg; BMI = Body Mass Index; Respiration in breaths per minute

## Appendix C. Percent Hemoglobin Oxygen Concentration and Pulse Rate for Each Mild Traumatic Brain Injury Subject at Each Altitude Condition.

| Subject | Percent Blood Oxygen | | | | | Pulse Rate (beats per minute) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 |
| 1101 | 97.00 | 94.69 | 91.58 | 87.00 | 97.75 | 51.08 | 48.92 | 50.50 | 55.38 | 50.63 |
| 1102 | 96.82 | 94.90 | 89.00 | 84.30 | 97.60 | 71.55 | 75.00 | 76.10 | 75.90 | 63.10 |
| 1103 | 97.58 | 93.70 | 88.60 | 83.50 | 97.50 | 61.33 | 67.30 | 67.10 | 70.70 | 59.00 |
| 1104 | 96.67 | 92.50 | 86.08 | 80.94 | 97.00 | 73.80 | 74.17 | 78.00 | 79.38 | 65.00 |
| 1105 | 97.80 | 94.69 | 91.46 | 89.00 | 97.46 | 79.67 | 82.46 | 79.38 | 82.55 | 76.54 |
| 1106 | 97.25 | 93.91 | 89.31 | 85.36 | 96.17 | 86.00 | 88.73 | 91.77 | 92.36 | 82.92 |
| 1107 | 97.23 | 94.73 | 90.82 | 85.25 | 96.64 | 70.31 | 73.45 | 75.00 | 76.75 | 71.91 |
| 1109 | 97.33 | 95.45 | 92.27 | 91.45 | 96.60 | 56.33 | 56.09 | 54.27 | 52.73 | 50.90 |
| 1111 | 96.91 | 93.70 | 87.91 | 84.73 | 97.40 | 59.55 | 60.90 | 65.55 | 65.00 | 57.20 |
| 1112 | 96.94 | 92.92 | 88.23 | 82.75 | 97.75 | 74.25 | 75.08 | 75.46 | 80.00 | 71.33 |
| 1113 | 96.67 | 93.62 | 90.18 | 89.44 | 97.21 | 73.61 | 76.62 | 81.82 | 82.61 | 71.00 |
| 1114 | 97.50 | 93.55 | 86.00 | 81.64 | 97.55 | 82.08 | 81.00 | 81.36 | 84.18 | 78.82 |
| 1116 | 96.85 | 89.50 | 81.75 | 74.27 | 96.58 | 59.54 | 61.29 | 66.63 | 67.36 | 54.42 |
| 1117 | 97.23 | 93.54 | 87.36 | 82.67 | 97.00 | 98.92 | 97.54 | 99.29 | 99.33 | 95.42 |
| 1118 | 96.57 | 91.00 | 86.18 | 83.45 | 96.09 | 77.14 | 77.36 | 81.55 | 80.45 | 74.64 |
| 1119 | 97.23 | 94.08 | 89.93 | 88.00 | 97.43 | 75.46 | 79.00 | 79.13 | 79.00 | 72.14 |
| 1120 | 96.56 | 91.55 | 86.83 | 83.92 | 95.45 | 86.19 | 91.82 | 96.17 | 94.17 | 81.36 |
| 1121 | 97.33 | 94.09 | 86.83 | 83.91 | 97.73 | 72.50 | 75.09 | 77.92 | 79.82 | 68.55 |
| 1122 | 97.09 | 94.45 | 91.60 | 93.64 | 97.10 | 72.91 | 73.82 | 72.30 | 70.45 | 69.40 |
| 1123 | 96.77 | 94.67 | 88.73 | 86.45 | 97.45 | 70.00 | 76.67 | 82.82 | 82.27 | 70.82 |
| 1124 | 96.86 | 93.46 | 85.57 | 83.46 | 97.23 | 80.71 | 78.69 | 73.00 | 73.08 | 70.00 |
| 1125 | 95.67 | 89.67 | 83.92 | 81.27 | 96.31 | 78.00 | 81.00 | 82.33 | 82.91 | 72.15 |
| 1126 | 96.92 | 93.17 | 88.82 | 88.18 | 96.92 | 85.08 | 85.75 | 83.00 | 83.27 | 81.00 |
| 1127 | 97.33 | 94.15 | 89.69 | 87.08 | 98.09 | 74.87 | 75.92 | 73.08 | 70.85 | 67.64 |
| 1129 | 97.92 | 93.91 | 89.55 | 84.08 | 97.91 | 68.25 | 70.27 | 75.45 | 76.83 | 66.91 |
| 1130 | 97.42 | 94.30 | 87.91 | 84.18 | 97.45 | 86.50 | 88.50 | 89.36 | 92.45 | 81.91 |
| 1132 | 97.55 | 95.09 | 88.45 | 83.27 | 97.55 | 68.73 | 69.45 | 72.18 | 75.27 | 67.45 |
| 1133 | 97.27 | 92.45 | 86.73 | 82.92 | 96.93 | 71.09 | 77.91 | 73.55 | 77.50 | 63.71 |
| 1134 | 97.08 | 92.64 | 87.00 | 82.92 | 96.00 | 78.08 | 79.73 | 85.42 | 88.15 | 69.45 |
| 1135 | 96.14 | 91.85 | 84.50 | 79.50 | 96.67 | 73.29 | 76.23 | 82.50 | 84.08 | 67.75 |
| 1136 | 96.85 | 95.45 | 94.75 | 93.45 | 96.75 | 67.38 | 67.73 | 66.67 | 67.55 | 58.92 |
| 1137 | 97.83 | 96.91 | 91.73 | 90.18 | 97.73 | 63.33 | 68.73 | 75.64 | 73.27 | 58.00 |
| 1138 | 96.38 | 92.77 | 86.92 | 84.92 | 96.77 | 68.94 | 69.15 | 75.50 | 74.46 | 60.62 |
| 1139 | 97.38 | 95.45 | 91.91 | 84.67 | 97.09 | 69.77 | 70.27 | 68.91 | 69.17 | 61.27 |
| 1140 | 97.43 | 94.60 | 91.75 | 87.00 | 98.00 | 77.21 | 78.13 | 75.17 | 78.23 | 74.10 |
| 1141 | 96.46 | 91.91 | 85.93 | 85.50 | 96.33 | 90.77 | 91.91 | 92.21 | 91.92 | 84.42 |

## Appendix D. Percent Oxygen Percent Hemoglobin Oxygen Concentration and Pulse Rate for Each Control Subject at Each Altitude Condition.

| Subject | Percent Blood Oxygen | | | | | Pulse Rate (beats per minute) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 |
| 1202 | 97.00 | 94.00 | 88.83 | 87.00 | 97.00 | 74.77 | 75.18 | 74.42 | 72.62 | 67.75 |
| 1203 | 97.45 | 92.92 | 79.82 | 80.10 | 96.91 | 66.09 | 68.25 | 72.09 | 75.30 | 62.18 |
| 1204 | 97.09 | 93.31 | 84.09 | 81.45 | 97.10 | 69.27 | 73.00 | 76.91 | 77.00 | 61.00 |
| 1205 | 96.91 | 92.55 | 85.73 | 82.18 | 97.27 | 78.27 | 82.36 | 88.91 | 88.27 | 73.45 |
| 1206 | 97.20 | 92.93 | 88.38 | 84.80 | 97.15 | 72.67 | 69.20 | 72.56 | 71.40 | 63.15 |
| 1207 | 97.15 | 93.13 | 89.77 | 84.08 | 97.60 | 87.23 | 88.47 | 88.15 | 94.33 | 89.30 |
| 1209 | 97.75 | 93.45 | 87.82 | 82.45 | 97.73 | 86.92 | 88.27 | 90.45 | 100.91 | 84.73 |
| 1211 | 97.15 | 93.23 | 88.58 | 85.23 | 97.00 | 56.31 | 61.23 | 62.95 | 67.00 | 56.57 |
| 1212 | 96.92 | 92.73 | 86.70 | 82.50 | 96.90 | 92.83 | 93.36 | 95.60 | 93.80 | 88.40 |
| 1213 | 96.17 | 91.73 | 87.00 | 83.80 | 95.90 | 85.42 | 89.45 | 91.80 | 90.20 | 81.40 |
| 1215 | 96.50 | 93.55 | 91.45 | 87.36 | 96.82 | 67.42 | 71.09 | 68.73 | 73.09 | 65.00 |
| 1216 | 96.73 | 90.92 | 81.85 | 74.29 | 96.54 | 81.13 | 85.08 | 89.08 | 86.79 | 79.85 |
| 1217 | 96.75 | 90.18 | 82.25 | 83.00 | 96.36 | 98.00 | 104.36 | 109.17 | 108.18 | 97.82 |
| 1218 | 96.00 | 90.64 | 84.36 | 80.36 | 96.18 | 86.75 | 94.09 | 95.36 | 93.82 | 75.73 |
| 1219 | 96.75 | 94.82 | 91.45 | 89.91 | 97.00 | 69.17 | 74.00 | 73.36 | 71.82 | 65.45 |
| 1220 | 96.69 | 91.27 | 87.82 | 85.36 | 97.00 | 82.23 | 88.45 | 89.91 | 97.00 | 85.00 |
| 1221 | 97.00 | 92.91 | 85.45 | 79.09 | 97.09 | 94.31 | 98.27 | 101.82 | 105.91 | 93.09 |
| 1222 | 96.92 | 92.40 | 87.40 | 83.00 | 96.50 | 86.92 | 86.70 | 86.70 | 86.30 | 75.30 |
| 1223 | 96.62 | 91.75 | 85.00 | 76.58 | 96.46 | 80.62 | 88.75 | 96.36 | 100.17 | 78.08 |
| 1224 | 97.58 | 95.09 | 90.64 | 88.80 | 97.40 | 68.17 | 71.18 | 69.82 | 72.80 | 65.20 |
| 1225 | 97.33 | 92.36 | 82.58 | 81.00 | 96.73 | 87.75 | 90.27 | 92.83 | 94.27 | 83.00 |
| 1226 | 96.64 | 93.92 | 77.36 | 86.44 | 96.54 | 78.50 | 76.54 | 76.14 | 76.06 | 65.85 |
| 1227 | 96.92 | 92.69 | 86.93 | 85.46 | 97.83 | 66.77 | 70.08 | 76.14 | 71.92 | 63.67 |
| 1229 | 96.79 | 93.50 | 85.42 | 79.30 | 97.36 | 82.79 | 80.25 | 85.08 | 87.90 | 73.73 |
| 1231 | 96.09 | 90.82 | 80.18 | 72.27 | 97.09 | 67.73 | 72.73 | 79.55 | 82.09 | 62.91 |
| 1232 | 97.46 | 92.21 | 85.29 | 82.38 | 98.54 | 81.92 | 82.71 | 81.43 | 83.85 | 78.69 |
| 1233 | 97.00 | 91.45 | 84.00 | 79.91 | 97.36 | 80.42 | 82.36 | 81.64 | 76.55 | 66.09 |
| 1234 | 97.25 | 91.40 | 83.73 | 76.55 | 96.09 | 75.17 | 77.00 | 78.55 | 78.91 | 62.45 |
| 1235 | 96.77 | 93.83 | 88.42 | 86.82 | 96.75 | 63.69 | 62.33 | 64.58 | 64.64 | 57.83 |
| 1236 | 96.67 | 93.18 | 88.58 | 86.00 | 96.45 | 73.67 | 75.00 | 75.58 | 75.00 | 70.18 |
| 1237 | 97.17 | 93.18 | 86.18 | 80.00 | 96.80 | 52.50 | 58.00 | 68.82 | 70.40 | 44.90 |
| 1238 | 96.23 | 87.73 | 76.82 | 76.38 | 95.94 | 65.31 | 66.47 | 70.64 | 71.38 | 64.69 |
| 1239 | 97.08 | 93.45 | 87.30 | 82.70 | 97.20 | 60.75 | 65.00 | 73.60 | 71.30 | 58.30 |
| 1240 | 97.57 | 92.36 | 83.40 | 78.07 | 97.13 | 63.57 | 67.64 | 70.53 | 74.93 | 58.27 |
| 1241 | 97.08 | 93.54 | 87.85 | 82.73 | 97.07 | 106.25 | 113.08 | 116.85 | 116.67 | 103.21 |

## Appendix E. Oculometrics Recorded in the Mild Traumatic Brain Injury Subjects.

| Subject | Pupil Diameter (mm) | | | | | Pupil Response Amplitude (mm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 |
| 1101 | 5.353 | 5.071 | 4.689 | 5.065 | 5.357 | 0.983 | 1.117 | 1.169 | 1.117 | 1.248 |
| 1102 | 5.523 | 5.120 | 4.811 | 5.053 | 5.675 | 1.331 | 1.100 | 1.063 | 1.022 | 1.339 |
| 1103 | 6.544 | 6.591 | 6.545 | 6.464 | 6.378 | 1.586 | 1.582 | 1.553 | 1.517 | 1.531 |
| 1104 | 3.953 | 4.266 | . | 3.008 | . | 0.965 | 0.918 | . | 0.454 | . |
| 1105 | 5.856 | 5.622 | 5.445 | 5.314 | 5.243 | 1.758 | 1.563 | 1.425 | 1.310 | 1.240 |
| 1106 | 5.071 | 4.971 | 4.774 | 4.681 | 4.165 | 1.534 | 1.573 | 1.609 | 1.650 | 1.461 |
| 1107 | 3.849 | 4.150 | 3.527 | 3.713 | 4.363 | 1.073 | 1.163 | 1.017 | 0.976 | 1.187 |
| 1109 | 7.579 | 7.244 | 7.317 | 7.416 | 6.868 | 1.166 | 1.409 | 1.320 | 1.275 | 1.465 |
| 1111 | 4.096 | 3.904 | 4.174 | 4.170 | 4.469 | 0.892 | 0.817 | 1.003 | 0.905 | 1.032 |
| 1112 | 5.930 | 6.104 | 6.273 | 6.039 | 6.330 | 1.122 | 1.212 | 0.965 | 1.092 | 1.155 |
| 1113 | 7.031 | 7.466 | 7.244 | . | . | 0.984 | 0.731 | 1.120 | . | . |
| 1114 | 6.755 | 6.026 | 6.591 | 6.033 | 6.419 | 1.113 | 1.079 | 0.999 | 1.008 | 1.016 |
| 1116 | 6.074 | 5.850 | 5.826 | 5.811 | 5.323 | 1.404 | 1.347 | 1.456 | 1.341 | 1.192 |
| 1117 | 6.339 | 5.925 | 5.826 | 5.644 | 6.029 | 1.092 | 1.333 | 1.406 | 1.319 | 1.143 |
| 1118 | 4.063 | 3.881 | 3.998 | 3.956 | 4.061 | 0.881 | 1.027 | 1.055 | 1.030 | 1.063 |
| 1119 | 4.713 | 4.996 | 5.228 | 5.152 | 5.366 | 1.142 | 1.315 | 1.358 | 1.354 | 1.462 |
| 1120 | 5.559 | 5.502 | 5.354 | 5.399 | 5.473 | 0.556 | 0.532 | 0.551 | 0.702 | 0.659 |
| 1121 | 4.452 | 4.724 | 4.376 | 4.064 | 4.123 | 1.026 | 1.109 | 0.900 | 0.882 | 1.013 |
| 1122 | 3.914 | 3.926 | 3.792 | 3.943 | 3.998 | 0.849 | 0.872 | 0.688 | 0.839 | 0.789 |
| 1123 | 5.293 | 5.157 | 5.392 | 5.447 | 5.079 | 0.967 | 0.848 | 0.983 | 1.032 | 0.860 |
| 1124 | 5.892 | 5.772 | 5.432 | 5.833 | 5.586 | 1.084 | 1.041 | 0.996 | 1.086 | 1.094 |
| 1125 | 6.575 | 6.628 | 6.329 | 6.240 | 6.422 | 1.106 | 1.186 | 1.065 | 0.927 | 1.241 |
| 1126 | 6.570 | 6.616 | 6.377 | 6.495 | 6.078 | 1.467 | 1.302 | 1.385 | 1.286 | 1.402 |
| 1127 | 5.408 | 5.600 | 5.263 | 5.173 | 5.353 | 1.282 | 1.280 | 1.121 | 1.148 | 1.116 |
| 1129 | 5.922 | 5.460 | 4.981 | 5.187 | 5.299 | 0.820 | 0.785 | 0.794 | 0.740 | 0.763 |
| 1130 | 4.927 | 4.850 | 4.787 | 4.031 | 4.690 | 1.090 | 1.130 | 1.106 | 0.927 | 1.114 |
| 1132 | 5.856 | 5.826 | 5.486 | 5.552 | 5.668 | 1.242 | 1.334 | 1.310 | 1.315 | 1.243 |
| 1133 | 3.941 | 3.698 | 3.797 | 3.567 | 4.176 | 1.026 | 0.966 | 0.966 | 0.930 | 1.066 |
| 1134 | 6.426 | 6.184 | 5.846 | 5.215 | 5.783 | 1.318 | 1.259 | 1.243 | 0.995 | 1.297 |
| 1135 | 3.413 | 3.887 | . | 3.440 | 4.018 | 1.109 | 1.144 | . | 0.997 | 1.114 |
| 1136 | 5.913 | 5.705 | 5.681 | 5.801 | 5.613 | 1.355 | 1.280 | 1.250 | 1.304 | 1.293 |
| 1137 | 5.034 | 4.666 | 4.888 | 4.984 | 4.863 | 0.892 | 0.752 | 0.723 | 0.703 | 0.793 |
| 1138 | 5.213 | 4.470 | 4.218 | 3.991 | 4.254 | 0.954 | 0.761 | 0.676 | 0.715 | 0.811 |
| 1139 | 4.481 | 4.493 | 4.358 | 4.074 | 4.582 | 0.716 | 0.790 | 0.766 | 0.743 | 0.806 |
| 1140 | 5.742 | 5.543 | 5.117 | 4.441 | 4.463 | 1.372 | 1.124 | 0.952 | 0.837 | 0.898 |
| 1141 | 4.167 | 4.277 | 4.124 | 3.803 | 3.706 | 1.207 | 1.173 | 1.259 | 1.004 | 0.941 |

*Note.* Subjects 1104, 1113, and 1135 had conditions in which the FIT did not measure the pupil accurately. It is interesting to note that both the mTBI and control groups had the same number, five, conditions in which the FIT did not accurately capture data because this is indicative of a constant error rate.

