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ENERGY EXPENDITURE AND VENTILATORY RESPONSES DURING SIDDHASANA - A YOGIC SEATED POSTURE

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Abstract : Reports of energy expenditure and ventilatory responses to yogic seated posture of Siddhasana are lacking in literature. Various cardio-ventilatory responses were studied in states of the horizontal supine, chair-sitting and Siddhasana. It was observed that sitting in Siddhasana posture was characterised by greater minute ventilation, larger tidal volume, higher oxygen consumption, greater CO_2 elimination, higher heart frequency greater oxygen pulse and lesser as compared with other two postures. These observations suggest that Siddhasana is a mild type of exercise and may have its application in conditions of low cardio-respiratory reserves especially in individuals in whom heavy exercises are contra-indicated.

Key words : siddhasana metabolic cost oxygen pulse ventilatory functions

INTRODUCTION

The yogic asanas, particularly those in which one sits erect while meditating, are said to be pleasant and comfortable, presumably because one spends less energy of the body sitting in these postures than otherwise. Numerous studies on varied types of physiological, biochemical and endocrinal responses to different yoga postural exercises are available in literature (1-5) and some even including the immediate effects in terms of energy spent by the body and other related functions like oxygen consumption, carbondioxide elimination, the minute ventilation etc. during the assumption of a particular yogic posture have been reported (7-11). The energy spent by the body in a particular activity can be measured by the amount of oxygen consumed by the body per minute, or indirectly by measuring the rate of respiration, heart rate minute ventilation, blood pressure and temperature of the body etc; the higher rate in these parameters being indicative of increased expenditure and vice versa. The purpose of this study was to determine the effect of energy spent by the body and other related ventilatory responses in man while sitting relaxed-in-chair and during Siddhasana posture in relation to horizontally supine (Shavasana) position of the body.

METHODS

The subjects of this study were ten, healthy male yoga-proficient-teachers between the ages of 25-37 years with a mean weight of 58.7±5.2 kg, and mean height of 169.3±6.0 cm. The body surface area ranged from 1.60 to 1.84 m^2. They were all non-smokers and had some practice of sitting in Siddhasana.

The experiments were carried out in the morning on empty stomach after about 20 min rest by assuming Shavasana technique in the Laboratory. Various ventilatory functions were recorded by connecting the subject to 'Mijnhardt Oxycon' (Holland) through a face mask. A photoelectric transducer was attached to one of the ear-lobes for monitoring the heart frequency (FH) and oxygen pulse (O_2P). The cardio ventilatory parameters of minute ventilation ($\dot{V}E$), respiratory frequency (FR), TIDAL VOLUME (VT), oxygen consumption (VO_2), oxygen consumption per kg body weight per min (VO_2/kg), carbondioxide elimination (VCO_2), respiratory exchang ratio (RER), ventilatory equivalent (VE-EQ) and METS were recorded by the use of computer analysis in Oxycon and recorded in

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a print-out at an interval of every half min, whence from the averages for different test parameters were computed.

The sequence of postures adopted during the recording of observations was : (i) sitting relaxed-in-chair, (ii) lying horizontally supine (yogic Shavasana), and (iii) Siddhasana. The first two postures of sitting relaxed-in-chair and horizontal supine Shavasana served as controls and reference levels for the yogic posture of Siddhasana.

Except during the performance of Siddhasana, all the readings were taken after a period of atleast 20 min had elapsed after assuming a particular posture. The period was considered to be sufficient for circulatory and metabolic adjustments and to develop a steady state in the subject. During Siddhasana, however, the recording of observations was made from 0 min to till the subject could sit comfortably in this posture.

The study was also based on a self-control system, where the initial preposture observations obtained during the relaxed state of horizontally supine position (Shavasana) were compared with the observations obtained during Chair-sitting and Siddhasana. Brief account of the techniques followed for adopting Shavasana (horizontally supine posture) and Siddhasana is given.

Technique of performing Shavasana : During the performance of the posture the subject lay in the supine position, with lower limbs 30 degree apart and the upper ones at an angle of 15 degrees with the trunk. The forearms were in the mid-prone position with fingers semiflexed. The eyes were kept closed with eyelids drooping. During this posture, the subjects performed slow, rhythmic, diaphragmatic breathing with a short pause after each inspiration and longer one at the end of each expiration. The subjects were instructed to relax their muscles completely.

Technique of performing Siddhasana : During this posture, the subject placed his right heel on the perineum (between anus and the genitals) in such a manner that the sole of the foot (planter surface) touched the left thigh; followed by fixing the left heel at the root of the genitals. Keeping head, neck and back straight, the subject fixed the gaze in the middle of eyebrows. Care was taken that the knees touched the ground. In this upright seated posture, the subject placed his hands on the respective knees taking care that the index finger touched the middle of the thumb of each hand and the other three fingers remained straight (Jnana Mudra).

