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CONSEQUENCES OF THE RIDE OF BARANY CHAIR – THE NEUROCOGNITIVE AND PHYSIOLOGICAL CHANGES ASSOCIATED WITH EXPERIENCES OF VESTIBULLAR ILLUSION DEMONSTRATOR (VID) AT A STATE OF THE ART INTERNATIONAL AIRPORT OF A THIRD WORLD COUNTRY

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ABSTRACT

Objective: To compare neurophysiological changes in participants/subjects before and after experience of the ride of vestibular illusion demonstrator (VID). STUDY DESIGN: Comparative observational study. **Setting And Duration of Study:** The study was carried out at an aeromedical institute of an airport of a third world country from June 2017 to August 2018. **Patients and Methods:** Healthy subjects (male and female) between ages 18 to 40 years were selected. As this study involved humans so all data was collected after prior approval of the president of the Ethical Committee of the airport authority. All the participants were briefed and a written informed consent was taken from the participants of the study. An in depth biometric proforma was distributed and filled by subjects. The participants were ensured of the confidentiality of the information. It was ensured that all the subjects were in good health and were suffering from no physical or mental ailment. Those subjects were excluded who had hypertension, diabetes, asthma, cardiac disease, ENT disease or psychiatric illness. Vitals signs were endorsed before the exposure ride to Vestibular Illusion Demonstrator (VID). Subjects were exposed to VID for 07 minutes and after that vital signs were checked. The Motion Sickness Assessment Questionnaire (MSAQ) was filled by the participants after the exposure. All collected data was analysed by SPSS (Statistical Package for Social Sciences) version 22. **Results:** Twenty (20) healthy individuals participated in this study. During the motion of VID 75% (15/20) individuals developed neurophysiologic changes leading to motion sickness like tachycardia(75%), vomiting(5%), nausea(40%), sweating(45%), disorientation(10%) , dizziness(35%), increased systolic BP(25%), decreased systolic BP(45%), increased diastolic BP(10%),decreased diastolic BP (45%). **Conclusion:** During the experience of VID, 75% individuals developed neurophysiologic changes due to the motion sickness.

KEYWORDS: neurophysiologic, motion sickness, VID, disorientation.

INTRODUCTION

With an appropriate and a strong enough motion stimulus mostly all people experience motion sickness. In many typical conditions, such as on cruise ships, the prevalence ranges from 3-60%.[1] Motion sickness is a normal response to un-adapted or unfamiliar movement. The term 'motion sickness' includes airsickness, seasickness, car sickness, space motion sickness, and other related entities. It is not typically considered a medical disorder and can be induced in anyone with an intact vestibular system given the right type and duration of provocative stimuli. The effects of motion sickness range from subtle performance deficit and distraction all the way to incapacitation. Motion sickness is thought to occur as a result of conflicting inputs to the brain from visual, vestibular, proprioceptive, and rarely, auditory systems. The term motion sickness is somewhat a misnomer, since it is possible to experience characteristic symptoms in the absence of unfamiliar motion, as in the case of "simulator-sickness," "virtual-reality-sickness," or "visually induced motion sickness." Signs and symptoms of motion sickness can include pallor, cold sweats, epigastric discomfort, nausea, vomiting, apprehension, hyperventilation, lightheadedness, drowsiness and apathy. Nausea is typically the cardinal symptom. Significant variability in susceptibility and adaptation exists in different individuals. The affected individual may become distracted by the symptoms, leading to decreased situational awareness and performance decrements. Some individuals experience significant amelioration after vomiting, while others may continue to experience symptoms for hours after the motion has stopped. Most often, the brain is able to adapt to these mismatched sensations, and symptoms

tend to decline or disappear with adaptation. Most aviators become asymptomatic after repeated exposures to the flying environment.[2] The importance of psychological and emotional factors on the experience of motion sickness cannot be overlooked. Patients who have anxiety about other portions of their travel experience are much more likely to report the sensations of motion sickness as extremely unpleasant while those individuals who frequently overcome unpleasant noxious stimuli often report motion sickness as a minor inconvenience.[3]

Exposure to real or perceived motion stimuli is required for the syndrome to be categorized as motion sickness. Motion stimuli may be categorized as a vertical linear acceleration (heave), horizontal translational motion in the lateral direction (sway), the fore-and-aft movement (surge), and/or an angular roll. The maximum symptoms frequently appear with motions with a frequency of 0.2 Hz (one cycle every 5 seconds). Long period motions like those experienced on a tilting train or large ship can be barely perceptible but still cause the syndrome. Virtual motions such as in a large video screen, microfiche reader, or other visual motions can precipitate motion sickness.[4]

Motion sickness familiarization is an integral part of the aviator's training and motion sickness prevention begins in the VID in order to reach the experience of neurophysiologic changes associated with motion of VID. The purpose of the study is to identify the neurophysiologic changes and effects on a person who experiences VID as an aviator.