**Oculometrics Recorded in the Mild Traumatic Brain Injury Subjects, continued.**

| Subject | Pupil Response Latency (ms) | | | | | Saccadic Velocity (deg/sec) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 |
| 1101 | 318.352 | 305.356 | 309.082 | 309.271 | 320.719 | 71.528 | 68.320 | 68.938 | 70.196 | 68.344 |
| 1102 | 311.362 | 322.875 | 306.062 | 326.848 | 307.708 | 74.824 | 73.893 | 72.878 | 71.247 | 68.814 |
| 1103 | 285.071 | 284.074 | 292.156 | 290.750 | 290.316 | 75.998 | 73.308 | 72.642 | 75.259 | 75.556 |
| 1104 | 283.831 | 294.391 | . | 328.580 | . | 68.029 | 62.621 | 63.974 | 52.951 | . |
| 1105 | 263.482 | 270.980 | 277.094 | 289.877 | 304.468 | 66.822 | 62.372 | 64.995 | 62.778 | 64.558 |
| 1106 | 286.685 | 280.061 | 283.140 | 282.082 | 286.440 | 76.268 | 66.104 | 67.813 | 61.813 | 59.328 |
| 1107 | 268.763 | 277.407 | 268.164 | 269.976 | 278.179 | 66.608 | 63.553 | 64.102 | 65.634 | 65.961 |
| 1109 | 301.252 | 294.592 | 309.531 | 295.544 | 304.580 | 83.126 | 82.355 | 79.461 | 85.994 | 83.862 |
| 1111 | 265.997 | 263.959 | 260.532 | 271.407 | 271.730 | 83.648 | 81.172 | 81.368 | 82.724 | 81.289 |
| 1112 | 277.045 | 282.777 | 285.062 | 267.559 | 275.637 | 72.631 | 70.387 | 70.660 | 73.829 | 69.759 |
| 1113 | 296.118 | 307.131 | 295.451 | . | . | 68.785 | 66.186 | 63.777 | 63.237 | 61.680 |
| 1114 | 298.030 | 291.513 | 301.036 | 296.421 | 304.366 | 70.320 | 68.209 | 66.377 | 74.232 | 64.471 |
| 1116 | 293.429 | 296.058 | 296.580 | 285.880 | 290.865 | 75.704 | 75.529 | 65.567 | 63.910 | 56.783 |
| 1117 | 307.231 | 292.349 | 288.699 | 290.050 | 313.641 | 67.992 | 67.537 | 67.033 | 65.554 | 72.839 |
| 1118 | 289.269 | 283.268 | 287.395 | 289.199 | 281.510 | 71.947 | 64.883 | 66.243 | 65.119 | 66.908 |
| 1119 | 325.403 | 329.825 | 328.123 | 330.237 | 318.406 | 72.368 | 76.916 | 81.488 | 76.104 | 74.798 |
| 1120 | 361.514 | 356.838 | 352.289 | 342.544 | 339.469 | 84.324 | 74.223 | 71.144 | 68.776 | 71.195 |
| 1121 | 295.933 | 289.574 | 289.033 | 281.493 | 281.768 | 70.263 | 63.829 | 64.764 | 66.854 | 65.021 |
| 1122 | 282.396 | 278.010 | 296.780 | 283.037 | 298.622 | 73.609 | 71.736 | 70.259 | 68.192 | 74.294 |
| 1123 | 344.410 | 330.620 | 330.800 | 340.325 | 355.043 | 67.258 | 64.898 | 74.648 | 63.166 | 60.835 |
| 1124 | 320.901 | 301.740 | 306.249 | 312.322 | 298.873 | 71.218 | 74.412 | 72.385 | 74.465 | 75.035 |
| 1125 | 328.559 | 328.269 | 326.637 | 335.215 | 319.548 | 66.259 | 61.491 | 72.077 | 60.614 | 60.690 |
| 1126 | 288.064 | 300.090 | 289.629 | 288.421 | 289.107 | 77.210 | 77.248 | 77.619 | 72.796 | 71.644 |
| 1127 | 309.459 | 307.548 | 318.131 | 308.940 | 319.727 | 72.886 | 68.930 | 71.938 | 72.917 | 71.989 |
| 1129 | 332.703 | 326.383 | 343.893 | 334.102 | 360.957 | 81.548 | 81.961 | 82.854 | 80.770 | 82.794 |
| 1130 | 267.116 | 266.912 | 254.758 | 250.369 | 257.250 | 91.329 | 86.244 | 88.421 | 90.872 | 88.761 |
| 1132 | 305.925 | 306.508 | 288.773 | 315.154 | 313.787 | 82.182 | 82.810 | 82.081 | 81.986 | 82.907 |
| 1133 | 281.833 | 286.362 | 289.392 | 284.049 | 296.708 | 84.471 | 86.844 | 82.477 | 85.825 | 80.928 |
| 1134 | 290.087 | 286.253 | 299.405 | 313.738 | 291.630 | 66.147 | 58.704 | 63.455 | 58.528 | 75.348 |
| 1135 | 271.581 | 282.090 | . | 283.259 | 280.009 | 65.142 | 66.632 | 64.043 | 68.262 | 65.535 |
| 1136 | 288.648 | 294.222 | 308.914 | 300.411 | 292.466 | 81.499 | 79.753 | 83.278 | 81.929 | 82.564 |
| 1137 | 291.448 | 309.098 | 335.881 | 301.807 | 327.881 | 70.570 | 74.440 | 69.340 | 75.765 | 73.919 |
| 1138 | 301.006 | 291.359 | 292.162 | 302.084 | 284.728 | 63.416 | 69.179 | 69.560 | 65.087 | 64.892 |
| 1139 | 293.453 | 286.416 | 305.993 | 297.414 | 303.993 | 66.386 | 69.929 | 72.430 | 68.461 | 64.295 |
| 1140 | 309.880 | 314.158 | 313.708 | 314.136 | 312.811 | 69.823 | 66.707 | 66.967 | 63.317 | 66.792 |
| 1141 | 314.475 | 307.785 | 306.883 | 294.483 | 306.764 | 79.957 | 83.795 | 82.453 | 83.169 | 78.076 |

*Note.* Subjects 1104, 1113, and 1135 had conditions in which the FIT did not measure the pupil accurately. It is interesting to note that both the mTBI and control groups had the same number, five, conditions in which the FIT did not accurately capture data because this is indicative of a constant error rate.

## Appendix F. Oculometrics Recorded in the Control Subjects.

| Subject | Pupil Diameter (mm) | | | | | Pupil Response Amplitude (mm) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| Number | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 |
| 1201 | 6.354 | 5.829 | 6.334 | 5.036 | 5.818 | 1.340 | 1.532 | 1.348 | 1.060 | 1.287 |
| 1202 | 6.153 | 6.058 | 6.255 | 5.884 | 6.241 | 1.489 | 1.367 | 1.530 | 1.620 | 1.499 |
| 1203 | 5.433 | 5.698 | 5.303 | 4.608 | 5.533 | 1.447 | 1.500 | 1.399 | 1.215 | 1.436 |
| 1204 | 4.945 | 4.451 | 4.256 | 4.385 | 4.873 | 1.174 | 1.103 | 0.919 | 1.087 | 1.253 |
| 1205 | 7.124 | 7.281 | 7.012 | 7.175 | 7.141 | 1.160 | 1.268 | 1.204 | 0.989 | 1.144 |
| 1206 | 3.903 | 3.942 | . | 3.862 | 4.199 | 1.182 | 1.233 | . | 1.169 | 1.284 |
| 1207 | 6.158 | 6.268 | 5.972 | 6.336 | 6.226 | 1.344 | 1.343 | 1.336 | 1.089 | 1.318 |
| 1209 | 7.426 | 7.176 | 7.158 | 7.026 | 7.368 | 0.890 | 1.029 | 0.833 | 0.791 | 0.855 |
| 1211 | 5.775 | 5.818 | . | 5.029 | 5.419 | 1.356 | 1.116 | . | 1.109 | 1.083 |
| 1212 | 7.329 | 7.137 | 7.169 | 7.119 | 6.852 | 1.054 | 1.007 | 1.028 | 1.011 | 1.021 |
| 1213 | 6.557 | 6.141 | 5.962 | 5.761 | 5.864 | 1.088 | 1.050 | 1.032 | 1.053 | 1.100 |
| 1215 | 6.333 | 6.197 | 5.922 | 6.411 | 6.632 | 1.280 | 1.333 | 1.374 | 1.242 | 1.423 |
| 1216 | 6.127 | 5.502 | 5.028 | 4.299 | 5.158 | 1.529 | 1.493 | 1.252 | 1.045 | 1.466 |
| 1217 | 5.146 | 5.120 | 5.039 | 4.900 | 4.714 | 0.932 | 0.856 | 0.980 | 0.874 | 0.877 |
| 1218 | 5.957 | 5.519 | 5.490 | 5.618 | 5.175 | 1.421 | 1.232 | 1.137 | 1.242 | 1.116 |
| 1219 | 4.544 | 4.389 | 4.415 | 4.358 | 4.597 | 0.679 | 0.664 | 0.645 | 0.715 | 0.760 |
| 1220 | 4.932 | 4.939 | 4.821 | 5.142 | 5.148 | 1.050 | 1.030 | 1.023 | 0.928 | 1.089 |
| 1221 | 6.767 | 6.423 | 6.447 | 6.393 | 6.866 | 1.048 | 1.176 | 1.116 | 1.062 | 0.947 |
| 1222 | 6.967 | 6.857 | 6.849 | 6.682 | 6.602 | 0.804 | 0.672 | 0.631 | 0.758 | 0.783 |
| 1223 | 5.108 | 5.470 | 4.696 | 4.686 | 4.412 | 1.205 | 1.139 | 1.154 | 1.448 | 1.203 |
| 1224 | 6.243 | 6.185 | 6.162 | 5.963 | 5.998 | 0.924 | 0.982 | 0.976 | 0.977 | 1.167 |
| 1225 | 5.824 | 5.517 | 5.279 | 5.087 | 5.736 | 1.149 | 1.136 | 1.087 | 1.062 | 1.099 |
| 1226 | 6.574 | 6.455 | 6.349 | 6.242 | 6.750 | 1.355 | 1.430 | 1.130 | 1.367 | 1.481 |
| 1227 | 5.166 | 4.364 | 4.450 | 4.735 | 4.869 | 1.430 | 1.150 | 1.212 | 1.281 | 1.376 |
| 1229 | 7.185 | 7.022 | 7.157 | 7.238 | 7.060 | 1.672 | 1.119 | 1.177 | 1.113 | 1.236 |
| 1231 | 5.434 | 4.719 | 4.749 | 3.988 | 5.096 | 1.198 | 0.927 | 0.995 | 0.801 | 1.098 |
| 1232 | 4.907 | 4.906 | 4.501 | 4.461 | 4.362 | 1.576 | 1.558 | 1.520 | 1.424 | 1.486 |
| 1233 | 5.383 | 5.549 | 5.565 | 5.346 | 5.701 | 1.258 | 1.174 | 1.096 | 1.054 | 1.092 |
| 1234 | 4.937 | 4.950 | 4.727 | 4.356 | 4.984 | 0.906 | 0.913 | 0.885 | 0.736 | 0.880 |
| 1235 | 4.470 | 4.194 | 4.073 | 3.861 | 4.269 | 1.066 | 0.990 | 1.069 | 0.957 | 1.043 |
| 1236 | 5.091 | 4.804 | 5.005 | 4.867 | 5.030 | 1.343 | 1.300 | 1.202 | 1.120 | 1.215 |
| 1237 | 5.993 | 6.054 | 5.769 | 5.486 | 5.476 | 1.129 | 1.062 | 1.083 | 0.894 | 1.189 |
| 1238 | 5.152 | 5.472 | 5.446 | 5.173 | . | 0.477 | 0.447 | 0.515 | 0.459 | . |
| 1239 | 5.489 | 4.940 | 5.331 | 4.988 | 5.052 | 1.063 | 0.892 | 1.016 | 0.918 | 0.993 |
| 1240 | 5.785 | 4.966 | 4.993 | 4.830 | . | 1.071 | 0.802 | 0.911 | 0.704 | . |
| 1241 | 6.473 | 6.546 | 6.005 | . | 5.594 | 1.337 | 1.221 | 1.336 | . | 1.174 |

*Note.* Subjects 1206, 1211, 1238, 1240, and 1241 had conditions in which the FIT did not measure the pupil accurately. It is interesting to note that both the mTBI and control groups had the same number, five, conditions in which the FIT did not accurately capture data because this is indicative of a constant error rate.

**Oculometrics Recorded in the Control Subjects, continued.**

| Subject Number | Pupil Response Latency (ms) | | | | | Saccadic Velocity (deg/sec) | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 | MSL-1 | 8,000 ft | 12,000 ft | 14,000 ft | MSL-2 |
| 1201 | 310.497 | 299.175 | 322.447 | 318.533 | 318.257 | 71.587 | 75.896 | 72.481 | 72.951 | 73.775 |
| 1202 | 279.793 | 285.982 | 278.581 | 267.291 | 278.282 | 67.237 | 67.694 | 64.779 | 68.415 | 64.114 |
| 1203 | 313.519 | 308.852 | 318.342 | 291.713 | 312.004 | 64.620 | 69.545 | 66.909 | 60.604 | 58.897 |
| 1204 | 304.763 | 295.081 | 294.860 | 286.228 | 289.478 | 66.144 | 68.064 | 67.326 | 67.019 | 64.829 |
| 1205 | 317.948 | 310.626 | 312.466 | 324.519 | 313.779 | 76.260 | 78.394 | 80.417 | 71.895 | 77.744 |
| 1206 | 284.216 | 290.499 | . | 286.102 | 286.514 | 72.193 | 74.094 | . | 72.134 | 76.698 |
| 1207 | 298.708 | 283.337 | 296.139 | 300.915 | 299.858 | 77.535 | 81.658 | 74.857 | 70.834 | 75.964 |
| 1209 | 282.820 | 276.393 | 296.130 | 293.770 | 289.911 | 70.583 | 75.060 | 73.508 | 68.833 | 77.369 |
| 1211 | 291.381 | 314.275 | . | 298.973 | 313.165 | 87.196 | 82.632 | 83.210 | 77.086 | 87.040 |
| 1212 | 307.365 | 314.991 | 311.480 | 319.443 | 312.923 | 65.226 | 64.507 | 64.515 | 62.923 | 63.633 |
| 1213 | 309.528 | 309.733 | 310.641 | 298.715 | 295.751 | 69.495 | 72.851 | 72.108 | 70.752 | 70.408 |
| 1215 | 279.726 | 271.488 | 267.826 | 288.919 | 284.845 | 68.861 | 70.328 | 70.830 | 64.152 | 67.962 |
| 1216 | 294.102 | 268.532 | 280.904 | 279.924 | 274.835 | 76.839 | 78.354 | 79.036 | 68.370 | 76.721 |
| 1217 | 360.657 | 357.502 | 342.300 | 342.364 | 359.454 | 85.153 | 79.579 | 78.124 | 84.512 | 72.516 |
| 1218 | 285.903 | 304.678 | 306.616 | 307.262 | 296.139 | 68.665 | 71.160 | 68.417 | 70.795 | 66.983 |
| 1219 | 280.386 | 281.825 | 290.054 | 275.486 | 276.505 | 68.219 | 69.215 | 68.247 | 72.027 | 64.771 |
| 1220 | 270.514 | 264.621 | 267.224 | 278.269 | 269.078 | 82.651 | 86.573 | 85.918 | 80.268 | 88.419 |
| 1221 | 272.830 | 271.592 | 277.656 | 267.941 | 270.395 | 73.791 | 70.179 | 69.311 | 66.293 | 71.931 |
| 1222 | 348.633 | 348.162 | 335.839 | 324.868 | 342.548 | 59.999 | 65.244 | 67.365 | 67.309 | 64.131 |
| 1223 | 290.739 | 294.818 | 283.164 | 278.760 | 284.010 | 66.220 | 61.756 | 66.248 | 67.950 | 70.071 |
| 1224 | 310.615 | 295.353 | 305.238 | 297.515 | 294.217 | 88.747 | 94.852 | 92.264 | 91.660 | 90.464 |
| 1225 | 281.990 | 286.158 | 291.699 | 281.036 | 291.990 | 70.569 | 71.906 | 72.863 | 68.054 | 64.371 |
| 1226 | 288.980 | 295.483 | 310.776 | 309.122 | 300.842 | 81.736 | 70.521 | 74.013 | 69.805 | 69.532 |
| 1227 | 244.671 | 247.498 | 246.406 | 245.275 | 240.477 | 61.485 | 69.357 | 65.430 | 68.074 | 69.548 |
| 1229 | 293.458 | 310.769 | 305.149 | 301.047 | 306.201 | 78.295 | 82.976 | 80.532 | 79.519 | 76.498 |
| 1231 | 281.319 | 282.377 | 286.910 | 277.065 | 287.902 | 84.115 | 84.565 | 76.639 | 83.709 | 83.966 |
| 1232 | 258.334 | 261.335 | 251.344 | 254.905 | 249.161 | 72.817 | 70.609 | 69.973 | 69.083 | 68.441 |
| 1233 | 259.938 | 274.602 | 272.995 | 267.303 | 272.280 | 65.260 | 71.891 | 62.248 | 65.454 | 60.843 |
| 1234 | 294.206 | 303.489 | 295.408 | 290.038 | 300.241 | 75.272 | 79.137 | 76.146 | 73.032 | 66.946 |
| 1235 | 303.010 | 300.238 | 290.290 | 287.967 | 298.735 | 73.484 | 72.477 | 70.146 | 72.610 | 71.230 |
| 1236 | 311.227 | 304.568 | 321.250 | 332.550 | 333.002 | 70.918 | 72.522 | 68.075 | 67.528 | 69.791 |
| 1237 | 297.020 | 305.872 | 302.106 | 317.130 | 306.002 | 66.895 | 66.167 | 67.567 | 67.573 | 70.592 |
| 1238 | 378.888 | 367.296 | 373.135 | 364.819 | . | 65.474 | 65.536 | 64.607 | 63.705 | 62.916 |
| 1239 | 287.798 | 289.888 | 280.270 | 294.883 | 278.641 | 73.135 | 69.684 | 65.494 | 69.319 | 69.225 |
| 1240 | 313.113 | 318.085 | 305.015 | 315.400 | . | 64.024 | 70.968 | 65.341 | 71.565 | 65.913 |
| 1241 | 316.965 | 312.180 | 304.640 | . | 324.633 | 86.998 | 85.767 | 79.678 | 86.164 | 80.360 |

*Note.* Subjects 1206, 1211, 1238, 1240, and 1241 had conditions in which the FIT did not measure the pupil accurately. It is interesting to note that both the mTBI and control groups had the same number, five, conditions in which the FIT did not accurately capture data because this is indicative of a constant error rate.

