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Research Article

EFFECT OF HEAD UPTILT ON HEART RATE VARIABILITY IN MALE AND FEMALE HUMAN SUBJECTS

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ABSTRACT
Cardiorespiratory fitness in adults affects cardiovascular autonomic responses to orthostatic challenges. The response to postural stress can be distinguished by changes in frequency components of Heart Rate Variability. The modulation of the heart can be assessed by power spectral analysis of Heart Rate Variability to show the autonomic control via sympathetic and parasympathetic modulation. This can be done by the head uptilt test. The Tilt Table Test is a standard clinical medical procedure used to diagnose dysautonomia or syncope. In this study, differences between males and females are assessed with regards to cardiovascular effects in response to passive Head uptilt test.

Keywords: *Heart Rate Variability (HRV), Head Up Tilt, High Frequency (HF), Low Frequency (LF)*

INTRODUCTION
The automaticity of the heart is intrinsic to the pacemaker tissues. Camm *et al.,* (1996) had explained that the autonomic nervous system has large control over the heart rate and rhythm. Heart rate influenced by parasympathetic is due to release of acetylcholine by the vagus nerve. And the influence on heart rate by sympathetic is due to release of nor epinephrine and epinephrine. It is the vagal tone which prevails during resting condition and any variations in heart rate are largely dependent on vagal modulation. The vagal and sympathetic activity interacts constantly. The vagal impulse is brief because the acetylcholine is rapidly hydrolysed as the sinus node is rich in acetylcholine esterase. There are two independent mechanisms by which parasympathetic influences exceed sympathetic effects. A cholinergically induced reduction of norepinephrine released in response to sympathetic activity, and a cholinergic attenuation of the response to a adrenergic stimulus. Huikuri *et al.,* (1995) had studied the sex related differences in autonomic modulation of heart rate in middle aged subjects. It was found that LF component of HRV was lower in women, whereas the HF was higher in women than in men. The increase of heart rate and decrease of HF component of HRV in response to an upright posture were smaller in magnitude in women than in men. Liao *et al.,* (1995) estimated the HF and LF of both sexes and concluded that HRV spectral indices were associated with age, sex and race. With increasing age, the parasympathetic and sympathetic spectral power components decrease. Sinnreich *et al.,* (1998) demonstrated the strong sex and age effects on HRV. Time and frequency domain analysis showed the HRV measures to be highly consistent with time with co relation of 0.76-0.80 for HF and total power. Total power declined with age by 45% in men and 32 % in women and was lower by 24% among women than among men ($p<0.005$). Men had a 34% higher very low and LF power and a higher ratio of LF/HF. Conversely HF in women represents a greater proportion of total power than in men.

MATERIALS AND METHODS
After taking into consideration the exclusion criteria, 100 healthy male and female subjects were selected randomly from the general population between the age groups of 15-45 years. A pre tested structured proforma was used to collect the relevant information. After proper explanation of the procedure to the subject consent was taken and the test was conducted pre lunch.

Exclusion Criteria

- Age below 15 and above 45 years
- Alcoholics and smokers
- Obese
- Any medical illness
- Subjects on any medication
- Menstruating and pregnant women
- Women taking oral contraceptive pills

The subjects were advised to fast for 4-6 hours prior to the test to limit the symptoms of nausea and vomiting. A manually operated tilt table was used with a foot support and with straps at the level of knee, waist and shoulders. The table can be tilted by various degrees to a completely vertical position. The subject is asked to lie on the tilt table kept in the horizontal position and the straps are fastened. ECG leads are fixed at right arm, left arm, left foot and right foot and ECG recordings are observed in a monitor. Normal lead II ECG recordings were saved for 5 minutes and frequency domain analysis was done in each position. The subjects blood pressure, pulse, heart rate and any symptoms were monitored throughout the test. The table is tilted to 30^0, 60^0 and 80^0 HUT position. Before changing the angle of the tilt table, the subject is brought to the supine position for 5 minutes. For frequency domain analysis Niviqure software was used. Statistical analysis was done.

Acquiring R-R Intervals:

Extracting R peaks RR intervals → Preprocessing ECG signals → Acquiring raw ECG signals

To analyze HRV, we must obtain the R-R intervals.

Process of acquiring R-R intervals HRV analysis methods: Linear and nonlinear methods

Linear measures of HRV: Linear measures of HRV include various time and frequency domain indices. Frequency domain indices provide information on both total variability as well as its distribution as a function of frequency. Spectral analyses of R-R intervals derived from short term recordings of 2 to 5min yields 3 separate bands.

A very low frequency (VLF) band located in the less than 0.04Hz.

A LF band located in the 0.04-0.15Hz range.

A HF band with a very large range from 0.15-0.50 Hz.

Frequency Domain Measures of HRV

Variables	**Units**	**Descriptions**
Peak Frequency	Hz	Peak frequencies of the power spectral density (PSD)
VLF	ms^2	Power from 0-0.04 Hz.
LF	ms^2	Power from 0.04-0.15 Hz.
HF	ms^2	Power from 0.15-0.4 Hz.
LF/HF Ratio		LF [ms^2]/ HF [ms^2].