LITERATURE REVIEW

Motion sickness is caused by certain types of motion and is induced during passive locomotion in vehicles, generated by unfamiliar body accelerations, to which the person has not adapted, or by an intersensory conflict between vestibular and visual stimuli.[5] Motion sickness indiscriminately affects air, sea, road and space travelers. All individuals (humans and animals) possessing an intact vestibular apparatus can get motion sickness given the right quality and quantity of provocative stimulation, although there are wide and consistent individual differences in the degree of susceptibility.[6]

Neuronal Mechanism of Motion Sickness

Currently, motion sickness is thought to arise from conflicting information processed within a multimodal sensory system whose function is to determine the individual's motion relative to his/her environment. This has been termed 'neural mismatch theory.[7, 8] For the past 4 decades, the sensory conflict theory, most extensively described by Reason and Brand, has provided a theoretical framework for understanding motion sickness. According to the theory, motion sickness results when the brain receives conflicting information about body movements from the visual and vestibular receptors and the proprioceptive system ('sensory mismatch'). Most sickness-provoking sensory conflicts can be classified into two different categories,

(1) Conflict between visual and vestibular/ proprioceptive signals and

(2) Conflict between canal and otolith signals.

Furthermore, for each sensory conflict category 3 subtypes of conflicts can be distinguished. From these 2 categories and 3 types of conflict, 6 basic conflict types can be derived in which motion sickness might reasonably be expected to occur (table 1).[9]

Table 1: Six types of sensory rearrangements that can provoke motion sickness.

Type of conflict	Category 1: conflict between visual (A) and vestibular/ proprioceptive (B) signals	Category 2: conflict between canal (A) and otolith (B) signals
Type 1 Input A and B simultaneously receive contradictory or uncorrelated information	Watching waves over the side of a ship	Head movements made about some axis other than that of bodily rotation – cross-coupled angular acceleration
	Looking out of the side or rear windows of a moving vehicle	Low-frequency oscillation between 0.1 and 0.3 Hz
	Making head movements while wearing an optical device that disturbs vision	
Type 2 Input A signals in the absence of the expected B signal	Cinema sickness	Space motion sickness
	Operating a fixed-base vehicle simulator with a moving visual display (simulator sickness)	Caloric stimulation of the outer ear
	'Haunted-swing' type of fairground device	Positional alcoholic nystagmus associated with alcohol and heavy water
Type 3 Input B signals in the absence of the expected A signal	Reading a map in a moving vehicle	Rotation about an earth-horizontal axis
	Riding in a vehicle without external visual reference	Any rotation about an off-vertical axis
	Being swung in an enclosed cabin	Counterrotation

Motion Sickness Susceptibility

Nearly all people experience motion sickness if given a strong enough motion stimuli. In many typical conditions, such as on cruise ships, the prevalence ranges from 3-60%, depending on the study.[10] About 5-10% of all people are very susceptible to motion sickness, while the remainder only shows moderate susceptibility. Motion sickness susceptibility fluctuates with age.[11] Infants below the age of 2 years are generally immune to motion sickness, but susceptibility seems to be at the highest level between the ages of 2 and 12. Beyond the age of 50, any type of motion sickness is very rare. Chinese individuals show a higher susceptibility to motion sickness than Caucasians[12], and women appear to be more susceptible to motion sickness, especially during menstruation[13,14] and pregnancy. Thus, a relationship between the female endocrine system and motion sickness has been found.[15] In contrast, Cheung et al. were not able to prove that different phases of the menstrual cycle influence subjective symptoms of motion sickness.[16] Because 45% of patients with motion sickness have been shown to benefit from a placebo, there is evidence that psychological factors also influence motion sickness susceptibility.[17]

Vestibular Illusion Demonstrator

The Vestibular Illusion Demonstrator (VID) – Barany Chair is an economical introductory, single axis flight training device for basic disorientation training and research applications. Supporting five Spatial Disorientation (SD) flight profiles, the vestibular illusion demonstrator (VID) – Barany Chair features a shielded enclosure, which ensures complete visual isolation from the surrounding training facility for an enhanced, more realistic training sessions. The controllable rate of acceleration allows acceleration from between 0 and 25 RPM. Each system is offered with a standard, remote controller station, and physiological monitoring and data acquisition system. The Vestibular Illusion Device (VID) – Barany Chair is equipped with medical monitoring capability and CCTV recording system. Its' automated control profile editor is self-diagnosing systems and the system as a whole possesses multiple safety features.[18]