## Appendix G. Correlation Matrix Among All Variables for the Mild Traumatic Brain Injury Subjects.

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| Age | Pearson Correlation | -.327 | 1 | .300 | .318 | .401 | .329 | .453 | .059 |
| | Sig. (2-tailed) | .051 | | .075 | .059 | .015 | .050 | .006 | .731 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| Pulse | Pearson Correlation | .128 | .300 | 1 | .408 | .542 | .163 | .312 | -.056 |
| | Sig. (2-tailed) | .457 | .075 | | .014 | .001 | .343 | .064 | .745 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| BPsystolic | Pearson Correlation | -.375 | .318 | .408 | 1 | .658 | .108 | .539 | .489 |
| | Sig. (2-tailed) | .024 | .059 | .014 | | .000 | .531 | .001 | .002 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| BPDiastolic | Pearson Correlation | -.027 | .401 | .542 | .658 | 1 | .256 | .417 | .073 |
| | Sig. (2-tailed) | .878 | .015 | .001 | .000 | | .132 | .011 | .672 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| Respiration | Pearson Correlation | -.117 | .329 | .163 | .108 | .256 | 1 | .145 | -.052 |
| | Sig. (2-tailed) | .498 | .050 | .343 | .531 | .132 | | .399 | .762 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| Weight | Pearson Correlation | -.376 | .453 | .312 | .539 | .417 | .145 | 1 | .476 |
| | Sig. (2-tailed) | .024 | .006 | .064 | .001 | .011 | .399 | | .003 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| Height_inches | Pearson Correlation | -.611 | .059 | -.056 | .489 | .073 | -.052 | .476 | 1 |
| | Sig. (2-tailed) | .000 | .731 | .745 | .002 | .672 | .762 | .003 | |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | BMI | MonthsPost_Inj | LOC | Amnesia | OX_PreSL | OX_8k | OX_12k | OX_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.175 | .002 | -.096 | .000 | .409 | .276 | .127 | -.002 |
| Sex | Sig. (2-tailed) | .308 | .989 | .576 | 1.000 | .013 | .104 | .459 | .989 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .460 | .164 | .076 | .381 | -.575 | -.327 | -.097 | .086 |
| Age | Sig. (2-tailed) | .005 | .339 | .661 | .022 | .000 | .052 | .574 | .620 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .316 | -.344 | -.123 | .169 | -.166 | -.377 | -.315 | -.163 |
| Pulse | Sig. (2-tailed) | .060 | .040 | .473 | .325 | .333 | .023 | .062 | .342 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .394 | -.049 | .001 | .233 | -.085 | -.047 | .071 | .237 |
| BPsystolic | Sig. (2-tailed) | .018 | .776 | .994 | .171 | .622 | .786 | .681 | .164 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .389 | -.047 | .024 | .325 | .006 | -.050 | .004 | .106 |
| BPDiastolic | Sig. (2-tailed) | .019 | .784 | .891 | .053 | .971 | .773 | .982 | .537 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .170 | -.140 | -.299 | .200 | -.211 | -.077 | .003 | .159 |
| Respiration | Sig. (2-tailed) | .322 | .417 | .076 | .242 | .217 | .655 | .986 | .355 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .938 | .208 | .016 | .114 | -.071 | -.075 | -.045 | .041 |
| Weight | Sig. (2-tailed) | .000 | .222 | .928 | .507 | .682 | .662 | .792 | .815 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .186 | -.033 | .092 | -.104 | .024 | .017 | .091 | .185 |
| Height_inches | Sig. (2-tailed) | .277 | .850 | .595 | .547 | .888 | .920 | .599 | .280 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | OX_PostSL | PLBPM_PreSL | PLBPM_8k | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .381 | -.098 | -.058 | -.103 | -.045 | .018 | .066 |
| Sex | Sig. (2-tailed) | .022 | .569 | .735 | .550 | .796 | .918 | .703 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.586 | .274 | .296 | .371 | .326 | .274 | -.315 |
| Age | Sig. (2-tailed) | .000 | .106 | .079 | .026 | .052 | .105 | .061 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.321 | .819 | .816 | .753 | .750 | .803 | -.045 |
| Pulse | Sig. (2-tailed) | .056 | .000 | .000 | .000 | .000 | .000 | .796 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.311 | .415 | .425 | .400 | .378 | .401 | -.195 |
| BPsystolic | Sig. (2-tailed) | .065 | .012 | .010 | .016 | .023 | .015 | .255 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.156 | .599 | .659 | .640 | .668 | .633 | -.253 |
| BPDiastolic | Sig. (2-tailed) | .364 | .000 | .000 | .000 | .000 | .000 | .137 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.160 | .245 | .283 | .300 | .243 | .224 | -.179 |
| Respiration | Sig. (2-tailed) | .351 | .150 | .095 | .075 | .153 | .189 | .295 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.341 | .482 | .498 | .569 | .541 | .512 | -.111 |
| Weight | Sig. (2-tailed) | .042 | .003 | .002 | .000 | .001 | .001 | .518 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.156 | .169 | .152 | .183 | .106 | .126 | .040 |
| Height_inches | Sig. (2-tailed) | .365 | .325 | .377 | .284 | .537 | .465 | .816 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITD_8k | FITD_12k | FITD_14k | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .086 | -.054 | .079 | -.016 | .212 | .140 | .015 | .085 |
| Sex | Sig. (2-tailed) | .618 | .761 | .653 | .930 | .214 | .417 | .934 | .629 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.269 | -.213 | -.234 | -.263 | -.304 | -.129 | -.104 | -.022 |
| Age | Sig. (2-tailed) | .112 | .227 | .175 | .133 | .072 | .453 | .558 | .901 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.027 | -.084 | -.123 | -.123 | .135 | .142 | .058 | .050 |
| Pulse | Sig. (2-tailed) | .876 | .637 | .480 | .490 | .432 | .410 | .743 | .774 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.228 | -.234 | -.278 | -.264 | -.283 | -.251 | -.258 | -.232 |
| BPsystolic | Sig. (2-tailed) | .182 | .183 | .106 | .131 | .095 | .140 | .141 | .180 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.194 | -.188 | -.352 | -.297 | -.255 | -.268 | -.301 | -.238 |
| BPDiastolic | Sig. (2-tailed) | .257 | .288 | .038 | .088 | .134 | .113 | .083 | .169 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.177 | -.133 | -.158 | -.192 | .048 | -.077 | -.112 | -.151 |
| Respiration | Sig. (2-tailed) | .301 | .454 | .365 | .277 | .783 | .654 | .528 | .387 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.124 | -.082 | -.158 | -.206 | -.209 | -.064 | .119 | .115 |
| Weight | Sig. (2-tailed) | .471 | .645 | .366 | .241 | .221 | .713 | .501 | .510 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.024 | -.054 | .016 | -.001 | -.293 | -.261 | -.106 | -.102 |
| Height_inches | Sig. (2-tailed) | .888 | .762 | .929 | .995 | .083 | .125 | .550 | .559 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITA_PostSL | FITL_PreSL | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.058 | .115 | .064 | .000 | .138 | .225 | -.108 | -.111 |
| Sex | Sig. (2-tailed) | .743 | .505 | .712 | .999 | .428 | .200 | .531 | .520 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.101 | .143 | .102 | .134 | .088 | -.017 | -.095 | -.173 |
| Age | Sig. (2-tailed) | .569 | .405 | .555 | .449 | .615 | .923 | .581 | .314 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.085 | .093 | .024 | -.088 | -.021 | -.077 | -.152 | -.206 |
| Pulse | Sig. (2-tailed) | .632 | .591 | .888 | .620 | .903 | .663 | .378 | .229 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.214 | -.061 | -.060 | -.132 | -.214 | -.208 | .174 | .177 |
| BPsystolic | Sig. (2-tailed) | .224 | .724 | .730 | .458 | .216 | .237 | .310 | .303 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.324 | -.064 | -.032 | -.058 | -.156 | -.071 | -.092 | -.154 |
| BPDiastolic | Sig. (2-tailed) | .062 | .713 | .852 | .746 | .370 | .688 | .592 | .371 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.105 | .101 | .229 | .280 | .281 | .174 | -.216 | -.259 |
| Respiration | Sig. (2-tailed) | .556 | .557 | .180 | .109 | .103 | .326 | .206 | .127 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.028 | .178 | .084 | .008 | -.030 | .034 | .241 | .140 |
| Weight | Sig. (2-tailed) | .876 | .298 | .627 | .965 | .864 | .849 | .156 | .415 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.138 | .217 | .241 | .207 | .099 | .149 | .239 | .273 |
| Height_inches | Sig. (2-tailed) | .437 | .203 | .157 | .240 | .571 | .400 | .160 | .108 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITV_12k | FITV_14k | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.041 | -.047 | -.012 | .336 | .294 | .341 | .300 |
| Sex | Sig. (2-tailed) | .812 | .786 | .946 | .045 | .082 | .042 | .076 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .001 | -.157 | -.080 | -.054 | -.160 | -.075 | -.173 |
| Age | Sig. (2-tailed) | .996 | .360 | .647 | .756 | .350 | .663 | .313 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.125 | -.221 | -.081 | .109 | .102 | .245 | .109 |
| Pulse | Sig. (2-tailed) | .467 | .195 | .643 | .525 | .554 | .150 | .527 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .177 | .215 | .232 | -.064 | -.230 | -.132 | -.094 |
| BPsystolic | Sig. (2-tailed) | .303 | .207 | .181 | .709 | .177 | .442 | .584 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.107 | -.068 | -.011 | .026 | -.088 | .069 | .126 |
| BPDiastolic | Sig. (2-tailed) | .536 | .695 | .949 | .879 | .611 | .691 | .463 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.192 | -.356 | -.217 | .135 | -.068 | -.110 | -.224 |
| Respiration | Sig. (2-tailed) | .262 | .033 | .211 | .431 | .696 | .523 | .190 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .231 | .089 | .126 | .015 | -.161 | -.082 | -.114 |
| Weight | Sig. (2-tailed) | .176 | .606 | .471 | .932 | .347 | .635 | .510 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .237 | .193 | .108 | -.183 | -.283 | -.387 | -.346 |
| Height_inches | Sig. (2-tailed) | .164 | .260 | .538 | .286 | .095 | .020 | .039 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | ESQams_PostSL |
|---|---|---|
| Sex | Pearson Correlation | .249 |
| | Sig. (2-tailed) | .143 |
| | N | 36 |
| Age | Pearson Correlation | -.203 |
| | Sig. (2-tailed) | .234 |
| | N | 36 |
| Pulse | Pearson Correlation | .009 |
| | Sig. (2-tailed) | .959 |
| | N | 36 |
| BPsystolic | Pearson Correlation | -.267 |
| | Sig. (2-tailed) | .115 |
| | N | 36 |
| BPDiastolic | Pearson Correlation | -.178 |
| | Sig. (2-tailed) | .300 |
| | N | 36 |
| Respiration | Pearson Correlation | -.225 |
| | Sig. (2-tailed) | .186 |
| | N | 36 |
| Weight | Pearson Correlation | -.111 |
| | Sig. (2-tailed) | .520 |
| | N | 36 |
| Height_inches | Pearson Correlation | -.212 |
| | Sig. (2-tailed) | .213 |
| | N | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| BMI | Pearson Correlation | -.175 | .460 | .316 | .394 | .389 | .170 | .938 | .186 |
| | Sig. (2-tailed) | .308 | .005 | .060 | .018 | .019 | .322 | .000 | .277 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| MonthsPost_Inj | Pearson Correlation | .002 | .164 | -.344 | -.049 | -.047 | -.140 | .208 | -.033 |
| | Sig. (2-tailed) | .989 | .339 | .040 | .776 | .784 | .417 | .222 | .850 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| LOC | Pearson Correlation | -.096 | .076 | -.123 | .001 | .024 | -.299 | .016 | .092 |
| | Sig. (2-tailed) | .576 | .661 | .473 | .994 | .891 | .076 | .928 | .595 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| Amnesia | Pearson Correlation | .000 | .381 | .169 | .233 | .325 | .200 | .114 | -.104 |
| | Sig. (2-tailed) | 1.000 | .022 | .325 | .171 | .053 | .242 | .507 | .547 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| OX_PreSL | Pearson Correlation | .409 | -.575 | -.166 | -.085 | .006 | -.211 | -.071 | .024 |
| | Sig. (2-tailed) | .013 | .000 | .333 | .622 | .971 | .217 | .682 | .888 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| OX_8k | Pearson Correlation | .276 | -.327 | -.377 | -.047 | -.050 | -.077 | -.075 | .017 |
| | Sig. (2-tailed) | .104 | .052 | .023 | .786 | .773 | .655 | .662 | .920 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| OX_12k | Pearson Correlation | .127 | -.097 | -.315 | .071 | .004 | .003 | -.045 | .091 |
| | Sig. (2-tailed) | .459 | .574 | .062 | .681 | .982 | .986 | .792 | .599 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| OX_14k | Pearson Correlation | -.002 | .086 | -.163 | .237 | .106 | .159 | .041 | .185 |
| | Sig. (2-tailed) | .989 | .620 | .342 | .164 | .537 | .355 | .815 | .280 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | BMI | MonthsPost_Inj | LOC | Amnesia | OX_PreSL | OX_8k | OX_12k | OX_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | 1 | .298 | -.041 | .090 | -.057 | -.042 | -.037 | .023 |
| BMI | Sig. (2-tailed) | | .078 | .814 | .602 | .742 | .808 | .831 | .893 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .298 | 1 | .166 | -.083 | -.002 | .217 | .270 | .232 |
| MonthsPost_Inj | Sig. (2-tailed) | .078 | | .334 | .628 | .990 | .203 | .111 | .173 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.041 | .166 | 1 | .334 | -.015 | -.168 | -.094 | -.199 |
| LOC | Sig. (2-tailed) | .814 | .334 | | .046 | .929 | .328 | .584 | .244 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .090 | -.083 | .334 | 1 | -.299 | -.332 | -.318 | -.229 |
| Amnesia | Sig. (2-tailed) | .602 | .628 | .046 | | .076 | .048 | .059 | .179 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.057 | -.002 | -.015 | -.299 | 1 | .671 | .506 | .265 |
| OX_PreSL | Sig. (2-tailed) | .742 | .990 | .929 | .076 | | .000 | .002 | .119 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.042 | .217 | -.168 | -.332 | .671 | 1 | .845 | .682 |
| OX_8k | Sig. (2-tailed) | .808 | .203 | .328 | .048 | .000 | | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.037 | .270 | -.094 | -.318 | .506 | .845 | 1 | .859 |
| OX_12k | Sig. (2-tailed) | .831 | .111 | .584 | .059 | .002 | .000 | | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .023 | .232 | -.199 | -.229 | .265 | .682 | .859 | 1 |
| OX_14k | Sig. (2-tailed) | .893 | .173 | .244 | .179 | .119 | .000 | .000 | |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | OX_PostSL | PLBPM_PreSL | PLBPM_8k | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.308 | .441 | .465 | .536 | .527 | .499 | -.089 |
| BMI | Sig. (2-tailed) | .068 | .007 | .004 | .001 | .001 | .002 | .604 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.089 | -.200 | -.158 | -.089 | -.102 | -.186 | .303 |
| MonthsPost_Inj | Sig. (2-tailed) | .605 | .243 | .356 | .606 | .554 | .278 | .072 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.199 | .003 | -.076 | .003 | .046 | .002 | .165 |
| LOC | Sig. (2-tailed) | .244 | .986 | .659 | .986 | .788 | .989 | .336 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.345 | .129 | .163 | .263 | .237 | .142 | -.346 |
| Amnesia | Sig. (2-tailed) | .039 | .452 | .341 | .121 | .164 | .410 | .039 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .555 | -.132 | -.121 | -.202 | -.157 | -.052 | .143 |
| OX_PreSL | Sig. (2-tailed) | .000 | .443 | .481 | .237 | .361 | .762 | .406 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .563 | -.251 | -.254 | -.320 | -.326 | -.204 | .039 |
| OX_8k | Sig. (2-tailed) | .000 | .140 | .135 | .057 | .053 | .232 | .821 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .347 | -.269 | -.274 | -.368 | -.380 | -.211 | .094 |
| OX_12k | Sig. (2-tailed) | .038 | .113 | .106 | .027 | .022 | .216 | .588 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .182 | -.110 | -.113 | -.214 | -.275 | -.083 | .088 |
| OX_14k | Sig. (2-tailed) | .288 | .523 | .513 | .210 | .104 | .632 | .609 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITD_8k | FITD_12k | FITD_14k | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.104 | -.075 | -.137 | -.201 | -.153 | -.015 | .136 | .151 |
| BMI | Sig. (2-tailed) | .547 | .673 | .433 | .255 | .372 | .931 | .443 | .386 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .316 | .332 | .281 | .266 | -.199 | -.185 | -.097 | -.066 |
| MonthsPost_Inj | Sig. (2-tailed) | .060 | .055 | .101 | .129 | .244 | .281 | .583 | .706 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .180 | .274 | .070 | .157 | -.121 | .012 | .082 | -.032 |
| LOC | Sig. (2-tailed) | .293 | .117 | .689 | .376 | .484 | .943 | .644 | .856 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.287 | -.212 | -.270 | -.319 | -.328 | -.220 | -.313 | -.197 |
| Amnesia | Sig. (2-tailed) | .090 | .230 | .116 | .066 | .050 | .197 | .071 | .256 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .073 | -.025 | .138 | .096 | .203 | .211 | .109 | .181 |
| OX_PreSL | Sig. (2-tailed) | .674 | .888 | .429 | .589 | .235 | .217 | .539 | .298 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .000 | -.077 | .061 | .025 | .037 | .004 | -.082 | .051 |
| OX_8k | Sig. (2-tailed) | .998 | .667 | .726 | .889 | .830 | .984 | .644 | .769 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .082 | -.036 | .106 | .030 | .063 | .029 | -.050 | .100 |
| OX_12k | Sig. (2-tailed) | .634 | .838 | .546 | .865 | .715 | .866 | .780 | .566 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .089 | -.011 | .122 | -.034 | .015 | -.049 | -.099 | .073 |
| OX_14k | Sig. (2-tailed) | .606 | .951 | .485 | .846 | .929 | .776 | .578 | .676 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITA_PostSL | FITL_PreSL | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.016 | .179 | .044 | -.023 | -.013 | .062 | .184 | .048 |
| BMI | Sig. (2-tailed) | .927 | .296 | .797 | .898 | .940 | .726 | .284 | .783 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.062 | .174 | .169 | .208 | .167 | .222 | .321 | .211 |
| MonthsPost_Inj | Sig. (2-tailed) | .727 | .311 | .324 | .237 | .338 | .207 | .056 | .217 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.071 | .021 | -.019 | .072 | .030 | .071 | -.045 | -.114 |
| LOC | Sig. (2-tailed) | .691 | .903 | .911 | .686 | .866 | .690 | .796 | .507 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.249 | .095 | .089 | .122 | -.018 | -.109 | -.040 | -.211 |
| Amnesia | Sig. (2-tailed) | .156 | .580 | .608 | .492 | .920 | .538 | .819 | .216 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .032 | -.200 | -.207 | -.098 | -.189 | .140 | .233 | .235 |
| OX_PreSL | Sig. (2-tailed) | .856 | .241 | .225 | .580 | .276 | .429 | .171 | .168 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .011 | -.121 | -.098 | -.007 | -.055 | .154 | .067 | .156 |
| OX_8k | Sig. (2-tailed) | .952 | .483 | .571 | .970 | .753 | .385 | .698 | .363 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .060 | -.096 | -.038 | .081 | -.013 | .176 | .079 | .094 |
| OX_12k | Sig. (2-tailed) | .736 | .578 | .824 | .648 | .939 | .319 | .646 | .587 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .004 | -.016 | .024 | .131 | .009 | .163 | .113 | .138 |
| OX_14k | Sig. (2-tailed) | .984 | .926 | .888 | .459 | .959 | .358 | .512 | .422 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITV_12k | FITV_14k | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .181 | .011 | .088 | .135 | -.069 | .050 | .044 |
| BMI | Sig. (2-tailed) | .289 | .950 | .613 | .434 | .688 | .774 | .798 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .390 | .267 | .292 | .120 | -.041 | -.038 | .118 |
| MonthsPost_Inj | Sig. (2-tailed) | .019 | .115 | .088 | .487 | .814 | .824 | .495 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.228 | -.101 | -.036 | -.225 | -.175 | -.226 | -.216 |
| LOC | Sig. (2-tailed) | .182 | .556 | .839 | .188 | .307 | .185 | .206 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.288 | -.160 | -.184 | .153 | .118 | .096 | -.140 |
| Amnesia | Sig. (2-tailed) | .089 | .351 | .289 | .374 | .493 | .578 | .414 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .153 | .326 | .340 | -.187 | -.199 | -.162 | -.022 |
| OX_PreSL | Sig. (2-tailed) | .374 | .052 | .046 | .274 | .245 | .344 | .900 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .205 | .307 | .321 | -.003 | -.115 | -.153 | -.134 |
| OX_8k | Sig. (2-tailed) | .230 | .069 | .060 | .988 | .505 | .373 | .436 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .190 | .204 | .260 | -.171 | -.315 | -.330 | -.206 |
| OX_12k | Sig. (2-tailed) | .266 | .234 | .132 | .318 | .061 | .049 | .229 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .247 | .232 | .298 | -.046 | -.228 | -.290 | -.270 |
| OX_14k | Sig. (2-tailed) | .146 | .173 | .082 | .789 | .180 | .086 | .111 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | ESQams_PostSL |
|---|---|---|
| BMI | Pearson Correlation | .022 |
| | Sig. (2-tailed) | .900 |
| | N | 36 |
| MonthsPost_Inj | Pearson Correlation | .119 |
| | Sig. (2-tailed) | .488 |
| | N | 36 |
| LOC | Pearson Correlation | -.205 |
| | Sig. (2-tailed) | .231 |
| | N | 36 |
| Amnesia | Pearson Correlation | -.141 |
| | Sig. (2-tailed) | .413 |
| | N | 36 |