RESULTS

Out of the total of 10 subjects, 6 subjects manifested the initial basal breathing frequency (observed during relaxed Shavasana posture) higher than 10 i.e. in the mean range of 11 to 21 per min. The other 4 subjects exhibited the initial basal breathing frequency less than 5 i.e. in the range of 3.5 to 4.7 per min. Based on this criteria of basal breathing frequency, either being more than 10, or less than 5, the subjects were categorised into two groups comprising respectively of 6 and 4 subjects.

The mean results of observations of these two groups of individuals were analysed separately and their details are given below:

(A) Cardio-ventilatory responses during Siddhasana in individuals manifesting initial higher breathing frequency : Table I to IV provide comparative data on cardio-ventilatory responses observed in the group of six healthy adult men, proficient in yoga, having initial breathing frequency more than 10. These were recorded during (i) horizontal supine Shavasana; (ii) sitting relaxed-in-chair, and (iii) during the yogic seated posture of Siddhasana. These tables illustrate that during the yogic posture of Siddhasana, the subjects showed greater minute ventilation, greater tidal volume, higher oxygen uptake, greater production of carbondioxide and higher respiratory exchange ratio as compared with the other two postures. A similar trend of changes in these ventilatory responses, though less in magnitude, was also observed during the comfortable posture of sitting relaxed-in-chair, when compared with the horizontal supine Shavasana posture.

(B) Cardio-ventilatory responses during Siddhasana in individuals manifesting initial lower breathing frequency : Tables I to IV provide comparative data on cardio-ventilatory responses observed in group of four young healthy adult men, having initial breathing frequency of less than five. These were recorded during (i) horizontal supine Shavasana posture; (ii) sitting

TABLE I : Mean values ± SD of minute ventilation (VE), breathing frequency (FR) and tidal volume (VT) during the performance of Siddhasana in relation to resting posture of chair-sitting and Shavasana.

	Parameters of assessment	*FR > 10 (n=6)* *Postures*			*FR < 5 (n=4)* *Postures*		
		HS	*CS*	*A*	*HS*	*CS*	*A*
1.	VE (L/min)						
	M	7.64	8.61	9.50	4.30	4.92	6.90
	SD	1.38	1.50	1.70	1.15	2.66	4.30
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	<0.01	<0.1	NS	NS	NS
2.	FR (Breaths/min)						
	M	15.71	15.70	16.40	4.28	5.75	10.70
	SD	3.21	2.39	2.70	0.53	2.07	7.90
		(HS) VS (CS)	(CS) VS (A)	(HS)VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	<0.05	<0.05	NS	NS	NS
3.	VT (Liters)						
	M	0.49	0.54	0.59	1.03	0.86	0.74
	SD	0.09	0.07	0.10	0.27	0.32	0.13
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	< 0.025	<0.025	NS	NS	< 0.05

Each mean value shown in the columns of Horizontal Supine-Shavasana (HS) and chair-siting posture (CS) is a pooled mean of a set of observations taken at half min interval for a period of 5 min (after elapsing 20 min of assuming the particular posture) on identical experimental sessions held on 6 consecutive days of a week.

The mean value shown in the column of Asana (A) is a pooled mean of set of observations taken at half min interval for the same individuals during the performance of the asana within individual's enduring capacity on a given experimental day.

TABLE II : Mean values ± SD of oxygen consumption (VO_2), carbondioxide production (VCO_2) and respiratory exchange ratio (RER) during the performance of Siddhasana in relation to resting postures of Chair-siting and Shavasana.

	Parameters of assessment	*FR > 10 (n=6)* *Postures*			*FR < 5 (n=4)* *Postures*		
		HS	*CS*	*A*	*HS*	*CS*	*A*
4.	VO_2 (L/Min)						
	M	0.22	0.23	0.28	0.19	0.19	0.23
	SD	0.05	0.05	0.07	0.04	0.102	0.07
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	<0.05	<0.01	NS	<0.05	NS
5.	VCO_2 (L/Min)						
	M	0.13	0.13	0.17	0.12	0.12	0.15
	SD	0.03	0.03	0.03	0.04	0.06	0.04
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	<0.01	<0.01	NS	<0.05	NS
6.	RER						
	M	0.58	0.57	0.62	0.65	0.63	0.68
	SD	0.99	0.09	0.09	0.01	0.02	0.05
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	NS	NS	NS	NS	NS

Each mean value shown in the columns of Horizontal Supine-Shavasana (HS) and chair-sitting posture (CS) is a pooled mean of a set of observations taken at half min interval for a period of 5 min (after elapsing10 min of assuming the particular posture) on identical experimental sessions held on 6 consecutive days of a week.

The mean value shown in the column of Asana (A) is a pooled mean of set of observations taken at half min interval for the same individuals during the performance of the asana within individual's enduring capacity on a given experimental day.

TABLE III : Mean values ± SD of heart frequency (FH) oxygen pulse (O_2P) and ventilatory equivalent (VE-EQ) during the performance of Siddhasana in relation to resting posture of chair-sitting and Shavasana.