Main parts of Vid

(a) Cabin Enclosure & Seat Assembly
(b) Motion Base Assembly
(c) Operator's Control Console
(d) CCTV Monitoring & Recording System
(e) Voice Communications System
(f) Medical Monitoring Facilities

MATERIAL AND METHOD

The study included 20 subjects which were randomly and who gave informed consent for participation in this research project. The subjects were from 18 to 40 years of age. The study did not include children or old aged individuals as well as those who were suffering from any ENT disease, Asthma, Diabetes Mellitus, Hypertension, Ischemic heart disease or psychiatric illness. The subjects who refused to participate in the study were also not included in the study. Participants were explained about the study's significance. Written and verbal informed consent was obtained from the subjects. Their name, age, gender, and marital status was noted on personal data form attached as per annexure B.Vitals including heart rate, blood pressure, oxygen saturation and respiratory rate were noted before exposure on Performa attached as per annexure C. Each subject exposed to VID was monitored for any neurophysiologic change on screen through CCTV camera. The time of exposure to VID was about 07 minutes. After exposure subjects were again checked and given questionnaire performa attached as per annexure C which included The Motion Sickness Assessment Questionnaire. Vitals were noted again after exposure to the VID. Pre and post exposure heart rate and blood pressure were included in the study. Post exposure symptoms like sweating, dizziness, disorientation, nausea and vomiting were then included. Data collected was then entered in SPSS (Statistical Package for Social Sciences) version 16.0.The results were formulated in form of tables and pie charts for better understanding.

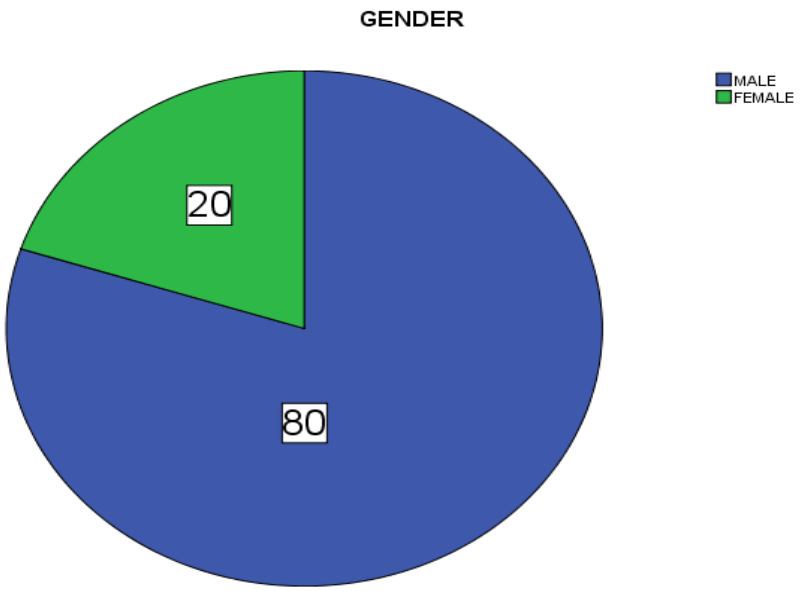
RESULTS

The Following results were obtained. Results are shown as in pie charts and includes the subjects who developed neurophysiological changes associated with experiences of VID.