| OX_PreSL | Pearson Correlation | .089 |
| | Sig. (2-tailed) | .608 |
| | N | 36 |
| OX_8k | Pearson Correlation | -.202 |
| | Sig. (2-tailed) | .237 |
| | N | 36 |
| OX_12k | Pearson Correlation | -.294 |
| | Sig. (2-tailed) | .082 |
| | N | 36 |
| OX_14k | Pearson Correlation | -.304 |
| | Sig. (2-tailed) | .072 |
| | N | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| OX_PostSL | Pearson Correlation | .381 | -.586 | -.321 | -.311 | -.156 | -.160 | -.341 | -.156 |
| | Sig. (2-tailed) | .022 | .000 | .056 | .065 | .364 | .351 | .042 | .365 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| PLBPM_PreSL | Pearson Correlation | -.098 | .274 | .819 | .415 | .599 | .245 | .482 | .169 |
| | Sig. (2-tailed) | .569 | .106 | .000 | .012 | .000 | .150 | .003 | .325 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| PLBPM_8k | Pearson Correlation | -.058 | .296 | .816 | .425 | .659 | .283 | .498 | .152 |
| | Sig. (2-tailed) | .735 | .079 | .000 | .010 | .000 | .095 | .002 | .377 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| PLBPM_12k | Pearson Correlation | -.103 | .371 | .753 | .400 | .640 | .300 | .569 | .183 |
| | Sig. (2-tailed) | .550 | .026 | .000 | .016 | .000 | .075 | .000 | .284 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| PLBPM_14k | Pearson Correlation | -.045 | .326 | .750 | .378 | .668 | .243 | .541 | .106 |
| | Sig. (2-tailed) | .796 | .052 | .000 | .023 | .000 | .153 | .001 | .537 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| PLBPM_PostSL | Pearson Correlation | .018 | .274 | .803 | .401 | .633 | .224 | .512 | .126 |
| | Sig. (2-tailed) | .918 | .105 | .000 | .015 | .000 | .189 | .001 | .465 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| FITD_PreSL | Pearson Correlation | .066 | -.315 | -.045 | -.195 | -.253 | -.179 | -.111 | .040 |
| | Sig. (2-tailed) | .703 | .061 | .796 | .255 | .137 | .295 | .518 | .816 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| FITD_8k | Pearson Correlation | .086 | -.269 | -.027 | -.228 | -.194 | -.177 | -.124 | -.024 |
| | Sig. (2-tailed) | .618 | .112 | .876 | .182 | .257 | .301 | .471 | .888 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | BMI | MonthsPost_Inj | LOC | Amnesia | OX_PreSL | OX_8k | OX_12k | OX_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.308 | -.089 | -.199 | -.345 | .555 | .563 | .347 | .182 |
| OX_PostSL | Sig. (2-tailed) | .068 | .605 | .244 | .039 | .000 | .000 | .038 | .288 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .441 | -.200 | .003 | .129 | -.132 | -.251 | -.269 | -.110 |
| PLBPM_PreSL | Sig. (2-tailed) | .007 | .243 | .986 | .452 | .443 | .140 | .113 | .523 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .465 | -.158 | -.076 | .163 | -.121 | -.254 | -.274 | -.113 |
| PLBPM_8k | Sig. (2-tailed) | .004 | .356 | .659 | .341 | .481 | .135 | .106 | .513 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .536 | -.089 | .003 | .263 | -.202 | -.320 | -.368 | -.214 |
| PLBPM_12k | Sig. (2-tailed) | .001 | .606 | .986 | .121 | .237 | .057 | .027 | .210 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .527 | -.102 | .046 | .237 | -.157 | -.326 | -.380 | -.275 |
| PLBPM_14k | Sig. (2-tailed) | .001 | .554 | .788 | .164 | .361 | .053 | .022 | .104 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .499 | -.186 | .002 | .142 | -.052 | -.204 | -.211 | -.083 |
| PLBPM_PostSL | Sig. (2-tailed) | .002 | .278 | .989 | .410 | .762 | .232 | .216 | .632 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.089 | .303 | .165 | -.346 | .143 | .039 | .094 | .088 |
| FITD_PreSL | Sig. (2-tailed) | .604 | .072 | .336 | .039 | .406 | .821 | .588 | .609 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.104 | .316 | .180 | -.287 | .073 | .000 | .082 | .089 |
| FITD_8k | Sig. (2-tailed) | .547 | .060 | .293 | .090 | .674 | .998 | .634 | .606 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | OX_PostSL | PLBPM_PreSL | PLBPM_8k | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | 1 | -.292 | -.307 | -.378 | -.326 | -.225 | .067 |
| OX_PostSL | Sig. (2-tailed) | | .084 | .068 | .023 | .053 | .187 | .699 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.292 | 1 | .974 | .899 | .892 | .957 | .002 |
| PLBPM_PreSL | Sig. (2-tailed) | .084 | | .000 | .000 | .000 | .000 | .989 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.307 | .974 | 1 | .943 | .935 | .943 | -.038 |
| PLBPM_8k | Sig. (2-tailed) | .068 | .000 | | .000 | .000 | .000 | .827 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.378 | .899 | .943 | 1 | .981 | .892 | -.082 |
| PLBPM_12k | Sig. (2-tailed) | .023 | .000 | .000 | | .000 | .000 | .636 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.326 | .892 | .935 | .981 | 1 | .899 | -.063 |
| PLBPM_14k | Sig. (2-tailed) | .053 | .000 | .000 | .000 | | .000 | .716 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.225 | .957 | .943 | .892 | .899 | 1 | .003 |
| PLBPM_PostSL | Sig. (2-tailed) | .187 | .000 | .000 | .000 | .000 | | .985 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .067 | .002 | -.038 | -.082 | -.063 | .003 | 1 |
| FITD_PreSL | Sig. (2-tailed) | .699 | .989 | .827 | .636 | .716 | .985 | |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .056 | .028 | .000 | -.051 | -.028 | .037 | .960 |
| FITD_8k | Sig. (2-tailed) | .747 | .873 | .999 | .768 | .873 | .830 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITD_8k | FITD_12k | FITD_14k | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .056 | .030 | .058 | .107 | .107 | .018 | -.082 | -.029 |
| OX_PostSL | Sig. (2-tailed) | .747 | .868 | .742 | .546 | .535 | .918 | .643 | .868 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .028 | .012 | -.096 | -.072 | .092 | .089 | .090 | .044 |
| PLBPM_PreSL | Sig. (2-tailed) | .873 | .946 | .585 | .686 | .593 | .606 | .614 | .803 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .000 | -.009 | -.118 | -.108 | .091 | .055 | .065 | .033 |
| PLBPM_8k | Sig. (2-tailed) | .999 | .961 | .501 | .543 | .598 | .750 | .715 | .851 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.051 | -.025 | -.191 | -.171 | -.028 | -.071 | .003 | -.058 |
| PLBPM_12k | Sig. (2-tailed) | .768 | .888 | .272 | .333 | .869 | .679 | .986 | .740 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.028 | -.002 | -.194 | -.144 | .041 | -.002 | .059 | -.024 |
| PLBPM_14k | Sig. (2-tailed) | .873 | .990 | .265 | .415 | .815 | .990 | .740 | .893 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .037 | .007 | -.072 | -.082 | .087 | .114 | .125 | .115 |
| PLBPM_PostSL | Sig. (2-tailed) | .830 | .970 | .681 | .645 | .612 | .508 | .480 | .511 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .960 | .945 | .920 | .892 | .363 | .307 | .361 | .420 |
| FITD_PreSL | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .029 | .068 | .036 | .012 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | 1 | .966 | .929 | .906 | .385 | .349 | .407 | .472 |
| FITD_8k | Sig. (2-tailed) | | .000 | .000 | .000 | .020 | .037 | .017 | .004 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITA_PostSL | FITL_PreSL | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.048 | -.073 | -.034 | -.022 | -.029 | .169 | -.037 | .114 |
| OX_PostSL | Sig. (2-tailed) | .786 | .672 | .845 | .900 | .869 | .339 | .832 | .506 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.093 | .104 | .063 | -.077 | -.033 | -.047 | -.040 | -.137 |
| PLBPM_PreSL | Sig. (2-tailed) | .602 | .546 | .714 | .665 | .850 | .793 | .817 | .427 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.109 | .124 | .123 | -.025 | .002 | .003 | -.014 | -.123 |
| PLBPM_8k | Sig. (2-tailed) | .540 | .469 | .473 | .888 | .990 | .986 | .937 | .474 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.198 | .154 | .167 | .020 | .053 | .040 | -.076 | -.202 |
| PLBPM_12k | Sig. (2-tailed) | .263 | .369 | .332 | .909 | .760 | .820 | .658 | .236 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.138 | .093 | .107 | -.055 | .004 | -.010 | -.075 | -.216 |
| PLBPM_14k | Sig. (2-tailed) | .435 | .588 | .533 | .757 | .980 | .956 | .665 | .206 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.086 | .105 | .061 | -.117 | -.075 | -.001 | -.029 | -.163 |
| PLBPM_PostSL | Sig. (2-tailed) | .630 | .542 | .722 | .512 | .669 | .993 | .865 | .343 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .378 | .281 | .267 | .220 | .248 | .262 | .039 | -.008 |
| FITD_PreSL | Sig. (2-tailed) | .028 | .097 | .115 | .212 | .150 | .134 | .820 | .962 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .469 | .252 | .278 | .196 | .240 | .220 | .007 | -.062 |
| FITD_8k | Sig. (2-tailed) | .005 | .138 | .100 | .266 | .164 | .212 | .966 | .718 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITV_12k | FITV_14k | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .139 | .244 | .138 | -.046 | -.008 | .034 | .196 |
| OX_PostSL | Sig. (2-tailed) | .417 | .151 | .429 | .792 | .965 | .846 | .253 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.054 | -.152 | -.053 | .162 | .110 | .176 | .042 |
| PLBPM_PreSL | Sig. (2-tailed) | .753 | .376 | .761 | .344 | .524 | .305 | .806 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.034 | -.149 | -.072 | .159 | .072 | .155 | .068 |
| PLBPM_8k | Sig. (2-tailed) | .842 | .386 | .682 | .355 | .675 | .366 | .691 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.125 | -.251 | -.154 | .121 | .035 | .083 | .012 |
| PLBPM_12k | Sig. (2-tailed) | .467 | .140 | .376 | .483 | .839 | .630 | .947 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.135 | -.245 | -.148 | .091 | .022 | .096 | .071 |
| PLBPM_14k | Sig. (2-tailed) | .433 | .151 | .395 | .596 | .900 | .579 | .679 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.066 | -.154 | -.094 | .119 | .068 | .138 | .078 |
| PLBPM_PostSL | Sig. (2-tailed) | .700 | .371 | .590 | .491 | .694 | .421 | .649 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .001 | .018 | -.009 | .107 | .042 | -.023 | .066 |
| FITD_PreSL | Sig. (2-tailed) | .995 | .917 | .959 | .534 | .808 | .894 | .702 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.036 | -.032 | -.046 | .083 | .032 | -.020 | .060 |
| FITD_8k | Sig. (2-tailed) | .837 | .852 | .791 | .630 | .855 | .906 | .726 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | ESQams_PostSL |
|---|---|---|
| OX_PostSL | Pearson Correlation | .233 |
| | Sig. (2-tailed) | .171 |
| | N | 36 |
| PLBPM_PreSL | Pearson Correlation | -.133 |
| | Sig. (2-tailed) | .441 |
| | N | 36 |
| PLBPM_8k | Pearson Correlation | -.083 |
| | Sig. (2-tailed) | .630 |
| | N | 36 |
| PLBPM_12k | Pearson Correlation | -.077 |
| | Sig. (2-tailed) | .655 |
| | N | 36 |
| PLBPM_14k | Pearson Correlation | -.076 |
| | Sig. (2-tailed) | .660 |
| | N | 36 |
| PLBPM_PostSL | Pearson Correlation | -.135 |
| | Sig. (2-tailed) | .433 |
| | N | 36 |
| FITD_PreSL | Pearson Correlation | .056 |
| | Sig. (2-tailed) | .747 |
| | N | 36 |
| FITD_8k | Pearson Correlation | -.014 |
| | Sig. (2-tailed) | .933 |
| | N | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.054 | -.213 | -.084 | -.234 | -.188 | -.133 | -.082 | -.054 |
| FITD_12k | Sig. (2-tailed) | .761 | .227 | .637 | .183 | .288 | .454 | .645 | .762 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .079 | -.234 | -.123 | -.278 | -.352 | -.158 | -.158 | .016 |
| FITD_14k | Sig. (2-tailed) | .653 | .175 | .480 | .106 | .038 | .365 | .366 | .929 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.016 | -.263 | -.123 | -.264 | -.297 | -.192 | -.206 | -.001 |
| FITD_PostSL | Sig. (2-tailed) | .930 | .133 | .490 | .131 | .088 | .277 | .241 | .995 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .212 | -.304 | .135 | -.283 | -.255 | .048 | -.209 | -.293 |
| FITA_PreSL | Sig. (2-tailed) | .214 | .072 | .432 | .095 | .134 | .783 | .221 | .083 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .140 | -.129 | .142 | -.251 | -.268 | -.077 | -.064 | -.261 |
| FITA_8k | Sig. (2-tailed) | .417 | .453 | .410 | .140 | .113 | .654 | .713 | .125 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .015 | -.104 | .058 | -.258 | -.301 | -.112 | .119 | -.106 |
| FITA_12k | Sig. (2-tailed) | .934 | .558 | .743 | .141 | .083 | .528 | .501 | .550 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .085 | -.022 | .050 | -.232 | -.238 | -.151 | .115 | -.102 |
| FITA_14k | Sig. (2-tailed) | .629 | .901 | .774 | .180 | .169 | .387 | .510 | .559 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.058 | -.101 | -.085 | -.214 | -.324 | -.105 | -.028 | -.138 |
| FITA_PostSL | Sig. (2-tailed) | .743 | .569 | .632 | .224 | .062 | .556 | .876 | .437 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | BMI | MonthsPost_Inj | LOC | Amnesia | OX_PreSL | OX_8k | OX_12k | OX_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.075 | .332 | .274 | -.212 | -.025 | -.077 | -.036 | -.011 |
| FITD_12k | Sig. (2-tailed) | .673 | .055 | .117 | .230 | .888 | .667 | .838 | .951 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.137 | .281 | .070 | -.270 | .138 | .061 | .106 | .122 |
| FITD_14k | Sig. (2-tailed) | .433 | .101 | .689 | .116 | .429 | .726 | .546 | .485 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.201 | .266 | .157 | -.319 | .096 | .025 | .030 | -.034 |
| FITD_PostSL | Sig. (2-tailed) | .255 | .129 | .376 | .066 | .589 | .889 | .865 | .846 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.153 | -.199 | -.121 | -.328 | .203 | .037 | .063 | .015 |
| FITA_PreSL | Sig. (2-tailed) | .372 | .244 | .484 | .050 | .235 | .830 | .715 | .929 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.015 | -.185 | .012 | -.220 | .211 | .004 | .029 | -.049 |
| FITA_8k | Sig. (2-tailed) | .931 | .281 | .943 | .197 | .217 | .984 | .866 | .776 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .136 | -.097 | .082 | -.313 | .109 | -.082 | -.050 | -.099 |
| FITA_12k | Sig. (2-tailed) | .443 | .583 | .644 | .071 | .539 | .644 | .780 | .578 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .151 | -.066 | -.032 | -.197 | .181 | .051 | .100 | .073 |
| FITA_14k | Sig. (2-tailed) | .386 | .706 | .856 | .256 | .298 | .769 | .566 | .676 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.016 | -.062 | -.071 | -.249 | .032 | .011 | .060 | .004 |
| FITA_PostSL | Sig. (2-tailed) | .927 | .727 | .691 | .156 | .856 | .952 | .736 | .984 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | OX_PostSL | PLBPM_PreSL | PLBPM_8k | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .030 | .012 | -.009 | -.025 | -.002 | .007 | .945 |
| FITD_12k | Sig. (2-tailed) | .868 | .946 | .961 | .888 | .990 | .970 | .000 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .058 | -.096 | -.118 | -.191 | -.194 | -.072 | .920 |
| FITD_14k | Sig. (2-tailed) | .742 | .585 | .501 | .272 | .265 | .681 | .000 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .107 | -.072 | -.108 | -.171 | -.144 | -.082 | .892 |
| FITD_PostSL | Sig. (2-tailed) | .546 | .686 | .543 | .333 | .415 | .645 | .000 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .107 | .092 | .091 | -.028 | .041 | .087 | .363 |
| FITA_PreSL | Sig. (2-tailed) | .535 | .593 | .598 | .869 | .815 | .612 | .029 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .018 | .089 | .055 | -.071 | -.002 | .114 | .307 |
| FITA_8k | Sig. (2-tailed) | .918 | .606 | .750 | .679 | .990 | .508 | .068 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.082 | .090 | .065 | .003 | .059 | .125 | .361 |
| FITA_12k | Sig. (2-tailed) | .643 | .614 | .715 | .986 | .740 | .480 | .036 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.029 | .044 | .033 | -.058 | -.024 | .115 | .420 |
| FITA_14k | Sig. (2-tailed) | .868 | .803 | .851 | .740 | .893 | .511 | .012 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.048 | -.093 | -.109 | -.198 | -.138 | -.086 | .378 |
| FITA_PostSL | Sig. (2-tailed) | .786 | .602 | .540 | .263 | .435 | .630 | .028 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITD_8k | FITD_12k | FITD_14k | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .966 | 1 | .955 | .919 | .344 | .326 | .404 | .457 |
| FITD_12k | Sig. (2-tailed) | .000 | | .000 | .000 | .046 | .060 | .018 | .007 |
| | N | 34 | 34 | 33 | 33 | 34 | 34 | 34 | 33 |
| | Pearson Correlation | .929 | .955 | 1 | .936 | .362 | .422 | .409 | .549 |
| FITD_14k | Sig. (2-tailed) | .000 | .000 | | .000 | .033 | .011 | .018 | .001 |
| | N | 35 | 33 | 35 | 34 | 35 | 35 | 33 | 35 |
| | Pearson Correlation | .906 | .919 | .936 | 1 | .270 | .353 | .323 | .374 |
| FITD_PostSL | Sig. (2-tailed) | .000 | .000 | .000 | | .123 | .041 | .067 | .029 |
| | N | 34 | 33 | 34 | 34 | 34 | 34 | 33 | 34 |
| | Pearson Correlation | .385 | .344 | .362 | .270 | 1 | .872 | .803 | .726 |
| FITA_PreSL | Sig. (2-tailed) | .020 | .046 | .033 | .123 | | .000 | .000 | .000 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .349 | .326 | .422 | .353 | .872 | 1 | .887 | .860 |
| FITA_8k | Sig. (2-tailed) | .037 | .060 | .011 | .041 | .000 | | .000 | .000 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .407 | .404 | .409 | .323 | .803 | .887 | 1 | .931 |
| FITA_12k | Sig. (2-tailed) | .017 | .018 | .018 | .067 | .000 | .000 | | .000 |
| | N | 34 | 34 | 33 | 33 | 34 | 34 | 34 | 33 |
| | Pearson Correlation | .472 | .457 | .549 | .374 | .726 | .860 | .931 | 1 |
| FITA_14k | Sig. (2-tailed) | .004 | .007 | .001 | .029 | .000 | .000 | .000 | |
| | N | 35 | 33 | 35 | 34 | 35 | 35 | 33 | 35 |
| | Pearson Correlation | .469 | .466 | .463 | .468 | .727 | .866 | .853 | .839 |
| FITA_PostSL | Sig. (2-tailed) | .005 | .006 | .006 | .005 | .000 | .000 | .000 | .000 |
| | N | 34 | 33 | 34 | 34 | 34 | 34 | 33 | 34 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITA_PostSL | FITL_PreSL | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .466 | .158 | .216 | .191 | .218 | .159 | -.035 | -.081 |
| FITD_12k | Sig. (2-tailed) | .006 | .373 | .221 | .279 | .224 | .378 | .846 | .650 |
| | N | 33 | 34 | 34 | 34 | 33 | 33 | 34 | 34 |
| | Pearson Correlation | .463 | .317 | .296 | .298 | .219 | .288 | .136 | .114 |
| FITD_14k | Sig. (2-tailed) | .006 | .064 | .085 | .092 | .207 | .099 | .437 | .515 |
| | N | 34 | 35 | 35 | 33 | 35 | 34 | 35 | 35 |
| | Pearson Correlation | .468 | .249 | .269 | .232 | .303 | .237 | .050 | .013 |
| FITD_PostSL | Sig. (2-tailed) | .005 | .156 | .124 | .195 | .081 | .178 | .778 | .943 |
| | N | 34 | 34 | 34 | 33 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .727 | -.331 | -.258 | -.322 | -.194 | -.258 | -.023 | -.073 |
| FITA_PreSL | Sig. (2-tailed) | .000 | .048 | .128 | .063 | .263 | .140 | .896 | .674 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .866 | -.308 | -.321 | -.355 | -.290 | -.310 | .031 | -.046 |
| FITA_8k | Sig. (2-tailed) | .000 | .067 | .056 | .040 | .091 | .075 | .860 | .789 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .853 | -.256 | -.249 | -.346 | -.203 | -.235 | .095 | .021 |
| FITA_12k | Sig. (2-tailed) | .000 | .144 | .155 | .045 | .257 | .187 | .594 | .907 |
| | N | 33 | 34 | 34 | 34 | 33 | 33 | 34 | 34 |
| | Pearson Correlation | .839 | -.119 | -.166 | -.278 | -.228 | -.179 | .150 | .097 |
| FITA_14k | Sig. (2-tailed) | .000 | .497 | .339 | .117 | .188 | .310 | .389 | .579 |
| | N | 34 | 35 | 35 | 33 | 35 | 34 | 35 | 35 |
| | Pearson Correlation | 1 | -.281 | -.224 | -.334 | -.165 | -.339 | .077 | -.006 |
| FITA_PostSL | Sig. (2-tailed) | | .107 | .202 | .058 | .352 | .050 | .664 | .974 |
| | N | 34 | 34 | 34 | 33 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITV_12k | FITV_14k | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.083 | -.048 | -.061 | .008 | .060 | -.027 | .025 |
| FITD_12k | Sig. (2-tailed) | .640 | .786 | .733 | .966 | .736 | .879 | .887 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .146 | .167 | .057 | .173 | .149 | .079 | .152 |
| FITD_14k | Sig. (2-tailed) | .403 | .336 | .748 | .319 | .392 | .652 | .384 |
| | N | 35 | 35 | 34 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .073 | .081 | .119 | .088 | .080 | .030 | .172 |
| FITD_PostSL | Sig. (2-tailed) | .680 | .648 | .503 | .622 | .653 | .864 | .330 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.052 | -.053 | -.086 | -.140 | -.107 | -.080 | -.103 |
| FITA_PreSL | Sig. (2-tailed) | .764 | .760 | .622 | .416 | .533 | .641 | .549 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .002 | .037 | .012 | -.243 | -.191 | -.106 | -.148 |
| FITA_8k | Sig. (2-tailed) | .990 | .832 | .946 | .153 | .265 | .539 | .389 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .046 | .005 | .000 | -.220 | -.197 | -.173 | -.236 |
| FITA_12k | Sig. (2-tailed) | .798 | .978 | .999 | .211 | .265 | .328 | .179 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .106 | .141 | -.038 | -.073 | -.043 | -.013 | -.092 |
