

Yoga Therapy for Countering the Adverse Effects on Astronauts' Health Due to Micro-G or Zero-G Environment: A Concept Study

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Introduction

Micro-gravity or zero-gravity (zero-G) environment causes premature ageing of the body, similar to what a sedentary lifestyle can do. In yoga terms, micro-gravity or zero-G environment can be considered as non-grounding environment, which is in contrast to Earth's gravitational environment, considered as grounding environment. Micro-gravity breaks down the body; hence, its effect is called **catabolic**, opposite of **anabolic**, which builds the body.

To reverse the effect of premature ageing, the daily practice of the following Yoga disciplines is recommended: (i) Āsana (Yogic Pose or Yogic Posture, or often referred to simply as Pose) and (ii) Prānāyāma (Yogic Breathing Exercises, or YBE), along with the use of (iii) Mudrā (Hand Gesture, or simply Gesture). Their health benefits increase in ascending order, namely: Āsana, Prānāyāma, and Mudrā.

[Note: In this paper, English transliteration, with diacritics to facilitate pronunciation of the Sanskrit term, for which there is often no exact translation in English, is given in italics.]

(1). The Āsana_s (Yogic Poses) can be both grounding and non-grounding. To counteract the effects of the anti-G non-grounding environment, one should perform the 'grounding āsana_s' that maintain the body in shape, and in flexible and energetic form. See Table 1.

The goal of Yoga Therapy is for through the use of Poses the body to achieve muscle relaxation resulting in parasympathetic response, which is anabolic.

While performing an āsana, the muscles temporally undergo the following three stages of contraction or relaxation:

1. In the initial stage, called *arrambha*, which occurs within the first 30 seconds, the muscle contracts, resulting in a sympathetic response, that is a catabolic stage;
2. In the second stage, called *sthithi* or stability, which occurs between 30-60 seconds, the muscle starts to relax resulting in a parasympathetic response;
3. And in the third stage, called *visarjan* or surrender, which occurs between 60-90 seconds, the muscle remains relaxed, resulting in a profound parasympathetic response with the release of endorphins, that is an anabolic stage.

By stretching the muscles through performing āsana_s, mostly the lower body (soleus) postural muscles and the para-spinal muscles will initially (during 0-30 seconds) begin muscle contractions resulting in a sympathetic response. After staying (or stabilizing) in the same pose for the next 30-60 seconds, however, these muscles will experience relaxation, resulting in parasympathetic response, which counteracts the ageing effects.

(2). The Prānāyāma_s (Yogic Breathing Exercises, or YBE) help remove toxins, bring in more oxygen, massage or exercise internal organs, and steady the mind. They are anti-catabolic or anabolic. (In contrast, the unsteady, hyperactive mind increases the breakdown of the body.) Seven prānāyāma_s are listed in Table 1.

(3). The Mudrā_s: While some mudrā_s (gestures) involve different parts of the body, most are performed with the hands and fingers. In Yoga, mudrā_s are used mostly in conjunction with prānāyāma_s (YBEs), to stimulate different parts of the body by involving

breathing to affect the flow of “prāna”, or “vital life,” in the body. Mudrā_s act as switches for neuro-physical transmission pathways directing the flow of the “prāna-shakti,” or “life energy,” life-energy, to diseased organs in order to heal them. They are more powerful in their beneficial health effects than prānāyāma_s, which, in turn, are more powerful than āsana_s.

Table 1 gives a summary of the description and health benefits of the āsana_s, prānāyāma_s, and mudrā_s that are relevant for countering the adverse health effects of ageing of the human body attributable

to time spent in micro-G or zero-G space satellite environments. These are a sub-set of those described in greater detail in the Yoga Therapy DVD (Sarkar and Deepak1, 2009) and in the compendium book (Sarkar and Deepak2, 2011, in press). Brief videos of four prānāyāma_s for countering some of the adverse effects on the health of astronauts due to living in space environments were shown as part of the paper (Vernikos, Sarkar and Deepak3, 2010) presented at the 2010 Annual Meeting of the American Society of Gravitational and Space Biology (ASGSB) in Washington DC.