Exposed Subjects

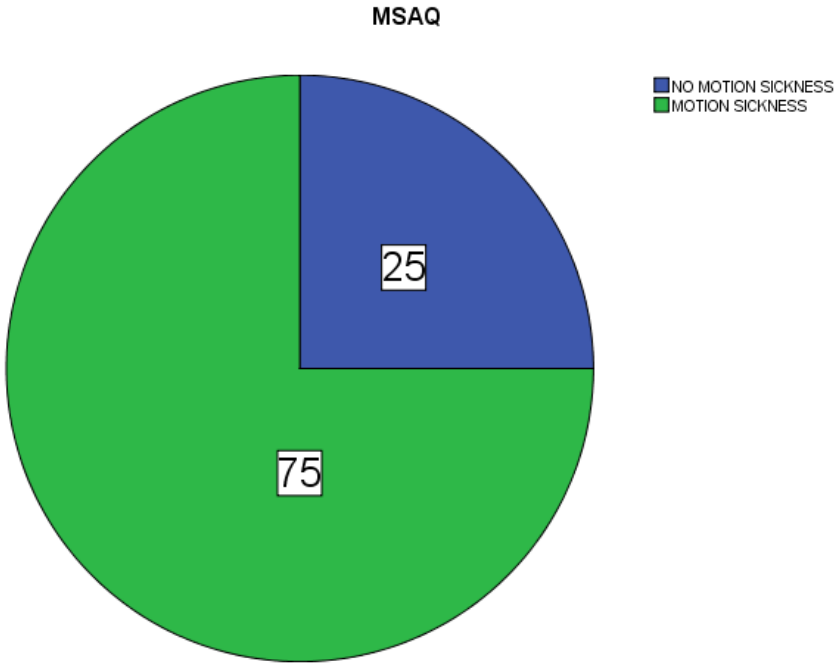
Overall 20 individuals were exposed to VID.

GENDER					
		Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
Valid	MALE	16	80.0	80.0	80.0
	FEMALE	4	20.0	20.0	100.0
	Total	20	100.0	100.0	



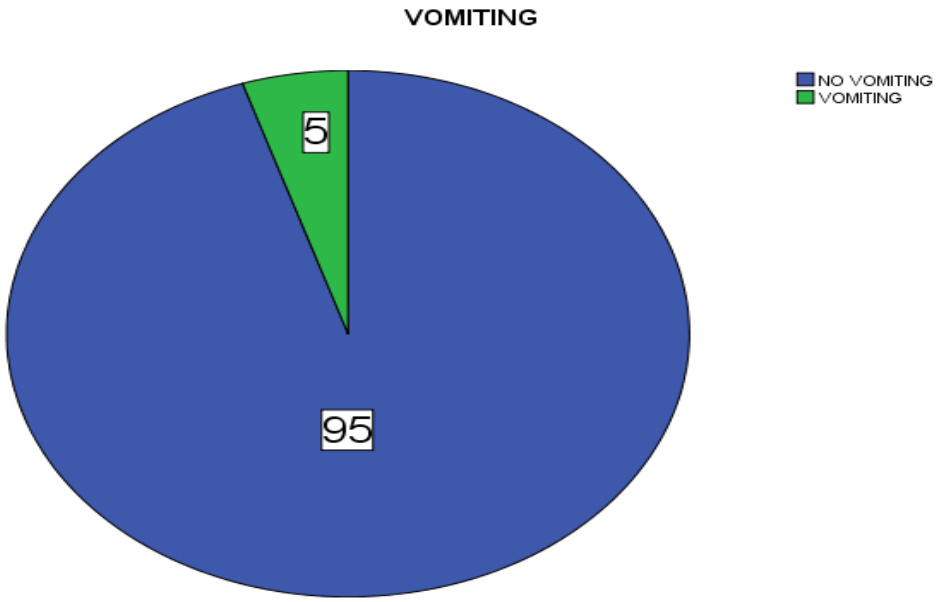
MOTION SICKNESS
(MSAQ: motion sickness assessment questionnaire)

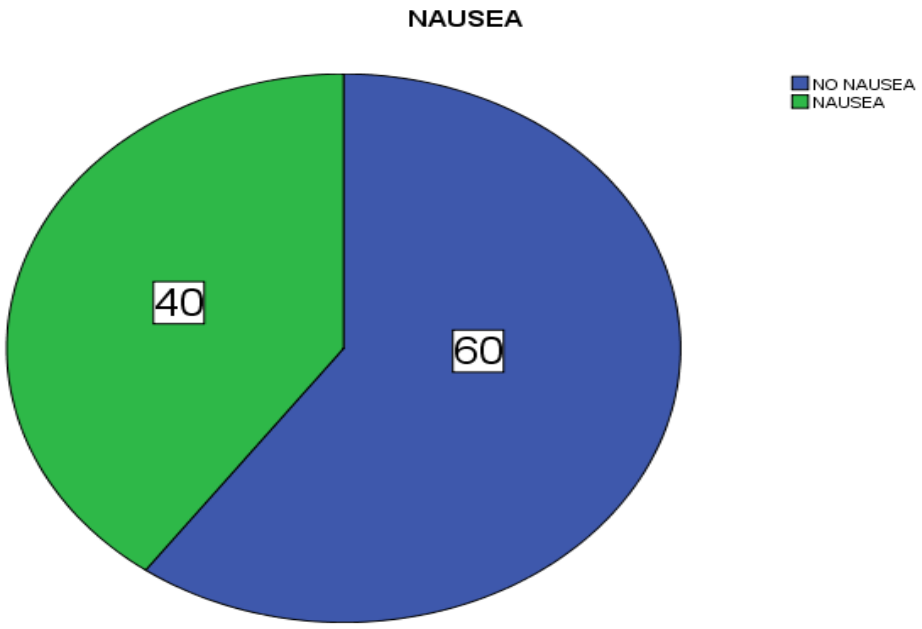
MSAQ				
	Frequency	**Percent**	**Valid Percent**	**Cumulative Percent**
NO MOTION SICKNESS	5	25.0	25.0	25.0
MOTION SICKNESS	15	75.0	75.0	75.0
Total	20	100.0	100.0	100.0