| FITA_14k | Sig. (2-tailed) | .545 | .420 | .830 | .676 | .805 | .939 | .601 |
| | N | 35 | 35 | 34 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .060 | .056 | .063 | -.170 | -.152 | -.121 | -.151 |
| FITA_PostSL | Sig. (2-tailed) | .735 | .751 | .725 | .337 | .391 | .496 | .395 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | ESQams_PostSL |
|---|---|---|
| FITD_12k | Pearson Correlation | -.071 |
| | Sig. (2-tailed) | .689 |
| | N | 34 |
| FITD_14k | Pearson Correlation | .088 |
| | Sig. (2-tailed) | .614 |
| | N | 35 |
| FITD_PostSL | Pearson Correlation | .003 |
| | Sig. (2-tailed) | .988 |
| | N | 34 |
| FITA_PreSL | Pearson Correlation | -.057 |
| | Sig. (2-tailed) | .739 |
| | N | 36 |
| FITA_8k | Pearson Correlation | -.135 |
| | Sig. (2-tailed) | .433 |
| | N | 36 |
| FITA_12k | Pearson Correlation | -.148 |
| | Sig. (2-tailed) | .402 |
| | N | 34 |
| FITA_14k | Pearson Correlation | -.028 |
| | Sig. (2-tailed) | .874 |
| | N | 35 |
| FITA_PostSL | Pearson Correlation | -.221 |
| | Sig. (2-tailed) | .210 |
| | N | 34 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .115 | .143 | .093 | -.061 | -.064 | .101 | .178 | .217 |
| FITL_PreSL | Sig. (2-tailed) | .505 | .405 | .591 | .724 | .713 | .557 | .298 | .203 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .064 | .102 | .024 | -.060 | -.032 | .229 | .084 | .241 |
| FITL_8k | Sig. (2-tailed) | .712 | .555 | .888 | .730 | .852 | .180 | .627 | .157 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .000 | .134 | -.088 | -.132 | -.058 | .280 | .008 | .207 |
| FITL_12k | Sig. (2-tailed) | .999 | .449 | .620 | .458 | .746 | .109 | .965 | .240 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .138 | .088 | -.021 | -.214 | -.156 | .281 | -.030 | .099 |
| FITL_14k | Sig. (2-tailed) | .428 | .615 | .903 | .216 | .370 | .103 | .864 | .571 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .225 | -.017 | -.077 | -.208 | -.071 | .174 | .034 | .149 |
| FITL_PostSL | Sig. (2-tailed) | .200 | .923 | .663 | .237 | .688 | .326 | .849 | .400 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.108 | -.095 | -.152 | .174 | -.092 | -.216 | .241 | .239 |
| FITV_PreSL | Sig. (2-tailed) | .531 | .581 | .378 | .310 | .592 | .206 | .156 | .160 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.111 | -.173 | -.206 | .177 | -.154 | -.259 | .140 | .273 |
| FITV_8k | Sig. (2-tailed) | .520 | .314 | .229 | .303 | .371 | .127 | .415 | .108 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.041 | .001 | -.125 | .177 | -.107 | -.192 | .231 | .237 |
| FITV_12k | Sig. (2-tailed) | .812 | .996 | .467 | .303 | .536 | .262 | .176 | .164 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | BMI | MonthsPost_Inj | LOC | Amnesia | OX_PreSL | OX_8k | OX_12k | OX_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .179 | .174 | .021 | .095 | -.200 | -.121 | -.096 | -.016 |
| FITL_PreSL | Sig. (2-tailed) | .296 | .311 | .903 | .580 | .241 | .483 | .578 | .926 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .044 | .169 | -.019 | .089 | -.207 | -.098 | -.038 | .024 |
| FITL_8k | Sig. (2-tailed) | .797 | .324 | .911 | .608 | .225 | .571 | .824 | .888 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.023 | .208 | .072 | .122 | -.098 | -.007 | .081 | .131 |
| FITL_12k | Sig. (2-tailed) | .898 | .237 | .686 | .492 | .580 | .970 | .648 | .459 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.013 | .167 | .030 | -.018 | -.189 | -.055 | -.013 | .009 |
| FITL_14k | Sig. (2-tailed) | .940 | .338 | .866 | .920 | .276 | .753 | .939 | .959 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .062 | .222 | .071 | -.109 | .140 | .154 | .176 | .163 |
| FITL_PostSL | Sig. (2-tailed) | .726 | .207 | .690 | .538 | .429 | .385 | .319 | .358 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .184 | .321 | -.045 | -.040 | .233 | .067 | .079 | .113 |
| FITV_PreSL | Sig. (2-tailed) | .284 | .056 | .796 | .819 | .171 | .698 | .646 | .512 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .048 | .211 | -.114 | -.211 | .235 | .156 | .094 | .138 |
| FITV_8k | Sig. (2-tailed) | .783 | .217 | .507 | .216 | .168 | .363 | .587 | .422 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .181 | .390 | -.228 | -.288 | .153 | .205 | .190 | .247 |
| FITV_12k | Sig. (2-tailed) | .289 | .019 | .182 | .089 | .374 | .230 | .266 | .146 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | OX_PostSL | PLBPM_PreSL | PLBPM_8k | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.073 | .104 | .124 | .154 | .093 | .105 | .281 |
| FITL_PreSL | Sig. (2-tailed) | .672 | .546 | .469 | .369 | .588 | .542 | .097 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.034 | .063 | .123 | .167 | .107 | .061 | .267 |
| FITL_8k | Sig. (2-tailed) | .845 | .714 | .473 | .332 | .533 | .722 | .115 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.022 | -.077 | -.025 | .020 | -.055 | -.117 | .220 |
| FITL_12k | Sig. (2-tailed) | .900 | .665 | .888 | .909 | .757 | .512 | .212 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.029 | -.033 | .002 | .053 | .004 | -.075 | .248 |
| FITL_14k | Sig. (2-tailed) | .869 | .850 | .990 | .760 | .980 | .669 | .150 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .169 | -.047 | .003 | .040 | -.010 | -.001 | .262 |
| FITL_PostSL | Sig. (2-tailed) | .339 | .793 | .986 | .820 | .956 | .993 | .134 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.037 | -.040 | -.014 | -.076 | -.075 | -.029 | .039 |
| FITV_PreSL | Sig. (2-tailed) | .832 | .817 | .937 | .658 | .665 | .865 | .820 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .114 | -.137 | -.123 | -.202 | -.216 | -.163 | -.008 |
| FITV_8k | Sig. (2-tailed) | .506 | .427 | .474 | .236 | .206 | .343 | .962 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .139 | -.054 | -.034 | -.125 | -.135 | -.066 | .001 |
| FITV_12k | Sig. (2-tailed) | .417 | .753 | .842 | .467 | .433 | .700 | .995 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITD_8k | FITD_12k | FITD_14k | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .252 | .158 | .317 | .249 | -.331 | -.308 | -.256 | -.119 |
| FITL_PreSL | Sig. (2-tailed) | .138 | .373 | .064 | .156 | .048 | .067 | .144 | .497 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .278 | .216 | .296 | .269 | -.258 | -.321 | -.249 | -.166 |
| FITL_8k | Sig. (2-tailed) | .100 | .221 | .085 | .124 | .128 | .056 | .155 | .339 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .196 | .191 | .298 | .232 | -.322 | -.355 | -.346 | -.278 |
| FITL_12k | Sig. (2-tailed) | .266 | .279 | .092 | .195 | .063 | .040 | .045 | .117 |
| | N | 34 | 34 | 33 | 33 | 34 | 34 | 34 | 33 |
| | Pearson Correlation | .240 | .218 | .219 | .303 | -.194 | -.290 | -.203 | -.228 |
| FITL_14k | Sig. (2-tailed) | .164 | .224 | .207 | .081 | .263 | .091 | .257 | .188 |
| | N | 35 | 33 | 35 | 34 | 35 | 35 | 33 | 35 |
| | Pearson Correlation | .220 | .159 | .288 | .237 | -.258 | -.310 | -.235 | -.179 |
| FITL_PostSL | Sig. (2-tailed) | .212 | .378 | .099 | .178 | .140 | .075 | .187 | .310 |
| | N | 34 | 33 | 34 | 34 | 34 | 34 | 33 | 34 |
| | Pearson Correlation | .007 | -.035 | .136 | .050 | -.023 | .031 | .095 | .150 |
| FITV_PreSL | Sig. (2-tailed) | .966 | .846 | .437 | .778 | .896 | .860 | .594 | .389 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.062 | -.081 | .114 | .013 | -.073 | -.046 | .021 | .097 |
| FITV_8k | Sig. (2-tailed) | .718 | .650 | .515 | .943 | .674 | .789 | .907 | .579 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.036 | -.083 | .146 | .073 | -.052 | .002 | .046 | .106 |
| FITV_12k | Sig. (2-tailed) | .837 | .640 | .403 | .680 | .764 | .990 | .798 | .545 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITA_PostSL | FITL_PreSL | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.281 | 1 | .922 | .843 | .825 | .809 | .013 | .027 |
| FITL_PreSL | Sig. (2-tailed) | .107 | | .000 | .000 | .000 | .000 | .941 | .875 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.224 | .922 | 1 | .879 | .865 | .812 | .013 | .041 |
| FITL_8k | Sig. (2-tailed) | .202 | .000 | | .000 | .000 | .000 | .938 | .811 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.334 | .843 | .879 | 1 | .856 | .867 | -.097 | -.017 |
| FITL_12k | Sig. (2-tailed) | .058 | .000 | .000 | | .000 | .000 | .586 | .923 |
| | N | 33 | 34 | 34 | 34 | 33 | 33 | 34 | 34 |
| | Pearson Correlation | -.165 | .825 | .865 | .856 | 1 | .842 | -.193 | -.166 |
| FITL_14k | Sig. (2-tailed) | .352 | .000 | .000 | .000 | | .000 | .268 | .340 |
| | N | 34 | 35 | 35 | 33 | 35 | 34 | 35 | 35 |
| | Pearson Correlation | -.339 | .809 | .812 | .867 | .842 | 1 | -.070 | -.008 |
| FITL_PostSL | Sig. (2-tailed) | .050 | .000 | .000 | .000 | .000 | | .693 | .966 |
| | N | 34 | 34 | 34 | 33 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .077 | .013 | .013 | -.097 | -.193 | -.070 | 1 | .858 |
| FITV_PreSL | Sig. (2-tailed) | .664 | .941 | .938 | .586 | .268 | .693 | | .000 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.006 | .027 | .041 | -.017 | -.166 | -.008 | .858 | 1 |
| FITV_8k | Sig. (2-tailed) | .974 | .875 | .811 | .923 | .340 | .966 | .000 | |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .060 | .140 | .122 | .042 | -.002 | .096 | .779 | .874 |
| FITV_12k | Sig. (2-tailed) | .735 | .417 | .479 | .815 | .990 | .591 | .000 | .000 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITV_12k | FITV_14k | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .140 | -.064 | -.086 | .488 | .202 | .168 | .174 |
| FITL_PreSL | Sig. (2-tailed) | .417 | .710 | .621 | .003 | .237 | .329 | .309 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .122 | -.083 | -.104 | .373 | .095 | .054 | .130 |
| FITL_8k | Sig. (2-tailed) | .479 | .630 | .551 | .025 | .583 | .754 | .451 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .042 | -.095 | -.074 | .224 | .040 | -.004 | .058 |
| FITL_12k | Sig. (2-tailed) | .815 | .592 | .677 | .203 | .822 | .982 | .746 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.002 | -.287 | -.119 | .365 | .107 | -.003 | .022 |
| FITL_14k | Sig. (2-tailed) | .990 | .094 | .504 | .031 | .541 | .988 | .898 |
| | N | 35 | 35 | 34 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .096 | -.090 | -.045 | .213 | -.027 | -.069 | .095 |
| FITL_PostSL | Sig. (2-tailed) | .591 | .614 | .799 | .227 | .879 | .698 | .591 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .779 | .788 | .726 | -.006 | -.059 | -.025 | .051 |
| FITV_PreSL | Sig. (2-tailed) | .000 | .000 | .000 | .974 | .731 | .885 | .767 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .874 | .908 | .766 | -.014 | .003 | .046 | .094 |
| FITV_8k | Sig. (2-tailed) | .000 | .000 | .000 | .935 | .985 | .788 | .586 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | 1 | .851 | .777 | .039 | -.045 | .002 | .123 |
| FITV_12k | Sig. (2-tailed) | | .000 | .000 | .822 | .794 | .989 | .476 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | ESQams_PostSL |
|---|---|---|
| FITL_PreSL | Pearson Correlation | .280 |
| | Sig. (2-tailed) | .098 |
| | N | 36 |
| FITL_8k | Pearson Correlation | .201 |
| | Sig. (2-tailed) | .240 |
| | N | 36 |
| FITL_12k | Pearson Correlation | .209 |
| | Sig. (2-tailed) | .235 |
| | N | 34 |
| FITL_14k | Pearson Correlation | .179 |
| | Sig. (2-tailed) | .303 |
| | N | 35 |
| FITL_PostSL | Pearson Correlation | .314 |
| | Sig. (2-tailed) | .071 |
| | N | 34 |
| FITV_PreSL | Pearson Correlation | .133 |
| | Sig. (2-tailed) | .439 |
| | N | 36 |
| FITV_8k | Pearson Correlation | .220 |
| | Sig. (2-tailed) | .196 |
| | N | 36 |
| FITV_12k | Pearson Correlation | .234 |
| | Sig. (2-tailed) | .170 |
| | N | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| FITV_14k | Pearson Correlation | -.047 | -.157 | -.221 | .215 | -.068 | -.356 | .089 | .193 |
| | Sig. (2-tailed) | .786 | .360 | .195 | .207 | .695 | .033 | .606 | .260 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| FITV_PostSL | Pearson Correlation | -.012 | -.080 | -.081 | .232 | -.011 | -.217 | .126 | .108 |
| | Sig. (2-tailed) | .946 | .647 | .643 | .181 | .949 | .211 | .471 | .538 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| ESQams_PreSL | Pearson Correlation | .336 | -.054 | .109 | -.064 | .026 | .135 | .015 | -.183 |
| | Sig. (2-tailed) | .045 | .756 | .525 | .709 | .879 | .431 | .932 | .286 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| ESQams_8k | Pearson Correlation | .294 | -.160 | .102 | -.230 | -.088 | -.068 | -.161 | -.283 |
| | Sig. (2-tailed) | .082 | .350 | .554 | .177 | .611 | .696 | .347 | .095 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| ESQams_12k | Pearson Correlation | .341 | -.075 | .245 | -.132 | .069 | -.110 | -.082 | -.387 |
| | Sig. (2-tailed) | .042 | .663 | .150 | .442 | .691 | .523 | .635 | .020 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| ESQams_14k | Pearson Correlation | .300 | -.173 | .109 | -.094 | .126 | -.224 | -.114 | -.346 |
| | Sig. (2-tailed) | .076 | .313 | .527 | .584 | .463 | .190 | .510 | .039 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| ESQams_PostSL | Pearson Correlation | .249 | -.203 | .009 | -.267 | -.178 | -.225 | -.111 | -.212 |
| | Sig. (2-tailed) | .143 | .234 | .959 | .115 | .300 | .186 | .520 | .213 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | BMI | MonthsPost_Inj | LOC | Amnesia | OX_PreSL | OX_8k | OX_12k | OX_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .011 | .267 | -.101 | -.160 | .326 | .307 | .204 | .232 |
| FITV_14k | Sig. (2-tailed) | .950 | .115 | .556 | .351 | .052 | .069 | .234 | .173 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .088 | .292 | -.036 | -.184 | .340 | .321 | .260 | .298 |
| FITV_PostSL | Sig. (2-tailed) | .613 | .088 | .839 | .289 | .046 | .060 | .132 | .082 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .135 | .120 | -.225 | .153 | -.187 | -.003 | -.171 | -.046 |
| ESQams_PreSL | Sig. (2-tailed) | .434 | .487 | .188 | .374 | .274 | .988 | .318 | .789 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.069 | -.041 | -.175 | .118 | -.199 | -.115 | -.315 | -.228 |
| ESQams_8k | Sig. (2-tailed) | .688 | .814 | .307 | .493 | .245 | .505 | .061 | .180 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .050 | -.038 | -.226 | .096 | -.162 | -.153 | -.330 | -.290 |
| ESQams_12k | Sig. (2-tailed) | .774 | .824 | .185 | .578 | .344 | .373 | .049 | .086 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .044 | .118 | -.216 | -.140 | -.022 | -.134 | -.206 | -.270 |
| ESQams_14k | Sig. (2-tailed) | .798 | .495 | .206 | .414 | .900 | .436 | .229 | .111 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .022 | .119 | -.205 | -.141 | .089 | -.202 | -.294 | -.304 |
| ESQams_PostSL | Sig. (2-tailed) | .900 | .488 | .231 | .413 | .608 | .237 | .082 | .072 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | OX_PostSL | PLBPM_PreSL | PLBPM_8k | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .244 | -.152 | -.149 | -.251 | -.245 | -.154 | .018 |
| FITV_14k | Sig. (2-tailed) | .151 | .376 | .386 | .140 | .151 | .371 | .917 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .138 | -.053 | -.072 | -.154 | -.148 | -.094 | -.009 |
| FITV_PostSL | Sig. (2-tailed) | .429 | .761 | .682 | .376 | .395 | .590 | .959 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.046 | .162 | .159 | .121 | .091 | .119 | .107 |
| ESQams_PreSL | Sig. (2-tailed) | .792 | .344 | .355 | .483 | .596 | .491 | .534 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.008 | .110 | .072 | .035 | .022 | .068 | .042 |
| ESQams_8k | Sig. (2-tailed) | .965 | .524 | .675 | .839 | .900 | .694 | .808 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .034 | .176 | .155 | .083 | .096 | .138 | -.023 |
| ESQams_12k | Sig. (2-tailed) | .846 | .305 | .366 | .630 | .579 | .421 | .894 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .196 | .042 | .068 | .012 | .071 | .078 | .066 |
| ESQams_14k | Sig. (2-tailed) | .253 | .806 | .691 | .947 | .679 | .649 | .702 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .233 | -.133 | -.083 | -.077 | -.076 | -.135 | .056 |
| ESQams_PostSL | Sig. (2-tailed) | .171 | .441 | .630 | .655 | .660 | .433 | .747 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITD_8k | FITD_12k | FITD_14k | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.032 | -.048 | .167 | .081 | -.053 | .037 | .005 | .141 |
| FITV_14k | Sig. (2-tailed) | .852 | .786 | .336 | .648 | .760 | .832 | .978 | .420 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.046 | -.061 | .057 | .119 | -.086 | .012 | .000 | -.038 |
| FITV_PostSL | Sig. (2-tailed) | .791 | .733 | .748 | .503 | .622 | .946 | .999 | .830 |
| | N | 35 | 34 | 34 | 34 | 35 | 35 | 34 | 34 |
| | Pearson Correlation | .083 | .008 | .173 | .088 | -.140 | -.243 | -.220 | -.073 |
| ESQams_PreSL | Sig. (2-tailed) | .630 | .966 | .319 | .622 | .416 | .153 | .211 | .676 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .032 | .060 | .149 | .080 | -.107 | -.191 | -.197 | -.043 |
| ESQams_8k | Sig. (2-tailed) | .855 | .736 | .392 | .653 | .533 | .265 | .265 | .805 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.020 | -.027 | .079 | .030 | -.080 | -.106 | -.173 | -.013 |
| ESQams_12k | Sig. (2-tailed) | .906 | .879 | .652 | .864 | .641 | .539 | .328 | .939 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .060 | .025 | .152 | .172 | -.103 | -.148 | -.236 | -.092 |
| ESQams_14k | Sig. (2-tailed) | .726 | .887 | .384 | .330 | .549 | .389 | .179 | .601 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.014 | -.071 | .088 | .003 | -.057 | -.135 | -.148 | -.028 |
| ESQams_PostSL | Sig. (2-tailed) | .933 | .689 | .614 | .988 | .739 | .433 | .402 | .874 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITA_PostSL | FITL_PreSL | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .056 | -.064 | -.083 | -.095 | -.287 | -.090 | .788 | .908 |
| FITV_14k | Sig. (2-tailed) | .751 | .710 | .630 | .592 | .094 | .614 | .000 | .000 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | .063 | -.086 | -.104 | -.074 | -.119 | -.045 | .726 | .766 |
| FITV_PostSL | Sig. (2-tailed) | .725 | .621 | .551 | .677 | .504 | .799 | .000 | .000 |
| | N | 34 | 35 | 35 | 34 | 34 | 34 | 35 | 35 |
| | Pearson Correlation | -.170 | .488 | .373 | .224 | .365 | .213 | -.006 | -.014 |
| ESQams_PreSL | Sig. (2-tailed) | .337 | .003 | .025 | .203 | .031 | .227 | .974 | .935 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.152 | .202 | .095 | .040 | .107 | -.027 | -.059 | .003 |
| ESQams_8k | Sig. (2-tailed) | .391 | .237 | .583 | .822 | .541 | .879 | .731 | .985 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.121 | .168 | .054 | -.004 | -.003 | -.069 | -.025 | .046 |
| ESQams_12k | Sig. (2-tailed) | .496 | .329 | .754 | .982 | .988 | .698 | .885 | .788 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.151 | .174 | .130 | .058 | .022 | .095 | .051 | .094 |
| ESQams_14k | Sig. (2-tailed) | .395 | .309 | .451 | .746 | .898 | .591 | .767 | .586 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |
| | Pearson Correlation | -.221 | .280 | .201 | .209 | .179 | .314 | .133 | .220 |
| ESQams_PostSL | Sig. (2-tailed) | .210 | .098 | .240 | .235 | .303 | .071 | .439 | .196 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | FITV_12k | FITV_14k | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .851 | 1 | .852 | -.058 | .005 | .077 | .120 |
| FITV_14k | Sig. (2-tailed) | .000 | | .000 | .735 | .977 | .653 | .487 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .777 | .852 | 1 | -.037 | -.052 | -.007 | .021 |
| FITV_PostSL | Sig. (2-tailed) | .000 | .000 | | .833 | .768 | .968 | .905 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .039 | -.058 | -.037 | 1 | .788 | .740 | .490 |
| ESQams_PreSL | Sig. (2-tailed) | .822 | .735 | .833 | | .000 | .000 | .002 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.045 | .005 | -.052 | .788 | 1 | .880 | .567 |
| ESQams_8k | Sig. (2-tailed) | .794 | .977 | .768 | .000 | | .000 | .000 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .002 | .077 | -.007 | .740 | .880 | 1 | .759 |
| ESQams_12k | Sig. (2-tailed) | .989 | .653 | .968 | .000 | .000 | | .000 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .123 | .120 | .021 | .490 | .567 | .759 | 1 |
| ESQams_14k | Sig. (2-tailed) | .476 | .487 | .905 | .002 | .000 | .000 | |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .234 | .143 | -.015 | .256 | .222 | .385 | .601 |
| ESQams_PostSL | Sig. (2-tailed) | .170 | .406 | .933 | .133 | .193 | .020 | .000 |
| | N | 36 | 36 | 35 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the mild traumatic brain injury subjects, continued.**