Parameters of assessment		*FR > 10 (n=6)*			*FR < 5 (n=4)*		
		Postures			*Postures*		
		HS	*CS*	*A*	*HS*	*CS*	*A*
7.	FH (Beats/min)						
	M	65.20	74.50	73.80	71.13	76.11	82.10
	SD	6.260	6.780	6.700	6.88	6.69	13.20
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	<0.025	< 0.005	<0.1	NS	<0.001	<0.001
8.	O_2P (ml O_2 beats)						
	M	3.32	3.17	3.80	2.69	2.46	3.00
	SD	0.69	0.56	1.10	0.57	1.14	1.30
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	<0.025	NS	NS	NS	NS
9.	VE-EQ						
	M	36.78	37.12	35.10	22.75	26.85	28.10
	SD	6.04	4.08	3.80	0.84	3.19	8.70
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	NS	NS	<0.05	NS	NS

Each mean value shown in the columns of Horizontal Supine-Shavasana (HS) and chair-sitting posture (CS) is a pooled mean of a set of observations taken at half min interval for a period of 5 min (after elapsing 20 min of assuming the particular posture) on identical experimental sessions held on 6 consecutive days of a week.

The mean value shown in the column of Asana (A) is a pooled mean of set of observations taken at half min interval for the same individuals during the performance of the asana within individual's enduring capacity on a given experimental day.

TABLE IV : Mean values ± SD of METS (VO_2 measured/VO_2 resting), oxygen consumption per kg body weight (VCO_2/kg), energy expenditure in Cal/min during the performance of Siddhasana in relation to resting posture of Chair-sitting and Shavasana.

Parameters of assessment		FR > 10 (n=6)			FR < 5 (n=4)		
		Postures			Postures		
		HS	CS	A	HS	CS	A
10.	METS						
	M	0.96	1.05	1.20	0.81	0.75	1.00
	SD	0.23	0.23	0.30	0.15	0.37	0.20
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	<0.01	NS	NS	<0.002	NS
11.	VO_2/kg						
	M	3.67	4.07	4.70	3.15	2.98	3.90
	SD	0.74	0.85	1.10	0.67	1.36	0.70
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	<0.01	NS	NS	<0.002	NS
12.	Cal /Min						
	M	1.04	1.13	1.35	1.91	0.90	1.12
	SD	0.23	0.24	0.34	0.24	0.49	0.33
		(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)	(HS) VS (CS)	(CS) VS (A)	(HS) VS (A)
	P	NS	<0.01	NS	NS	<0.05	NS

Each mean value shown in the columns of Horizontal Supine-Shavasana (HS) and chair-sitting posture (CS) is a pooled mean of a set of observations taken at half min interval for a period of 5 min (after elapsing 10 min of assuming the particular posture) on identical experimental sessions held on 6 consecutive days of a week.

The mean value shown in the column of Asana (A) is a pooled mean of set of observations taken at half min interval for the same individuals during the performance of the asana within individual's enduring capacity on a given experimental day.

relaxed-in-chair; and (iii) during the yogic seated posture of Siddhasana. It is observed that in these subjects with low initial respiration rate, Siddhasana was characterised by the tendency to increase breathing frequency at the cost of decrease in tidal volume, besides showing increase in minute ventilation, higher oxygen consumption, higher carbondioxide elimination, higher oxygen pulse and higher metabolic cost, as compared to the values observed during horizontal supine Shavasana posture.

DISCUSSION

From the results of ventilatory responses studied during three positions of chair-sitting, horizontal supine Shavasana, and yogic seated posture of Siddhasana, it is obvious that the physiologic parameter which gets increased significantly during the performance of Siddhasana is minute ventilation. The mean minute ventilation was largest during Siddhasana, smallest in the horizontal supine Shavasana posture and intermediate in chair-sitting position. In addition to this, there were significant changes in a series of other pulmonary parameters that were simultaneously recorded during the performance of Siddhasana. The results observed of increased oxygen consumption and carbondioxide elimination during Siddhasana indicate that though it is a static posture, it appears to be a mild exercise in comparison to chair-sitting, or horizontal supine posture. Thus the concept that Siddhasana is not an exercise appears to be incorrect. Could yogic asana of Siddhasana type be of any use to the individual? The proposition is attractive particularly so because it involves mild physical exercise which is necessary for the individuals.

As regards the frequency of breathing and minute ventilation, it appears that the yoga proficient subjects manifesting initial breathing frequency higher than ten, increased their ventilation by allowing increases in tidal volume during the three postures. While those subjects who manifested an initial breathing frequency less than five, increased their ventilation by allowing increases in respiratory frequency, as tidal volume in these cases rather decreased.

It may thus be inferred that the Siddhasana posture is characterised by higher minute ventilation, higher oxygen utilisation, greater carbondioxide elimination, faster heart frequency, greater oxygen pulse, lesser ventilatory equivalent and slightly raised metabolic cost, in relation to horizontal supine Shavasana posture and posture of sitting relaxed-in-chair. The difference between these parameters in two positions of horizontal supine and chair-sitting, however, was not significant statistically. These observations suggest that Siddhasana is a mild type of postural exercise and appears to have its value in conditions of low cardio respiratory reserves, especially in patients in whom heavy exercises are contra-indicated.

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