RESULTS AND DISCUSSION

The autonomic responses to postural stress are mediated by both cardiopulmonary and arterial mechanisms and can be distinguished by changes in frequency components of heart rate variability in terms of low frequency and high frequency. The low frequency is the marker for sympathetic activity and high frequency is the marker for parasympathetic activity. The ratio of low frequency to high frequency is a quantitative and specific index of sympatho vagal activity.

In our study the resting mean value of low frequency in males was 0.1. On head uptilt the mean values in males were 0.2, 0.3 and 0.4 at 30^0, $60^0$and 80^0 tilt respectively (Table 1). There was a increase in low frequency value in males with head uptilt. Low frequency values showed a highly significant value ($p<0.001$) in all positions (Table 3). In females the mean values were 0.1, 0.2, 0.3 and 0.4 at supine position, 30^0, 60^0 and 80^0 tilt respectively (Table 2). The low frequency values showed a significant increase (p<0.001) with gradual increase in the tilt angle in head uptilt test (Table 4). In our study, the low frequency values showed a significant increase both for males and females (p<0.001) with gradual increase in the tilt angle in head uptilt test.

Mukai *et al.*, (1995) had reported that on standing 300 to 800 ml of blood is forced downward to the abdominal area and lower extremities. Within seconds of this sudden decrease in venous return, pressure receptors in the heart, lungs, carotid sinus and aortic arch are activated and mediate an increase in sympathetic outflow and increase in low frequency on head uptilt.

In this study, the mean high frequency value in males in supine position was 0.3. The mean high frequency value on head uptilt in males were 0.3, 0.2 and 0.1 at 30^0, 60^0 and 80^0 respectively (Table 1). It was seen that there was a decrease in high frequency with head uptilt in males. In comparison with supine and head uptilt position, high frequency values showed a statistically significant decrease only at 60^0 and 80^0 head uptilt in males. In females the high frequency showed statistically significant decrease only at 80^0 head uptilt with mean value of 0.2 at 80^0 tilt. The decrease in the high frequency component on head uptilt was mainly due to decrease in the vagal tone. Lt Col KK Tripathi *et al.*, had similar findings.

It was observed that women had smaller high frequency changes in response to an upright posture, suggesting that the vagal responses to cardiovascular unloading are attenuated in women. Hormonal factors may be responsible for sex related differences in autonomic modulation of heart rate. Huikuri *et al.*, had observed that baroreflex responsiveness is attenuated in women compared with men, but the tonic modulation of heart rate is augmented. Along with cardiovascular neural regulation, hormones also play an important role in cardiac mortality.

Table 1: Cardiovascular responses to HUT in males

Parameters	Supine		30 Deg		60 Deg		80 Deg	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
LF(Hz)	0.1	0.0	0.2	0.1	0.3	0.1	0.4	0.1
HF (Hz)	0.3	0.1	0.3	0.1	0.2	0.1	0.1	0.1
LF/HF	0.3	0.1	0.4	0.2	1.5	1.4	2.2	2.0

Table 2: Cardiovascular responses to HUT in females

Parameters	Supine		30 Deg		60 Deg		80 Deg	
	Mean	**SD**	**Mean**	**SD**	**Mean**	**SD**	**Mean**	**SD**
LF(Hz)	0.1	0.0	0.2	0.1	0.3	0.1	0.4	0.1
HF (Hz)	0.3	0.1	0.3	0.1	0.3	0.1	0.2	0.1
LF/HF	0.2	0.1	0.3	0.1	0.6	0.5	0.7	0.2

Table 3: Comparison between supine and various degrees of HUT in males

Parameters	Supine I	30 Deg II	60 Deg III	80 Deg IV	P* Value	Significant Pairs**
LF(Hz)	0.1	0.2	0.3	0.4	p <0.001 HS	I&II, I&III, I&IV, II& III, II&IV
HF(Hz)	0.3	0.3	0.2	0.1	p <0.001 HS	I&II, I&III, I&IV, II& III, II&IV, III&IV
LF/HF	0.3	0.4	1.5	2.2	p <0.001 HS	I&III, I&IV, II&III, II&IV, III&IV

Table 4: Comparison between supine and various degrees of HUT in females

Parameters	Supine I	30 Deg II	60 Deg III	80 Deg IV	P* Value	Significant Pairs**
LF(Hz)	0.1	0.2	0.3	0.4	p <0.001 HS	I&II, I&III, I&IV, II&IV, III&IV
HF(Hz)	0.3	0.3	0.3	0.2	p <0.001 HS	I&II, I&III, I&IV, II&III, II&IV, III&IV
LF/HF	0.2	0.3	0.6	0.7	p <0.001 HS	I&III, I&IV, II&III, II&IV, III&IV

**Repeated measures ANNOVA test*
***Tukey's test*
HS – Highly significant
NS – Not significant

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