| | | ESQams_PostSL |
|---|---|---|
| FITV_14k | Pearson Correlation | .143 |
| | Sig. (2-tailed) | .406 |
| | N | 36 |
| FITV_PostSL | Pearson Correlation | -.015 |
| | Sig. (2-tailed) | .933 |
| | N | 35 |
| ESQams_PreSL | Pearson Correlation | .256 |
| | Sig. (2-tailed) | .133 |
| | N | 36 |
| ESQams_8k | Pearson Correlation | .222 |
| | Sig. (2-tailed) | .193 |
| | N | 36 |
| ESQams_12k | Pearson Correlation | .385 |
| | Sig. (2-tailed) | .020 |
| | N | 36 |
| ESQams_14k | Pearson Correlation | .601 |
| | Sig. (2-tailed) | .000 |
| | N | 36 |
| ESQams_PostSL | Pearson Correlation | 1 |
| | Sig. (2-tailed) | |
| | N | 36 |

## Appendix H. Correlation Matrix Among All Variables for the Control Subjects.

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.303 | 1 | .313 | .347 | .436 | -.005 | .164 | -.108 |
| Age | Sig. (2-tailed) | .073 | | .063 | .038 | .008 | .977 | .340 | .532 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .181 | .313 | 1 | .140 | .194 | .276 | .262 | -.223 |
| Pulse | Sig. (2-tailed) | .292 | .063 | | .414 | .257 | .103 | .123 | .192 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.541 | .347 | .140 | 1 | .690 | -.078 | .528 | .107 |
| BPsystolic | Sig. (2-tailed) | .001 | .038 | .414 | | .000 | .652 | .001 | .536 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.270 | .436 | .194 | .690 | 1 | .027 | .529 | -.125 |
| BPDiastolic | Sig. (2-tailed) | .112 | .008 | .257 | .000 | | .876 | .001 | .467 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .193 | -.005 | .276 | -.078 | .027 | 1 | .234 | -.232 |
| Respiration | Sig. (2-tailed) | .258 | .977 | .103 | .652 | .876 | | .170 | .173 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.266 | .164 | .262 | .528 | .529 | .234 | 1 | .035 |
| Weight | Sig. (2-tailed) | .117 | .340 | .123 | .001 | .001 | .170 | | .841 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.503 | -.108 | -.223 | .107 | -.125 | -.232 | .035 | 1 |
| Height_inches | Sig. (2-tailed) | .002 | .532 | .192 | .536 | .467 | .173 | .841 | |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | BMI | OX_PreSL | OX_8k | OX_12k | OX_14k | OX_PostSL | PLBPM_PreSL | PLBPM_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.135 | .352 | .170 | -.017 | -.153 | .403 | .073 | .053 |
| Sex | Sig. (2-tailed) | .433 | .035 | .321 | .922 | .374 | .015 | .672 | .757 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .288 | -.314 | -.223 | .047 | .131 | -.391 | .290 | .287 |
| Age | Sig. (2-tailed) | .089 | .062 | .191 | .786 | .445 | .018 | .087 | .090 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .303 | -.109 | -.032 | .112 | .066 | -.022 | .907 | .889 |
| Pulse | Sig. (2-tailed) | .073 | .528 | .854 | .516 | .701 | .899 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .514 | .070 | -.185 | -.001 | .052 | -.092 | .294 | .333 |
| BPsystolic | Sig. (2-tailed) | .001 | .687 | .281 | .994 | .763 | .593 | .082 | .047 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .579 | .160 | -.137 | .135 | .203 | -.063 | .301 | .353 |
| BPDiastolic | Sig. (2-tailed) | .000 | .350 | .425 | .433 | .236 | .717 | .074 | .034 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .175 | -.135 | -.070 | -.264 | -.121 | -.244 | .233 | .238 |
| Respiration | Sig. (2-tailed) | .307 | .433 | .685 | .120 | .481 | .152 | .171 | .163 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .893 | -.129 | -.463 | -.344 | -.198 | -.232 | .353 | .404 |
| Weight | Sig. (2-tailed) | .000 | .453 | .004 | .040 | .248 | .172 | .035 | .014 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.320 | -.289 | -.173 | .058 | .154 | -.176 | -.186 | -.207 |
| Height_inches | Sig. (2-tailed) | .057 | .087 | .313 | .738 | .371 | .305 | .279 | .225 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL | FITD_8k | FITD_12k | FITD_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .063 | .167 | .135 | .182 | .253 | .152 | .236 |
| Sex | Sig. (2-tailed) | .714 | .330 | .433 | .288 | .137 | .390 | .172 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .244 | .181 | .214 | -.430 | -.357 | -.338 | -.302 |
| Age | Sig. (2-tailed) | .151 | .292 | .211 | .009 | .032 | .050 | .078 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .835 | .795 | .865 | .310 | .336 | .233 | .382 |
| Pulse | Sig. (2-tailed) | .000 | .000 | .000 | .066 | .045 | .184 | .023 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .310 | .293 | .295 | -.114 | -.072 | -.126 | -.201 |
| BPsystolic | Sig. (2-tailed) | .065 | .083 | .081 | .507 | .677 | .478 | .248 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .305 | .331 | .361 | -.155 | -.076 | -.050 | -.166 |
| BPDiastolic | Sig. (2-tailed) | .070 | .049 | .031 | .367 | .660 | .777 | .342 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .262 | .262 | .229 | .063 | .144 | .130 | .103 |
| Respiration | Sig. (2-tailed) | .123 | .123 | .179 | .713 | .403 | .465 | .555 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .435 | .372 | .413 | -.137 | -.133 | -.226 | -.267 |
| Weight | Sig. (2-tailed) | .008 | .026 | .012 | .425 | .440 | .199 | .121 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.228 | -.341 | -.240 | .065 | -.009 | .154 | .051 |
| Height_inches | Sig. (2-tailed) | .182 | .042 | .158 | .705 | .960 | .385 | .770 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k | FITA_PostSL | FITL_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .211 | .213 | .214 | .280 | .187 | .227 | -.017 |
| Sex | Sig. (2-tailed) | .230 | .213 | .210 | .109 | .281 | .197 | .920 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | -.454 | -.270 | -.280 | -.294 | -.137 | -.429 | .187 |
| Age | Sig. (2-tailed) | .007 | .111 | .098 | .091 | .432 | .011 | .276 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .178 | .072 | .078 | .111 | .215 | -.182 | .098 |
| Pulse | Sig. (2-tailed) | .313 | .678 | .651 | .531 | .215 | .302 | .569 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | -.176 | -.122 | -.116 | -.105 | -.227 | -.241 | -.009 |
| BPsystolic | Sig. (2-tailed) | .320 | .479 | .500 | .553 | .190 | .170 | .957 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | -.204 | -.139 | -.019 | -.048 | -.117 | -.267 | .167 |
| BPDiastolic | Sig. (2-tailed) | .246 | .420 | .911 | .790 | .503 | .128 | .329 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .019 | -.068 | -.124 | -.085 | .022 | -.007 | .269 |
| Respiration | Sig. (2-tailed) | .915 | .692 | .471 | .634 | .899 | .970 | .112 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | -.316 | -.035 | -.032 | -.024 | -.058 | .004 | .299 |
| Weight | Sig. (2-tailed) | .069 | .838 | .852 | .892 | .741 | .981 | .077 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .086 | .024 | .038 | .011 | -.007 | .118 | -.019 |
| Height_inches | Sig. (2-tailed) | .628 | .891 | .824 | .953 | .969 | .505 | .913 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k | FITV_12k | FITV_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.057 | -.076 | -.088 | -.103 | .067 | .139 | .159 | .061 |
| Sex | Sig. (2-tailed) | .741 | .668 | .617 | .562 | .697 | .419 | .362 | .724 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .249 | .233 | .123 | .257 | -.069 | -.079 | -.092 | .098 |
| Age | Sig. (2-tailed) | .143 | .184 | .481 | .143 | .688 | .647 | .598 | .571 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .089 | .023 | -.039 | .181 | .093 | .048 | .098 | .150 |
| Pulse | Sig. (2-tailed) | .605 | .899 | .824 | .305 | .588 | .782 | .576 | .384 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .021 | -.023 | -.040 | .072 | .292 | .234 | .224 | .279 |
| BPsystolic | Sig. (2-tailed) | .903 | .898 | .818 | .687 | .084 | .169 | .196 | .099 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .153 | .157 | .115 | .279 | .339 | .252 | .317 | .303 |
| BPDiastolic | Sig. (2-tailed) | .373 | .374 | .509 | .110 | .043 | .138 | .064 | .072 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .323 | .320 | .264 | .173 | .201 | .008 | .025 | .190 |
| Respiration | Sig. (2-tailed) | .055 | .065 | .125 | .329 | .240 | .962 | .885 | .267 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .226 | .189 | .199 | .200 | .270 | .069 | .150 | .220 |
| Weight | Sig. (2-tailed) | .184 | .284 | .253 | .257 | .112 | .690 | .389 | .197 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.005 | .067 | .103 | -.089 | -.326 | -.235 | -.284 | -.302 |
| Height_inches | Sig. (2-tailed) | .977 | .707 | .555 | .618 | .052 | .168 | .098 | .074 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k | ESQams_PostSL |
|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .104 | .618 | .513 | .511 | .489 | .510 |
| Sex | Sig. (2-tailed) | .547 | .000 | .001 | .001 | .002 | .001 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.185 | -.260 | -.417 | -.350 | -.347 | -.182 |
| Age | Sig. (2-tailed) | .280 | .125 | .011 | .036 | .038 | .289 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.028 | -.044 | -.122 | -.136 | -.074 | -.141 |
| Pulse | Sig. (2-tailed) | .873 | .799 | .478 | .431 | .669 | .413 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .151 | -.409 | -.224 | -.332 | -.297 | -.429 |
| BPsystolic | Sig. (2-tailed) | .380 | .013 | .190 | .048 | .078 | .009 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .254 | -.164 | -.069 | -.130 | -.111 | -.239 |
| BPDiastolic | Sig. (2-tailed) | .136 | .340 | .687 | .449 | .517 | .160 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.001 | .245 | .072 | .170 | .101 | .224 |
| Respiration | Sig. (2-tailed) | .996 | .149 | .677 | .323 | .557 | .188 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .058 | -.162 | -.186 | -.241 | -.293 | -.278 |
| Weight | Sig. (2-tailed) | .737 | .346 | .277 | .156 | .083 | .100 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.190 | -.369 | -.194 | -.152 | -.204 | -.230 |
| Height_inches | Sig. (2-tailed) | .267 | .027 | .258 | .378 | .232 | .178 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.135 | .288 | .303 | .514 | .579 | .175 | .893 | -.320 |
| BMI | Sig. (2-tailed) | .433 | .089 | .073 | .001 | .000 | .307 | .000 | .057 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .352 | -.314 | -.109 | .070 | .160 | -.135 | -.129 | -.289 |
| OX_PreSL | Sig. (2-tailed) | .035 | .062 | .528 | .687 | .350 | .433 | .453 | .087 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .170 | -.223 | -.032 | -.185 | -.137 | -.070 | -.463 | -.173 |
| OX_8k | Sig. (2-tailed) | .321 | .191 | .854 | .281 | .425 | .685 | .004 | .313 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.017 | .047 | .112 | -.001 | .135 | -.264 | -.344 | .058 |
| OX_12k | Sig. (2-tailed) | .922 | .786 | .516 | .994 | .433 | .120 | .040 | .738 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.153 | .131 | .066 | .052 | .203 | -.121 | -.198 | .154 |
| OX_14k | Sig. (2-tailed) | .374 | .445 | .701 | .763 | .236 | .481 | .248 | .371 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .403 | -.391 | -.022 | -.092 | -.063 | -.244 | -.232 | -.176 |
| OX_PostSL | Sig. (2-tailed) | .015 | .018 | .899 | .593 | .717 | .152 | .172 | .305 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .073 | .290 | .907 | .294 | .301 | .233 | .353 | -.186 |
| PLBPM_PreSL | Sig. (2-tailed) | .672 | .087 | .000 | .082 | .074 | .171 | .035 | .279 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .053 | .287 | .889 | .333 | .353 | .238 | .404 | -.207 |
| PLBPM_8k | Sig. (2-tailed) | .757 | .090 | .000 | .047 | .034 | .163 | .014 | .225 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | BMI | OX_PreSL | OX_8k | OX_12k | OX_14k | OX_PostSL | PLBPM_PreSL | PLBPM_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | 1 | .002 | -.363 | -.345 | -.210 | -.193 | .409 | .460 |
| BMI | Sig. (2-tailed) | | .993 | .030 | .039 | .220 | .260 | .013 | .005 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .002 | 1 | .480 | .213 | .154 | .579 | -.066 | -.119 |
| OX_PreSL | Sig. (2-tailed) | .993 | | .003 | .212 | .369 | .000 | .700 | .490 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.363 | .480 | 1 | .618 | .651 | .439 | -.145 | -.206 |
| OX_8k | Sig. (2-tailed) | .030 | .003 | | .000 | .000 | .007 | .398 | .228 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.345 | .213 | .618 | 1 | .668 | .322 | -.035 | -.016 |
| OX_12k | Sig. (2-tailed) | .039 | .212 | .000 | | .000 | .056 | .838 | .928 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.210 | .154 | .651 | .668 | 1 | .204 | -.073 | -.114 |
| OX_14k | Sig. (2-tailed) | .220 | .369 | .000 | .000 | | .233 | .673 | .506 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.193 | .579 | .439 | .322 | .204 | 1 | -.040 | -.078 |
| OX_PostSL | Sig. (2-tailed) | .260 | .000 | .007 | .056 | .233 | | .819 | .650 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .409 | -.066 | -.145 | -.035 | -.073 | -.040 | 1 | .963 |
| PLBPM_PreSL | Sig. (2-tailed) | .013 | .700 | .398 | .838 | .673 | .819 | | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .460 | -.119 | -.206 | -.016 | -.114 | -.078 | .963 | 1 |
| PLBPM_8k | Sig. (2-tailed) | .005 | .490 | .228 | .928 | .506 | .650 | .000 | |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL | FITD_8k | FITD_12k | FITD_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .495 | .464 | .467 | -.151 | -.128 | -.262 | -.268 |
| BMI | Sig. (2-tailed) | .002 | .004 | .004 | .380 | .457 | .134 | .119 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.139 | -.052 | -.051 | .054 | .093 | .112 | .045 |
| OX_PreSL | Sig. (2-tailed) | .419 | .763 | .769 | .755 | .591 | .528 | .799 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.263 | -.222 | -.157 | .175 | .152 | .196 | .214 |
| OX_8k | Sig. (2-tailed) | .122 | .194 | .362 | .308 | .377 | .266 | .217 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.090 | -.062 | .032 | .049 | .045 | .133 | .179 |
| OX_12k | Sig. (2-tailed) | .603 | .720 | .854 | .775 | .793 | .454 | .304 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.240 | -.247 | -.035 | -.050 | -.012 | .090 | .168 |
| OX_14k | Sig. (2-tailed) | .159 | .147 | .838 | .773 | .944 | .613 | .335 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.099 | -.033 | .017 | .043 | .014 | .053 | .095 |
| OX_PostSL | Sig. (2-tailed) | .567 | .850 | .921 | .804 | .935 | .765 | .587 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .916 | .894 | .947 | .379 | .413 | .359 | .427 |
| PLBPM_PreSL | Sig. (2-tailed) | .000 | .000 | .000 | .023 | .012 | .037 | .011 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .971 | .943 | .933 | .373 | .389 | .304 | .371 |
| PLBPM_8k | Sig. (2-tailed) | .000 | .000 | .000 | .025 | .019 | .080 | .028 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k | FITA_PostSL | FITL_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.305 | -.049 | -.039 | -.017 | -.026 | -.062 | .239 |
| BMI | Sig. (2-tailed) | .079 | .778 | .820 | .925 | .883 | .730 | .160 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .117 | .020 | .133 | .113 | .002 | -.004 | -.149 |
| OX_PreSL | Sig. (2-tailed) | .510 | .909 | .441 | .526 | .993 | .983 | .385 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .255 | .212 | .245 | .256 | .335 | .097 | -.367 |
| OX_8k | Sig. (2-tailed) | .146 | .214 | .149 | .144 | .049 | .586 | .028 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .031 | .010 | .049 | .162 | .143 | -.186 | -.280 |
| OX_12k | Sig. (2-tailed) | .862 | .953 | .777 | .360 | .412 | .293 | .098 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .048 | -.031 | .093 | .120 | .267 | .024 | -.132 |
| OX_14k | Sig. (2-tailed) | .786 | .857 | .591 | .500 | .121 | .891 | .444 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .084 | .347 | .313 | .367 | .250 | .249 | -.541 |
| OX_PostSL | Sig. (2-tailed) | .637 | .038 | .063 | .033 | .148 | .156 | .001 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .295 | .049 | .114 | .106 | .121 | -.206 | .084 |
| PLBPM_PreSL | Sig. (2-tailed) | .090 | .775 | .506 | .550 | .490 | .242 | .628 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .238 | .044 | .129 | .130 | .100 | -.230 | .092 |
| PLBPM_8k | Sig. (2-tailed) | .176 | .799 | .452 | .462 | .568 | .191 | .592 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k | FITV_12k | FITV_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .192 | .135 | .114 | .205 | .302 | .096 | .201 | .259 |
| BMI | Sig. (2-tailed) | .263 | .445 | .515 | .244 | .073 | .576 | .247 | .127 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.173 | -.192 | -.206 | -.062 | .000 | .119 | .096 | .006 |
| OX_PreSL | Sig. (2-tailed) | .312 | .276 | .235 | .726 | .998 | .488 | .583 | .972 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.362 | -.350 | -.338 | -.076 | .104 | .099 | .124 | .105 |
| OX_8k | Sig. (2-tailed) | .030 | .043 | .047 | .668 | .547 | .566 | .477 | .543 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.309 | -.355 | -.240 | -.073 | .037 | .180 | .158 | .181 |
| OX_12k | Sig. (2-tailed) | .066 | .039 | .165 | .683 | .830 | .294 | .366 | .291 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.148 | -.123 | -.072 | .029 | .095 | .077 | .130 | .123 |
| OX_14k | Sig. (2-tailed) | .389 | .487 | .680 | .871 | .582 | .656 | .457 | .476 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.575 | -.582 | -.524 | -.491 | .084 | .203 | .089 | .105 |
| OX_PostSL | Sig. (2-tailed) | .000 | .000 | .001 | .003 | .627 | .235 | .612 | .542 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .059 | .068 | -.002 | .213 | .185 | .137 | .153 | .151 |
| PLBPM_PreSL | Sig. (2-tailed) | .730 | .701 | .993 | .227 | .281 | .427 | .381 | .379 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .052 | .066 | .015 | .230 | .210 | .164 | .180 | .206 |
| PLBPM_8k | Sig. (2-tailed) | .761 | .711 | .934 | .190 | .219 | .338 | .302 | .229 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k | ESQams_PostSL |
|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .044 | -.060 | -.149 | -.219 | -.245 | -.200 |