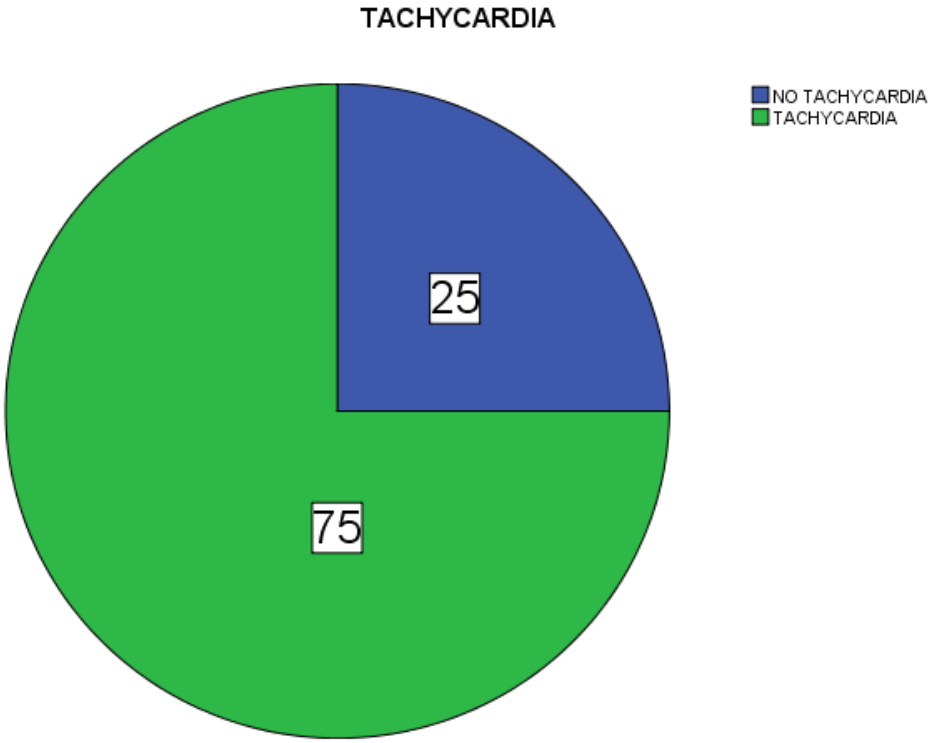


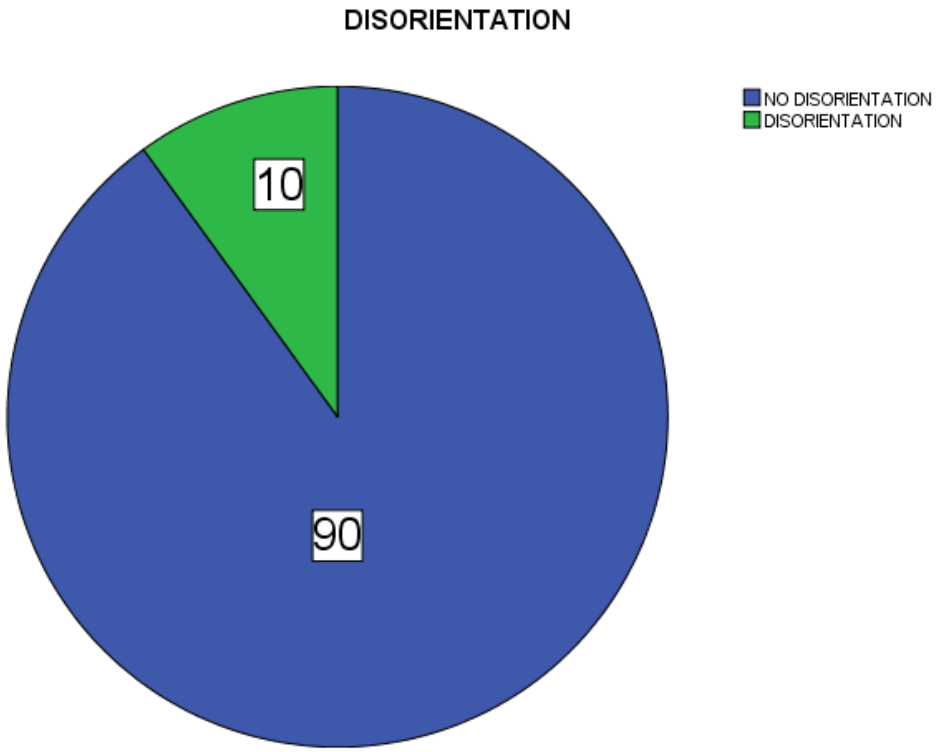
75% Individuals who suffered from motion sickness developed following signs and symptoms