| BMI | Sig. (2-tailed) | .798 | .727 | .385 | .200 | .150 | .241 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .036 | .364 | .436 | .333 | .359 | .259 |
| OX_PreSL | Sig. (2-tailed) | .833 | .029 | .008 | .047 | .031 | .126 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .139 | .165 | .100 | .129 | .089 | .230 |
| OX_8k | Sig. (2-tailed) | .418 | .335 | .560 | .453 | .607 | .177 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .292 | .041 | -.049 | -.104 | -.113 | -.167 |
| OX_12k | Sig. (2-tailed) | .084 | .811 | .778 | .545 | .511 | .329 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .108 | -.059 | -.142 | -.163 | -.218 | -.082 |
| OX_14k | Sig. (2-tailed) | .532 | .731 | .410 | .342 | .201 | .634 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .238 | .123 | .201 | .158 | .135 | .080 |
| OX_PostSL | Sig. (2-tailed) | .162 | .474 | .239 | .356 | .432 | .642 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .020 | -.127 | -.155 | -.152 | -.073 | -.229 |
| PLBPM_PreSL | Sig. (2-tailed) | .908 | .460 | .367 | .378 | .673 | .180 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .072 | -.067 | -.139 | -.162 | -.066 | -.281 |
| PLBPM_8k | Sig. (2-tailed) | .677 | .698 | .419 | .346 | .702 | .097 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .063 | .244 | .835 | .310 | .305 | .262 | .435 | -.228 |
| PLBPM_12k | Sig. (2-tailed) | .714 | .151 | .000 | .065 | .070 | .123 | .008 | .182 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .167 | .181 | .795 | .293 | .331 | .262 | .372 | -.341 |
| PLBPM_14k | Sig. (2-tailed) | .330 | .292 | .000 | .083 | .049 | .123 | .026 | .042 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .135 | .214 | .865 | .295 | .361 | .229 | .413 | -.240 |
| PLBPM_PostSL | Sig. (2-tailed) | .433 | .211 | .000 | .081 | .031 | .179 | .012 | .158 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .182 | -.430 | .310 | -.114 | -.155 | .063 | -.137 | .065 |
| FITD_PreSL | Sig. (2-tailed) | .288 | .009 | .066 | .507 | .367 | .713 | .425 | .705 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .253 | -.357 | .336 | -.072 | -.076 | .144 | -.133 | -.009 |
| FITD_8k | Sig. (2-tailed) | .137 | .032 | .045 | .677 | .660 | .403 | .440 | .960 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .152 | -.338 | .233 | -.126 | -.050 | .130 | -.226 | .154 |
| FITD_12k | Sig. (2-tailed) | .390 | .050 | .184 | .478 | .777 | .465 | .199 | .385 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .236 | -.302 | .382 | -.201 | -.166 | .103 | -.267 | .051 |
| FITD_14k | Sig. (2-tailed) | .172 | .078 | .023 | .248 | .342 | .555 | .121 | .770 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .211 | -.454 | .178 | -.176 | -.204 | .019 | -.316 | .086 |
| FITD_PostSL | Sig. (2-tailed) | .230 | .007 | .313 | .320 | .246 | .915 | .069 | .628 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | BMI | OX_PreSL | OX_8k | OX_12k | OX_14k | OX_PostSL | PLBPM_PreSL | PLBPM_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .495 | -.139 | -.263 | -.090 | -.240 | -.099 | .916 | .971 |
| PLBPM_12k | Sig. (2-tailed) | .002 | .419 | .122 | .603 | .159 | .567 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .464 | -.052 | -.222 | -.062 | -.247 | -.033 | .894 | .943 |
| PLBPM_14k | Sig. (2-tailed) | .004 | .763 | .194 | .720 | .147 | .850 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .467 | -.051 | -.157 | .032 | -.035 | .017 | .947 | .933 |
| PLBPM_PostSL | Sig. (2-tailed) | .004 | .769 | .362 | .854 | .838 | .921 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.151 | .054 | .175 | .049 | -.050 | .043 | .379 | .373 |
| FITD_PreSL | Sig. (2-tailed) | .380 | .755 | .308 | .775 | .773 | .804 | .023 | .025 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.128 | .093 | .152 | .045 | -.012 | .014 | .413 | .389 |
| FITD_8k | Sig. (2-tailed) | .457 | .591 | .377 | .793 | .944 | .935 | .012 | .019 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.262 | .112 | .196 | .133 | .090 | .053 | .359 | .304 |
| FITD_12k | Sig. (2-tailed) | .134 | .528 | .266 | .454 | .613 | .765 | .037 | .080 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.268 | .045 | .214 | .179 | .168 | .095 | .427 | .371 |
| FITD_14k | Sig. (2-tailed) | .119 | .799 | .217 | .304 | .335 | .587 | .011 | .028 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.305 | .117 | .255 | .031 | .048 | .084 | .295 | .238 |
| FITD_PostSL | Sig. (2-tailed) | .079 | .510 | .146 | .862 | .786 | .637 | .090 | .176 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL | FITD_8k | FITD_12k | FITD_14k |
|---|---|---|---|---|---|---|---|---|
| PLBPM_12k | Pearson Correlation | 1 | .967 | .899 | .363 | .370 | .280 | .331 |
| | Sig. (2-tailed) | | .000 | .000 | .030 | .026 | .109 | .052 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| PLBPM_14k | Pearson Correlation | .967 | 1 | .915 | .398 | .421 | .303 | .383 |
| | Sig. (2-tailed) | .000 | | .000 | .016 | .011 | .081 | .023 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| PLBPM_PostSL | Pearson Correlation | .899 | .915 | 1 | .340 | .377 | .279 | .385 |
| | Sig. (2-tailed) | .000 | .000 | | .042 | .023 | .110 | .022 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| FITD_PreSL | Pearson Correlation | .363 | .398 | .340 | 1 | .941 | .944 | .890 |
| | Sig. (2-tailed) | .030 | .016 | .042 | | .000 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| FITD_8k | Pearson Correlation | .370 | .421 | .377 | .941 | 1 | .959 | .926 |
| | Sig. (2-tailed) | .026 | .011 | .023 | .000 | | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| FITD_12k | Pearson Correlation | .280 | .303 | .279 | .944 | .959 | 1 | .934 |
| | Sig. (2-tailed) | .109 | .081 | .110 | .000 | .000 | | .000 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 33 |
| FITD_14k | Pearson Correlation | .331 | .383 | .385 | .890 | .926 | .934 | 1 |
| | Sig. (2-tailed) | .052 | .023 | .022 | .000 | .000 | .000 | |
| | N | 35 | 35 | 35 | 35 | 35 | 33 | 35 |
| FITD_PostSL | Pearson Correlation | .193 | .257 | .249 | .921 | .911 | .938 | .929 |
| | Sig. (2-tailed) | .273 | .142 | .156 | .000 | .000 | .000 | .000 |
| | N | 34 | 34 | 34 | 34 | 34 | 32 | 33 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k | FITA_PostSL | FITL_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .193 | .036 | .085 | .105 | .049 | -.252 | .122 |
| PLBPM_12k | Sig. (2-tailed) | .273 | .834 | .621 | .554 | .779 | .150 | .478 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .257 | .009 | .073 | .088 | .013 | -.260 | .105 |
| PLBPM_14k | Sig. (2-tailed) | .142 | .957 | .673 | .619 | .942 | .137 | .544 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .249 | .008 | .086 | .120 | .076 | -.186 | .104 |
| PLBPM_PostSL | Sig. (2-tailed) | .156 | .964 | .617 | .500 | .665 | .291 | .546 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .921 | .119 | .142 | .113 | .019 | -.041 | .131 |
| FITD_PreSL | Sig. (2-tailed) | .000 | .488 | .408 | .525 | .913 | .820 | .447 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .911 | .065 | .142 | .119 | .047 | -.039 | .213 |
| FITD_8k | Sig. (2-tailed) | .000 | .707 | .408 | .504 | .787 | .827 | .212 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .938 | .028 | .112 | .061 | .021 | -.066 | .193 |
| FITD_12k | Sig. (2-tailed) | .000 | .874 | .529 | .731 | .907 | .719 | .274 |
| | N | 32 | 34 | 34 | 34 | 33 | 32 | 34 |
| | Pearson Correlation | .929 | -.001 | .036 | .030 | .045 | -.097 | .116 |
| FITD_14k | Sig. (2-tailed) | .000 | .995 | .835 | .869 | .797 | .593 | .508 |
| | N | 33 | 35 | 35 | 33 | 35 | 33 | 35 |
| | Pearson Correlation | 1 | .005 | .096 | .023 | -.039 | -.034 | .128 |
| FITD_PostSL | Sig. (2-tailed) | | .977 | .590 | .899 | .831 | .850 | .470 |
| | N | 34 | 34 | 34 | 32 | 33 | 34 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k | FITV_12k | FITV_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .090 | .086 | .049 | .242 | .200 | .133 | .157 | .209 |
| PLBPM_12k | Sig. (2-tailed) | .602 | .627 | .780 | .168 | .241 | .439 | .369 | .221 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .059 | .062 | .041 | .222 | .257 | .197 | .242 | .237 |
| PLBPM_14k | Sig. (2-tailed) | .733 | .728 | .817 | .207 | .130 | .248 | .162 | .165 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .023 | .032 | -.001 | .160 | .270 | .207 | .238 | .193 |
| PLBPM_PostSL | Sig. (2-tailed) | .893 | .858 | .995 | .367 | .112 | .226 | .169 | .259 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .122 | .202 | .245 | .274 | .055 | .085 | .184 | -.024 |
| FITD_PreSL | Sig. (2-tailed) | .478 | .253 | .156 | .116 | .748 | .621 | .290 | .891 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .219 | .284 | .310 | .345 | .091 | .083 | .215 | -.035 |
| FITD_8k | Sig. (2-tailed) | .199 | .104 | .070 | .045 | .598 | .632 | .215 | .838 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .226 | .319 | .344 | .350 | .058 | .084 | .164 | -.023 |
| FITD_12k | Sig. (2-tailed) | .199 | .066 | .050 | .050 | .746 | .636 | .354 | .897 |
| | N | 34 | 34 | 33 | 32 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .142 | .193 | .284 | .238 | -.011 | .022 | .128 | -.088 |
| FITD_14k | Sig. (2-tailed) | .416 | .281 | .098 | .182 | .948 | .899 | .470 | .616 |
| | N | 35 | 33 | 35 | 33 | 35 | 35 | 34 | 35 |
| | Pearson Correlation | .112 | .255 | .285 | .206 | .002 | .061 | .131 | -.127 |
| FITD_PostSL | Sig. (2-tailed) | .529 | .158 | .109 | .241 | .992 | .731 | .466 | .474 |
| | N | 34 | 32 | 33 | 34 | 34 | 34 | 33 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k | ESQams_PostSL |
|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .092 | -.062 | -.126 | -.152 | -.047 | -.274 |
| PLBPM_12k | Sig. (2-tailed) | .594 | .721 | .464 | .376 | .786 | .105 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .190 | .028 | -.025 | -.051 | .083 | -.210 |
| PLBPM_14k | Sig. (2-tailed) | .268 | .869 | .887 | .769 | .629 | .220 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .151 | -.086 | -.104 | -.133 | -.009 | -.267 |
| PLBPM_PostSL | Sig. (2-tailed) | .381 | .618 | .546 | .439 | .957 | .116 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .108 | .143 | .215 | .240 | .238 | .072 |
| FITD_PreSL | Sig. (2-tailed) | .529 | .404 | .207 | .159 | .162 | .677 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .098 | .143 | .163 | .166 | .170 | .012 |
| FITD_8k | Sig. (2-tailed) | .571 | .405 | .341 | .333 | .321 | .944 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .127 | .090 | .165 | .215 | .165 | .028 |
| FITD_12k | Sig. (2-tailed) | .474 | .614 | .350 | .221 | .350 | .874 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .049 | .098 | .134 | .143 | .111 | .023 |
| FITD_14k | Sig. (2-tailed) | .782 | .577 | .443 | .412 | .524 | .894 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .035 | .128 | .402 | .370 | .376 | .152 |
| FITD_PostSL | Sig. (2-tailed) | .844 | .472 | .018 | .031 | .028 | .390 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .213 | -.270 | .072 | -.122 | -.139 | -.068 | -.035 | .024 |
| FITA_PreSL | Sig. (2-tailed) | .213 | .111 | .678 | .479 | .420 | .692 | .838 | .891 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .214 | -.280 | .078 | -.116 | -.019 | -.124 | -.032 | .038 |
| FITA_8k | Sig. (2-tailed) | .210 | .098 | .651 | .500 | .911 | .471 | .852 | .824 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .280 | -.294 | .111 | -.105 | -.048 | -.085 | -.024 | .011 |
| FITA_12k | Sig. (2-tailed) | .109 | .091 | .531 | .553 | .790 | .634 | .892 | .953 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .187 | -.137 | .215 | -.227 | -.117 | .022 | -.058 | -.007 |
| FITA_14k | Sig. (2-tailed) | .281 | .432 | .215 | .190 | .503 | .899 | .741 | .969 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .227 | -.429 | -.182 | -.241 | -.267 | -.007 | .004 | .118 |
| FITA_PostSL | Sig. (2-tailed) | .197 | .011 | .302 | .170 | .128 | .970 | .981 | .505 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.017 | .187 | .098 | -.009 | .167 | .269 | .299 | -.019 |
| FITL_PreSL | Sig. (2-tailed) | .920 | .276 | .569 | .957 | .329 | .112 | .077 | .913 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.057 | .249 | .089 | .021 | .153 | .323 | .226 | -.005 |
| FITL_8k | Sig. (2-tailed) | .741 | .143 | .605 | .903 | .373 | .055 | .184 | .977 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.076 | .233 | .023 | -.023 | .157 | .320 | .189 | .067 |
| FITL_12k | Sig. (2-tailed) | .668 | .184 | .899 | .898 | .374 | .065 | .284 | .707 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | BMI | OX_PreSL | OX_8k | OX_12k | OX_14k | OX_PostSL | PLBPM_PreSL | PLBPM_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.049 | .020 | .212 | .010 | -.031 | .347 | .049 | .044 |
| FITA_PreSL | Sig. (2-tailed) | .778 | .909 | .214 | .953 | .857 | .038 | .775 | .799 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.039 | .133 | .245 | .049 | .093 | .313 | .114 | .129 |
| FITA_8k | Sig. (2-tailed) | .820 | .441 | .149 | .777 | .591 | .063 | .506 | .452 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.017 | .113 | .256 | .162 | .120 | .367 | .106 | .130 |
| FITA_12k | Sig. (2-tailed) | .925 | .526 | .144 | .360 | .500 | .033 | .550 | .462 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.026 | .002 | .335 | .143 | .267 | .250 | .121 | .100 |
| FITA_14k | Sig. (2-tailed) | .883 | .993 | .049 | .412 | .121 | .148 | .490 | .568 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.062 | -.004 | .097 | -.186 | .024 | .249 | -.206 | -.230 |
| FITA_PostSL | Sig. (2-tailed) | .730 | .983 | .586 | .293 | .891 | .156 | .242 | .191 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .239 | -.149 | -.367 | -.280 | -.132 | -.541 | .084 | .092 |
| FITL_PreSL | Sig. (2-tailed) | .160 | .385 | .028 | .098 | .444 | .001 | .628 | .592 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .192 | -.173 | -.362 | -.309 | -.148 | -.575 | .059 | .052 |
| FITL_8k | Sig. (2-tailed) | .263 | .312 | .030 | .066 | .389 | .000 | .730 | .761 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .135 | -.192 | -.350 | -.355 | -.123 | -.582 | .068 | .066 |
| FITL_12k | Sig. (2-tailed) | .445 | .276 | .043 | .039 | .487 | .000 | .701 | .711 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL | FITD_8k | FITD_12k | FITD_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .036 | .009 | .008 | .119 | .065 | .028 | -.001 |
| FITA_PreSL | Sig. (2-tailed) | .834 | .957 | .964 | .488 | .707 | .874 | .995 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .085 | .073 | .086 | .142 | .142 | .112 | .036 |
| FITA_8k | Sig. (2-tailed) | .621 | .673 | .617 | .408 | .408 | .529 | .835 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .105 | .088 | .120 | .113 | .119 | .061 | .030 |
| FITA_12k | Sig. (2-tailed) | .554 | .619 | .500 | .525 | .504 | .731 | .869 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 33 |
| | Pearson Correlation | .049 | .013 | .076 | .019 | .047 | .021 | .045 |
| FITA_14k | Sig. (2-tailed) | .779 | .942 | .665 | .913 | .787 | .907 | .797 |
| | N | 35 | 35 | 35 | 35 | 35 | 33 | 35 |
| | Pearson Correlation | -.252 | -.260 | -.186 | -.041 | -.039 | -.066 | -.097 |
| FITA_PostSL | Sig. (2-tailed) | .150 | .137 | .291 | .820 | .827 | .719 | .593 |
| | N | 34 | 34 | 34 | 34 | 34 | 32 | 33 |
| | Pearson Correlation | .122 | .105 | .104 | .131 | .213 | .193 | .116 |
| FITL_PreSL | Sig. (2-tailed) | .478 | .544 | .546 | .447 | .212 | .274 | .508 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .090 | .059 | .023 | .122 | .219 | .226 | .142 |
| FITL_8k | Sig. (2-tailed) | .602 | .733 | .893 | .478 | .199 | .199 | .416 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .086 | .062 | .032 | .202 | .284 | .319 | .193 |
| FITL_12k | Sig. (2-tailed) | .627 | .728 | .858 | .253 | .104 | .066 | .281 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 33 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k | FITA_PostSL | FITL_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .005 | 1 | .844 | .873 | .779 | .832 | -.486 |
| FITA_PreSL | Sig. (2-tailed) | .977 | | .000 | .000 | .000 | .000 | .003 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .096 | .844 | 1 | .907 | .787 | .859 | -.444 |
| FITA_8k | Sig. (2-tailed) | .590 | .000 | | .000 | .000 | .000 | .007 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .023 | .873 | .907 | 1 | .825 | .840 | -.428 |
| FITA_12k | Sig. (2-tailed) | .899 | .000 | .000 | | .000 | .000 | .011 |
| | N | 32 | 34 | 34 | 34 | 33 | 32 | 34 |
| | Pearson Correlation | -.039 | .779 | .787 | .825 | 1 | .793 | -.512 |
| FITA_14k | Sig. (2-tailed) | .831 | .000 | .000 | .000 | | .000 | .002 |
| | N | 33 | 35 | 35 | 33 | 35 | 33 | 35 |
| | Pearson Correlation | -.034 | .832 | .859 | .840 | .793 | 1 | -.299 |
| FITA_PostSL | Sig. (2-tailed) | .850 | .000 | .000 | .000 | .000 | | .086 |
| | N | 34 | 34 | 34 | 32 | 33 | 34 | 34 |
| | Pearson Correlation | .128 | -.486 | -.444 | -.428 | -.512 | -.299 | 1 |
| FITL_PreSL | Sig. (2-tailed) | .470 | .003 | .007 | .011 | .002 | .086 | |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .112 | -.436 | -.508 | -.460 | -.457 | -.390 | .924 |
| FITL_8k | Sig. (2-tailed) | .529 | .008 | .002 | .006 | .006 | .022 | .000 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .255 | -.446 | -.389 | -.452 | -.484 | -.314 | .925 |
| FITL_12k | Sig. (2-tailed) | .158 | .008 | .023 | .007 | .004 | .080 | .000 |
| | N | 32 | 34 | 34 | 34 | 33 | 32 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k | FITV_12k | FITV_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.436 | -.446 | -.407 | -.204 | .122 | .122 | .067 | -.029 |
| FITA_PreSL | Sig. (2-tailed) | .008 | .008 | .015 | .248 | .479 | .480 | .704 | .869 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.508 | -.389 | -.362 | -.190 | .117 | .077 | .090 | -.160 |
| FITA_8k | Sig. (2-tailed) | .002 | .023 | .033 | .281 | .496 | .654 | .608 | .350 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.460 | -.452 | -.398 | -.191 | .154 | .113 | .062 | -.045 |