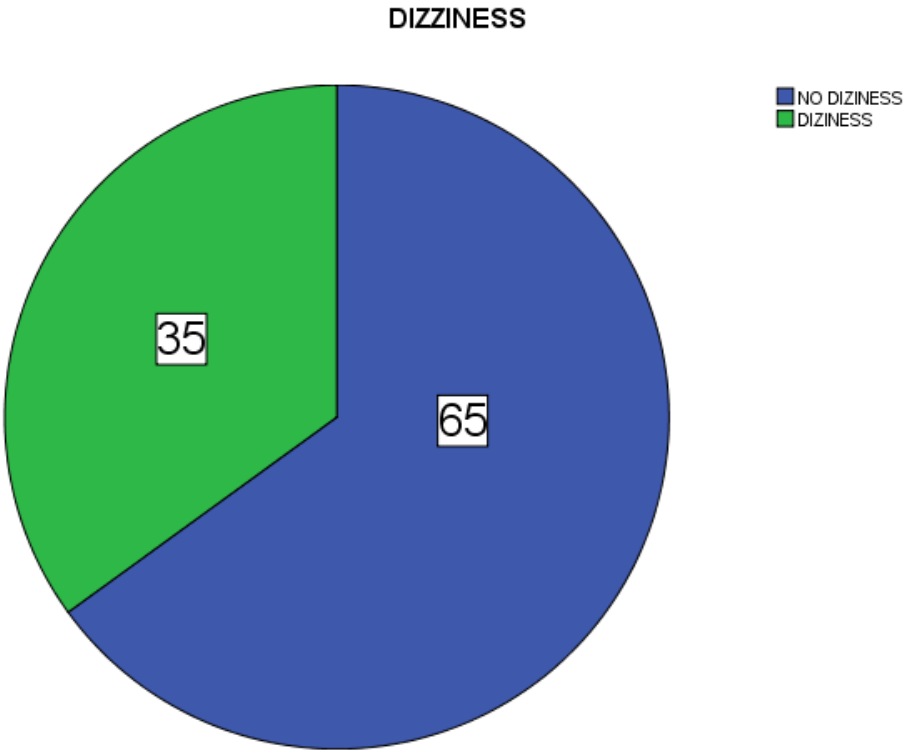
SIGNS AND SYMPTOMS	PERCENTAGE
VOMITING	5%
NAUSEA	40%
TACHYCARDIA	75%
DISORIENTATION	10%
DIZZINESS	35%
SWEATING	45%
INCREASED SYSTOLIC BP	25%
DECREASED SYSTOLIC BP	45%
INCREASED DIASTOLIC BP	10%
DECREASED DIASTOLIC BP	45%