| FITA_12k | Sig. (2-tailed) | .006 | .007 | .022 | .296 | .384 | .523 | .726 | .798 |
| | N | 34 | 34 | 33 | 32 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.457 | -.484 | -.487 | -.326 | -.030 | -.165 | -.098 | -.183 |
| FITA_14k | Sig. (2-tailed) | .006 | .004 | .003 | .064 | .864 | .345 | .582 | .292 |
| | N | 35 | 33 | 35 | 33 | 35 | 35 | 34 | 35 |
| | Pearson Correlation | -.390 | -.314 | -.269 | -.310 | -.021 | -.040 | -.036 | -.198 |
| FITA_PostSL | Sig. (2-tailed) | .022 | .080 | .130 | .074 | .905 | .824 | .842 | .261 |
| | N | 34 | 32 | 33 | 34 | 34 | 34 | 33 | 34 |
| | Pearson Correlation | .924 | .925 | .881 | .911 | .033 | -.010 | .057 | .105 |
| FITL_PreSL | Sig. (2-tailed) | .000 | .000 | .000 | .000 | .848 | .952 | .745 | .542 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | 1 | .922 | .868 | .919 | -.007 | -.091 | -.028 | .096 |
| FITL_8k | Sig. (2-tailed) | | .000 | .000 | .000 | .967 | .597 | .871 | .578 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .922 | 1 | .920 | .940 | .008 | -.035 | .020 | .050 |
| FITL_12k | Sig. (2-tailed) | .000 | | .000 | .000 | .964 | .844 | .911 | .781 |
| | N | 34 | 34 | 33 | 32 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k | ESQams_PostSL |
|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .087 | -.138 | -.056 | .114 | -.117 | .180 |
| FITA_PreSL | Sig. (2-tailed) | .614 | .424 | .745 | .506 | .495 | .293 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .068 | -.065 | -.137 | -.040 | -.117 | -.025 |
| FITA_8k | Sig. (2-tailed) | .694 | .706 | .425 | .817 | .498 | .883 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .082 | -.063 | -.133 | -.026 | -.137 | .011 |
| FITA_12k | Sig. (2-tailed) | .643 | .723 | .454 | .886 | .441 | .952 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.068 | -.033 | -.258 | -.160 | -.281 | -.040 |
| FITA_14k | Sig. (2-tailed) | .697 | .849 | .135 | .358 | .103 | .817 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.032 | -.003 | -.107 | .094 | -.142 | .205 |
| FITA_PostSL | Sig. (2-tailed) | .855 | .989 | .548 | .596 | .424 | .245 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | -.095 | .112 | .165 | .207 | .197 | .139 |
| FITL_PreSL | Sig. (2-tailed) | .582 | .517 | .336 | .226 | .249 | .420 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.173 | .054 | .187 | .228 | .165 | .200 |
| FITL_8k | Sig. (2-tailed) | .314 | .753 | .275 | .181 | .335 | .243 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.138 | .076 | .161 | .255 | .215 | .159 |
| FITL_12k | Sig. (2-tailed) | .436 | .668 | .363 | .146 | .222 | .369 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.088 | .123 | -.039 | -.040 | .115 | .264 | .199 | .103 |
| FITL_14k | Sig. (2-tailed) | .617 | .481 | .824 | .818 | .509 | .125 | .253 | .555 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | -.103 | .257 | .181 | .072 | .279 | .173 | .200 | -.089 |
| FITL_PostSL | Sig. (2-tailed) | .562 | .143 | .305 | .687 | .110 | .329 | .257 | .618 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .067 | -.069 | .093 | .292 | .339 | .201 | .270 | -.326 |
| FITV_PreSL | Sig. (2-tailed) | .697 | .688 | .588 | .084 | .043 | .240 | .112 | .052 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .139 | -.079 | .048 | .234 | .252 | .008 | .069 | -.235 |
| FITV_8k | Sig. (2-tailed) | .419 | .647 | .782 | .169 | .138 | .962 | .690 | .168 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .159 | -.092 | .098 | .224 | .317 | .025 | .150 | -.284 |
| FITV_12k | Sig. (2-tailed) | .362 | .598 | .576 | .196 | .064 | .885 | .389 | .098 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .061 | .098 | .150 | .279 | .303 | .190 | .220 | -.302 |
| FITV_14k | Sig. (2-tailed) | .724 | .571 | .384 | .099 | .072 | .267 | .197 | .074 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .104 | -.185 | -.028 | .151 | .254 | -.001 | .058 | -.190 |
| FITV_PostSL | Sig. (2-tailed) | .547 | .280 | .873 | .380 | .136 | .996 | .737 | .267 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .618 | -.260 | -.044 | -.409 | -.164 | .245 | -.162 | -.369 |
| ESQams_PreSL | Sig. (2-tailed) | .000 | .125 | .799 | .013 | .340 | .149 | .346 | .027 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | BMI | OX_PreSL | OX_8k | OX_12k | OX_14k | OX_PostSL | PLBPM_PreSL | PLBPM_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .114 | -.206 | -.338 | -.240 | -.072 | -.524 | -.002 | .015 |
| FITL_14k | Sig. (2-tailed) | .515 | .235 | .047 | .165 | .680 | .001 | .993 | .934 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .205 | -.062 | -.076 | -.073 | .029 | -.491 | .213 | .230 |
| FITL_PostSL | Sig. (2-tailed) | .244 | .726 | .668 | .683 | .871 | .003 | .227 | .190 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .302 | .000 | .104 | .037 | .095 | .084 | .185 | .210 |
| FITV_PreSL | Sig. (2-tailed) | .073 | .998 | .547 | .830 | .582 | .627 | .281 | .219 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .096 | .119 | .099 | .180 | .077 | .203 | .137 | .164 |
| FITV_8k | Sig. (2-tailed) | .576 | .488 | .566 | .294 | .656 | .235 | .427 | .338 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .201 | .096 | .124 | .158 | .130 | .089 | .153 | .180 |
| FITV_12k | Sig. (2-tailed) | .247 | .583 | .477 | .366 | .457 | .612 | .381 | .302 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .259 | .006 | .105 | .181 | .123 | .105 | .151 | .206 |
| FITV_14k | Sig. (2-tailed) | .127 | .972 | .543 | .291 | .476 | .542 | .379 | .229 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .044 | .036 | .139 | .292 | .108 | .238 | .020 | .072 |
| FITV_PostSL | Sig. (2-tailed) | .798 | .833 | .418 | .084 | .532 | .162 | .908 | .677 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.060 | .364 | .165 | .041 | -.059 | .123 | -.127 | -.067 |
| ESQams_PreSL | Sig. (2-tailed) | .727 | .029 | .335 | .811 | .731 | .474 | .460 | .698 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL | FITD_8k | FITD_12k | FITD_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .049 | .041 | -.001 | .245 | .310 | .344 | .284 |
| FITL_14k | Sig. (2-tailed) | .780 | .817 | .995 | .156 | .070 | .050 | .098 |
| | N | 35 | 35 | 35 | 35 | 35 | 33 | 35 |
| | Pearson Correlation | .242 | .222 | .160 | .274 | .345 | .350 | .238 |
| FITL_PostSL | Sig. (2-tailed) | .168 | .207 | .367 | .116 | .045 | .050 | .182 |
| | N | 34 | 34 | 34 | 34 | 34 | 32 | 33 |
| | Pearson Correlation | .200 | .257 | .270 | .055 | .091 | .058 | -.011 |
| FITV_PreSL | Sig. (2-tailed) | .241 | .130 | .112 | .748 | .598 | .746 | .948 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .133 | .197 | .207 | .085 | .083 | .084 | .022 |
| FITV_8k | Sig. (2-tailed) | .439 | .248 | .226 | .621 | .632 | .636 | .899 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .157 | .242 | .238 | .184 | .215 | .164 | .128 |
| FITV_12k | Sig. (2-tailed) | .369 | .162 | .169 | .290 | .215 | .354 | .470 |
| | N | 35 | 35 | 35 | 35 | 35 | 34 | 34 |
| | Pearson Correlation | .209 | .237 | .193 | -.024 | -.035 | -.023 | -.088 |
| FITV_14k | Sig. (2-tailed) | .221 | .165 | .259 | .891 | .838 | .897 | .616 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | .092 | .190 | .151 | .108 | .098 | .127 | .049 |
| FITV_PostSL | Sig. (2-tailed) | .594 | .268 | .381 | .529 | .571 | .474 | .782 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.062 | .028 | -.086 | .143 | .143 | .090 | .098 |
| ESQams_PreSL | Sig. (2-tailed) | .721 | .869 | .618 | .404 | .405 | .614 | .577 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k | FITA_PostSL | FITL_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .285 | -.407 | -.362 | -.398 | -.487 | -.269 | .881 |
| FITL_14k | Sig. (2-tailed) | .109 | .015 | .033 | .022 | .003 | .130 | .000 |
| | N | 33 | 35 | 35 | 33 | 35 | 33 | 35 |
| | Pearson Correlation | .206 | -.204 | -.190 | -.191 | -.326 | -.310 | .911 |
| FITL_PostSL | Sig. (2-tailed) | .241 | .248 | .281 | .296 | .064 | .074 | .000 |
| | N | 34 | 34 | 34 | 32 | 33 | 34 | 34 |
| | Pearson Correlation | .002 | .122 | .117 | .154 | -.030 | -.021 | .033 |
| FITV_PreSL | Sig. (2-tailed) | .992 | .479 | .496 | .384 | .864 | .905 | .848 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .061 | .122 | .077 | .113 | -.165 | -.040 | -.010 |
| FITV_8k | Sig. (2-tailed) | .731 | .480 | .654 | .523 | .345 | .824 | .952 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .131 | .067 | .090 | .062 | -.098 | -.036 | .057 |
| FITV_12k | Sig. (2-tailed) | .466 | .704 | .608 | .726 | .582 | .842 | .745 |
| | N | 33 | 35 | 35 | 34 | 34 | 33 | 35 |
| | Pearson Correlation | -.127 | -.029 | -.160 | -.045 | -.183 | -.198 | .105 |
| FITV_14k | Sig. (2-tailed) | .474 | .869 | .350 | .798 | .292 | .261 | .542 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .035 | .087 | .068 | .082 | -.068 | -.032 | -.095 |
| FITV_PostSL | Sig. (2-tailed) | .844 | .614 | .694 | .643 | .697 | .855 | .582 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .128 | -.138 | -.065 | -.063 | -.033 | -.003 | .112 |
| ESQams_PreSL | Sig. (2-tailed) | .472 | .424 | .706 | .723 | .849 | .989 | .517 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k | FITV_12k | FITV_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .868 | .920 | 1 | .922 | .038 | -.032 | .039 | .035 |
| FITL_14k | Sig. (2-tailed) | .000 | .000 | | .000 | .827 | .857 | .827 | .842 |
| | N | 35 | 33 | 35 | 33 | 35 | 35 | 34 | 35 |
| | Pearson Correlation | .919 | .940 | .922 | 1 | .215 | .142 | .192 | .234 |
| FITL_PostSL | Sig. (2-tailed) | .000 | .000 | .000 | | .223 | .424 | .285 | .182 |
| | N | 34 | 32 | 33 | 34 | 34 | 34 | 33 | 34 |
| | Pearson Correlation | -.007 | .008 | .038 | .215 | 1 | .855 | .868 | .821 |
| FITV_PreSL | Sig. (2-tailed) | .967 | .964 | .827 | .223 | | .000 | .000 | .000 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.091 | -.035 | -.032 | .142 | .855 | 1 | .908 | .851 |
| FITV_8k | Sig. (2-tailed) | .597 | .844 | .857 | .424 | .000 | | .000 | .000 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.028 | .020 | .039 | .192 | .868 | .908 | 1 | .794 |
| FITV_12k | Sig. (2-tailed) | .871 | .911 | .827 | .285 | .000 | .000 | | .000 |
| | N | 35 | 34 | 34 | 33 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .096 | .050 | .035 | .234 | .821 | .851 | .794 | 1 |
| FITV_14k | Sig. (2-tailed) | .578 | .781 | .842 | .182 | .000 | .000 | .000 | |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | -.173 | -.138 | -.057 | .029 | .813 | .833 | .871 | .774 |
| FITV_PostSL | Sig. (2-tailed) | .314 | .436 | .747 | .872 | .000 | .000 | .000 | .000 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .054 | .076 | .066 | .000 | .024 | .159 | .187 | .220 |
| ESQams_PreSL | Sig. (2-tailed) | .753 | .668 | .708 | .999 | .891 | .353 | .281 | .197 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k | ESQams_PostSL |
|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.057 | .066 | .176 | .198 | .142 | .135 |
| FITL_14k | Sig. (2-tailed) | .747 | .708 | .311 | .254 | .416 | .439 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .029 | .000 | .168 | .256 | .136 | .200 |
| FITL_PostSL | Sig. (2-tailed) | .872 | .999 | .343 | .144 | .442 | .256 |
| | N | 34 | 34 | 34 | 34 | 34 | 34 |
| | Pearson Correlation | .813 | .024 | .017 | -.014 | -.046 | -.047 |
| FITV_PreSL | Sig. (2-tailed) | .000 | .891 | .924 | .933 | .791 | .784 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .833 | .159 | .171 | .171 | .072 | .064 |
| FITV_8k | Sig. (2-tailed) | .000 | .353 | .318 | .318 | .677 | .709 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .871 | .187 | .128 | .088 | .001 | .027 |
| FITV_12k | Sig. (2-tailed) | .000 | .281 | .465 | .616 | .995 | .878 |
| | N | 35 | 35 | 35 | 35 | 35 | 35 |
| | Pearson Correlation | .774 | .220 | .123 | .121 | .000 | .091 |
| FITV_14k | Sig. (2-tailed) | .000 | .197 | .473 | .481 | .998 | .598 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | 1 | .194 | .133 | .064 | .060 | -.056 |
| FITV_PostSL | Sig. (2-tailed) | | .257 | .438 | .712 | .730 | .745 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .194 | 1 | .661 | .512 | .544 | .492 |
| ESQams_PreSL | Sig. (2-tailed) | .257 | | .000 | .001 | .001 | .002 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | Sex | Age | Pulse | BPsystolic | BPDiastolic | Respiration | Weight | Height_inches |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .513 | -.417 | -.122 | -.224 | -.069 | .072 | -.186 | -.194 |
| ESQams_8k | Sig. (2-tailed) | .001 | .011 | .478 | .190 | .687 | .677 | .277 | .258 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .511 | -.350 | -.136 | -.332 | -.130 | .170 | -.241 | -.152 |
| ESQams_12k | Sig. (2-tailed) | .001 | .036 | .431 | .048 | .449 | .323 | .156 | .378 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .489 | -.347 | -.074 | -.297 | -.111 | .101 | -.293 | -.204 |
| ESQams_14k | Sig. (2-tailed) | .002 | .038 | .669 | .078 | .517 | .557 | .083 | .232 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .510 | -.182 | -.141 | -.429 | -.239 | .224 | -.278 | -.230 |
| ESQams_PostSL | Sig. (2-tailed) | .001 | .289 | .413 | .009 | .160 | .188 | .100 | .178 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | BMI | OX_PreSL | OX_8k | OX_12k | OX_14k | OX_PostSL | PLBPM_PreSL | PLBPM_8k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.149 | .436 | .100 | -.049 | -.142 | .201 | -.155 | -.139 |
| ESQams_8k | Sig. (2-tailed) | .385 | .008 | .560 | .778 | .410 | .239 | .367 | .419 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.219 | .333 | .129 | -.104 | -.163 | .158 | -.152 | -.162 |
| ESQams_12k | Sig. (2-tailed) | .200 | .047 | .453 | .545 | .342 | .356 | .378 | .346 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.245 | .359 | .089 | -.113 | -.218 | .135 | -.073 | -.066 |
| ESQams_14k | Sig. (2-tailed) | .150 | .031 | .607 | .511 | .201 | .432 | .673 | .702 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.200 | .259 | .230 | -.167 | -.082 | .080 | -.229 | -.281 |
| ESQams_PostSL | Sig. (2-tailed) | .241 | .126 | .177 | .329 | .634 | .642 | .180 | .097 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 | 36 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | PLBPM_12k | PLBPM_14k | PLBPM_PostSL | FITD_PreSL | FITD_8k | FITD_12k | FITD_14k |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | -.126 | -.025 | -.104 | .215 | .163 | .165 | .134 |
| ESQams_8k | Sig. (2-tailed) | .464 | .887 | .546 | .207 | .341 | .350 | .443 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.152 | -.051 | -.133 | .240 | .166 | .215 | .143 |
| ESQams_12k | Sig. (2-tailed) | .376 | .769 | .439 | .159 | .333 | .221 | .412 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.047 | .083 | -.009 | .238 | .170 | .165 | .111 |
| ESQams_14k | Sig. (2-tailed) | .786 | .629 | .957 | .162 | .321 | .350 | .524 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |
| | Pearson Correlation | -.274 | -.210 | -.267 | .072 | .012 | .028 | .023 |
| ESQams_PostSL | Sig. (2-tailed) | .105 | .220 | .116 | .677 | .944 | .874 | .894 |
| | N | 36 | 36 | 36 | 36 | 36 | 34 | 35 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITD_PostSL | FITA_PreSL | FITA_8k | FITA_12k | FITA_14k | FITA_PostSL | FITL_PreSL |
|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .402 | -.056 | -.137 | -.133 | -.258 | -.107 | .165 |
| ESQams_8k | Sig. (2-tailed) | .018 | .745 | .425 | .454 | .135 | .548 | .336 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .370 | .114 | -.040 | -.026 | -.160 | .094 | .207 |
| ESQams_12k | Sig. (2-tailed) | .031 | .506 | .817 | .886 | .358 | .596 | .226 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .376 | -.117 | -.117 | -.137 | -.281 | -.142 | .197 |
| ESQams_14k | Sig. (2-tailed) | .028 | .495 | .498 | .441 | .103 | .424 | .249 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |
| | Pearson Correlation | .152 | .180 | -.025 | .011 | -.040 | .205 | .139 |
| ESQams_PostSL | Sig. (2-tailed) | .390 | .293 | .883 | .952 | .817 | .245 | .420 |
| | N | 34 | 36 | 36 | 34 | 35 | 34 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITL_8k | FITL_12k | FITL_14k | FITL_PostSL | FITV_PreSL | FITV_8k | FITV_12k | FITV_14k |
|---|---|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .187 | .161 | .176 | .168 | .017 | .171 | .128 | .123 |
| ESQams_8k | Sig. (2-tailed) | .275 | .363 | .311 | .343 | .924 | .318 | .465 | .473 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .228 | .255 | .198 | .256 | -.014 | .171 | .088 | .121 |
| ESQams_12k | Sig. (2-tailed) | .181 | .146 | .254 | .144 | .933 | .318 | .616 | .481 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .165 | .215 | .142 | .136 | -.046 | .072 | .001 | .000 |
| ESQams_14k | Sig. (2-tailed) | .335 | .222 | .416 | .442 | .791 | .677 | .995 | .998 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |
| | Pearson Correlation | .200 | .159 | .135 | .200 | -.047 | .064 | .027 | .091 |
| ESQams_PostSL | Sig. (2-tailed) | .243 | .369 | .439 | .256 | .784 | .709 | .878 | .598 |
| | N | 36 | 34 | 35 | 34 | 36 | 36 | 35 | 36 |

**Correlation matrix among all variables for the control subjects, continued.**

| | | FITV_PostSL | ESQams_PreSL | ESQams_8k | ESQams_12k | ESQams_14k | ESQams_PostSL |
|---|---|---|---|---|---|---|---|
| | Pearson Correlation | .133 | .661 | 1 | .851 | .853 | .686 |
| ESQams_8k | Sig. (2-tailed) | .438 | .000 | | .000 | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .064 | .512 | .851 | 1 | .848 | .838 |
| ESQams_12k | Sig. (2-tailed) | .712 | .001 | .000 | | .000 | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | .060 | .544 | .853 | .848 | 1 | .640 |
| ESQams_14k | Sig. (2-tailed) | .730 | .001 | .000 | .000 | | .000 |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |
| | Pearson Correlation | -.056 | .492 | .686 | .838 | .640 | 1 |
| ESQams_PostSL | Sig. (2-tailed) | .745 | .002 | .000 | .000 | .000 | |
| | N | 36 | 36 | 36 | 36 | 36 | 36 |

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