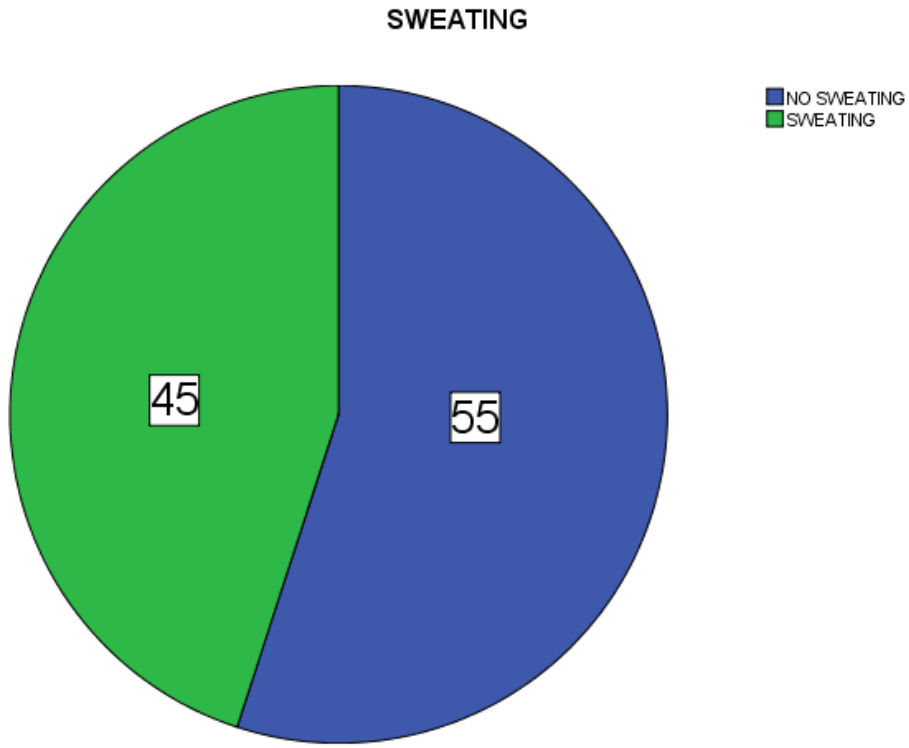


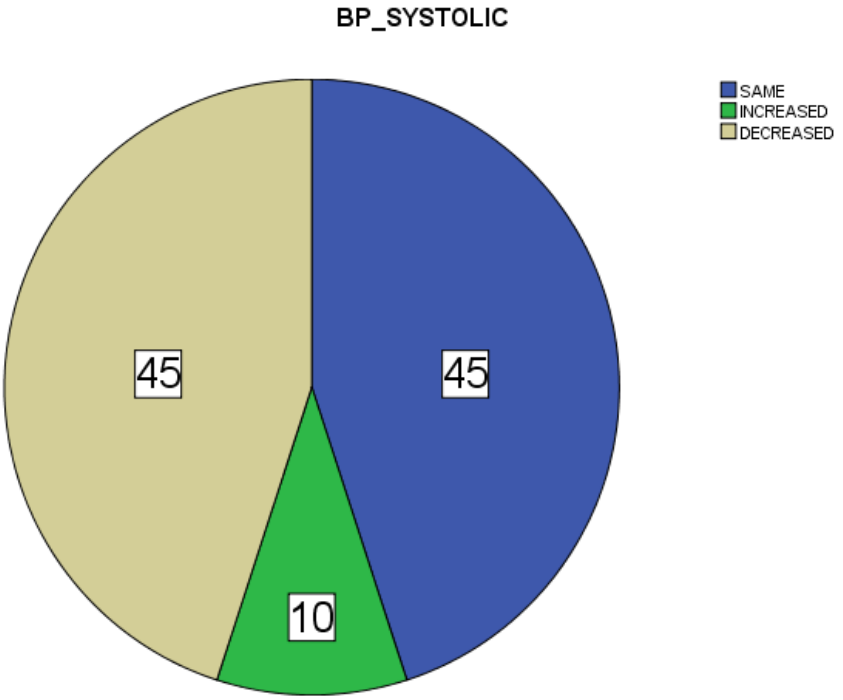


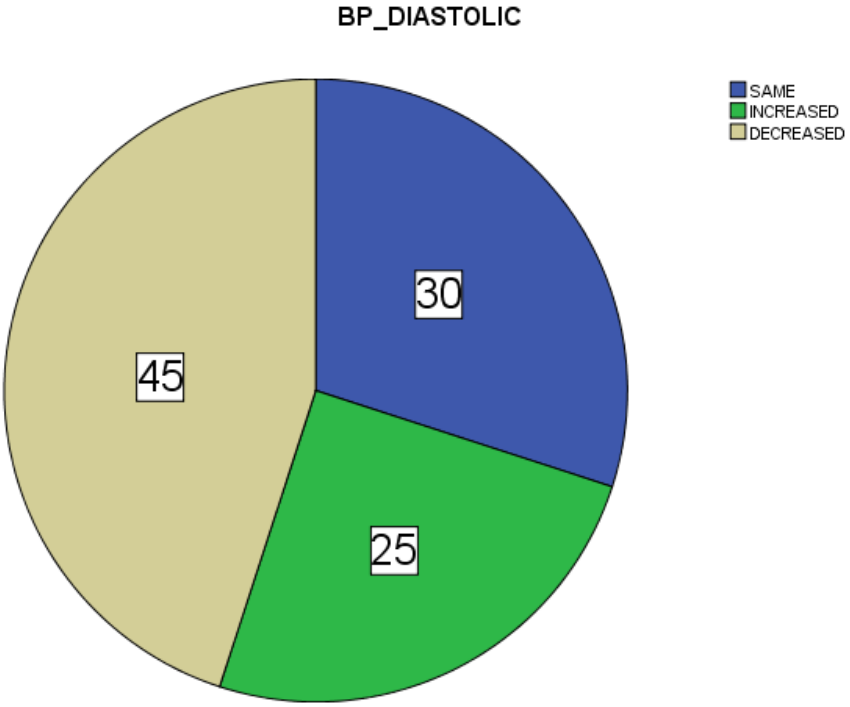

TACHYCARDIA
NO TACHYCARDIA
TACHYCARDIA
25
75


DISORIENTATION
NO DISORIENTATION
DISORIENTATION
10
90


DIZZINESS
NO DIZINESS
DIZINESS
35
65


SWEATING
NO SWEATING
SWEATING
45
55





25% INDIVIDUALS EXPOSED REMAINED SYMPTOMS FREE

DISCUSSION

Motion sickness is not an illness; it is a physiological response to a conflict between two or more of the following senses; vision, proprioception and the vestibular system.[19] These conflicts can lead to discomfort, nausea and difficulties concentrating and in worst case scenario, vomiting (Dahlman, 2009). It is unclear if the brain can compare different types of sensory input directly, but it seems to be capable of creating expectations of motion based on earlier experience which is compared with the perceived motion (Bowins, 2010). When we are asleep these comparisons

do not happen because the brain does not analyze the inputs, consequently the sensory conflict does not occur and we can accordingly not become motion sick when we are asleep (Dahlman J, 2012). Motion sickness can occur when an unexpected stimulus occurs or when an expected stimulus does not emerge (Dahlman, 2009). One example of this conflict is when reading in a car when it is dark outside; the vestibular system gives then cues of movement, but the visual system does not confirm this movement and these contradictory factors can cause motion sickness (Turner & Griffin, 1999).

According to Golding, Bles, Bos, Haynes and Gresty (2003), head alignment also has influence on motion sickness and tests have shown that it is preferable to align the head with gravito-inertial force(GIF).[20] Women reported significantly greater incidence of feeling motion sickness than did men on buses, on trains, on planes, in cars, and on amusement rides before the age of 12 yr. and on buses, on trains, on planes, in boats, on ships, in cars, on amusement rides, and on swings between the ages of 12 and 25 yr. Women also reported significantly higher incidence of being actually sick than did men on buses before the age of 12 yr and on buses, on ships, and in cars between the ages of 12 and 25 yr.[21] The sensation of movement frequently persists after the cessation of motion. This syndrome, called Mal de Barque, is considered worrisome if it lasts for longer than 3 days.[22] A small study has suggested visually induced motion sickness may be alleviated with pleasant odors.[23]

Patients should attempt to reduce as many other noxious stimuli as possible. Avoid any noxious stimuli such as odors, particularly the smell of hydrocarbons. Avoiding alcohol and other nausea producing substances is essential. The cessation of nicotine ingestion can reduce symptoms. Caffeine may increase some patient's nausea. Controlled breathing has been shown to suppress symptoms in mild cases.[24] Sopite syndrome, which is a constellation of symptoms that involves apathy, depression, disinclination for work, and decreased participation in group activities, can occur. These and other neurophysiologic symptoms such as malaise, lethargy and agitation can persist for some time after the motion stimuli has ended.[25]

CONCLUSION

In this research we have investigated neurophysiological changes of motion sickness associated with experiences of VID. 75% subjects exposed to VID developed neurophysiologic changes like nausea, vomiting, sweating, dizziness, disorientation, tachycardia and blood pressure changes. While 25% subjects remained symptom free. The exposure of aircrew to VID is also extremely important to remove the 'Enigma' or 'Fear' of neurophysiologic changes of motion sickness by teaching them how to cope up with it.

ETHICAL COMMITTEE APPROVAL

Approval to undertake this research was taken by the ethical committee of the airport authority prior to collection of data and conduction of this study.

CONFLICT OF INTEREST

This study has no conflict of interest to declare by any researcher/ author.

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