Table 1: *Āsana_s, Prānāyāma_s, and Mudrā_s for Yoga Therapy for Space Health*

<i>Āsana</i>	Yogic Posture or Pose (P)	Description	Health Benefits
<i>Padmāsana</i>	Full-Lotus-P	Grounding pose	Anti-catabolic, or anabolic; Builds muscle tone
<i>Sarvang āsana</i>	Shoulder-stand-P	Grounding pose	Anabolic; builds muscle tone
<i>Halāsana</i>	Plough-P	Grounding pose	Anabolic; builds muscle tone
<i>Sirshāsana</i>	Head-stand-P	Grounding pose, most effective	Anabolic; builds muscle tone
<i>Bhujangāsana</i>	Cobra-P	Back-bending pose	Anabolic; removes stress; relieves back pain
<i>Shalabhāsana</i>	Locust-P	Back-bending pose	Anabolic; removes stress; relieves back pain
<i>Dhanurāsana</i>	Bow-P	Back-bending pose	Anabolic; removes stress; relieves back pain
<i>Naukāsana</i>	Boat-P	Back-bending pose	Anabolic; removes stress; relieves back pain
<i>Vrkāsana</i>	Tree-P	Balancing pose	Balances left & right brains; improves coordination; relieves pain
<i>Natarājāsana</i>	Dancer-P	Balancing pose	Balances left & right brains; improves coordination; relieves pain
<i>Supta baddha kon-āsana</i>	Reclining-cobbler-P	Restorative Reclining pose	Anabolic; induces sleep
<i>Vajrāsana</i>	Thunderbolt or Hero-P	Spine-straightening pose	Metabolic; improves digestion

<i>Prānāyāma (p)</i>	Yogic Breathing Exercise (YBE)	Description	Health Benefits
<i>Bhastrikā-p</i>	Bellows-YBE	Active-inhalation, active-exhalation	Exercises lungs; loosens and removes toxins (e.g., CO ₂) from the lung
<i>Kapālbhati-p</i>	Forehead-Shining-YBE	Active exhalation by contracting abdominal muscles while keeping spine straight	Massages intra-abdominal organs; activates Vagus nerve that, in turn, induces parasympathetic response
<i>Anulom-vilom-p</i>	Alternate-Nostril-YBE	Inhalation through one nostril, exhalation through the other	Balances left and right brain; corrects physical imbalance; improves memory
<i>Bhramri-p</i>	Bumblebee Sounding Nasal Vibration-YBE	Exhalation with humming sound through the nose with ears and eyes closed with fingers	Quiets the mind; induces sleep; very useful for mitigating sleeplessness or insomnia in space
<i>Ujjayi-p</i>	Victorious-YBE	Inhalation through a contracted larynx	Improves sleep apnea, snoring, and thyroid and parathyroid gland function; helps osteoporosis in space
<i>Om-p</i>	Om-Sound Vibration-YBE	Long exhalation through the mouth producing the vibratory sound of OM	Quiets down the mind and body to mitigate the effects of loss of Circadian rhythm in space
<i>Shitbli-p</i>	Cooling-Through-Mouth-Inhalation- TBE.	Inhalation through straw-like rolled tongue	Cools body core temperature when the body feels hot or feverish in space

<i>Mudrā (m)</i>	Hand Gesture, or gesture	Description	Benefits of <i>Prānāyāma-Mudrā</i> Combination
<i>Shakti-m</i>	Energizing-gesture	Little and ring fingertips touching thumb tip	Combined with <i>Kapālbhati-p</i> , it energizes the body to mitigate weakness
<i>Vāyu-m</i>	<i>Vata</i> * Pacifying gesture	Thumb pressing index finger bent down to touch the thumb base	Combined with <i>Kapālbhati-p</i> , it improves bones and joints disorders, and neurological disorders
<i>Varun-m</i>	Water-Balancing-gesture	Little fingertip touching the thumb tip	Combined with <i>Kapālbhati-p</i> , it balances the extra fluid in head and neck area in space
<i>Dhyāna-m</i> (or, <i>Gyāna-m</i>)	Meditation gesture	Index fingertip touches thumb tip	Quiets the mind and body and relieves stress, when done independently or with any P

<i>Brahma-m</i>	Neck-rotation-yogic-gesture (example of body, non-hand, gesture)	Slowly turning the head in six ways, while doing yogic breathing (i.e. exhalation twice the inhalation time)	Stretches the neck muscles; improves circulation through the vertebral artery to the cerebellum part of brain; mitigates imbalance
<i>Hridaya-m</i> (or <i>apanā-vāyu-m</i>)	Heart-gesture	Middle & ring fingertips touching thumb tip, keeping index finger bent down to touch thumb base	Combined with <i>Kapālbhati-p</i> , or independently, it improves heart and lung functions
<i>Apanā-m</i> (or <i>Pachan-m</i>)	Digestive-gesture	Middle & ring fingertips touching thumb tip	Combined with <i>Kapālbhati-p</i> on an empty stomach, or independently after eating, it improves digestive functions
<i>Shunya-m</i> (or <i>Akaash-m</i>)	Zero-gesture	Middle fingertip touching thumb tip	Combined with <i>Kapālbhati-p</i> on an empty stomach, or independently after eating, it improves hearing and mitigates ear-problems

*Vātā is one of three psycho-physiological body-types described in Ayurveda (ancient Indian health system of Longevity)

The Biomarkers of Ageing Due to Adverse Health Effects of Micro-G or Zero-G

The eight major categories of biomarkers and component biomarkers of ageing due to the effects of micro-G or zero-G are summarized in Table 2. The yogic practice of āsana_s, prānāyāma_s, and mudrā_s

recommended for correcting the adverse health effects indicated by each component biomarker, is summarized in Table 2.

Table 2: Yoga Therapy to Mitigate or Rehabilitate the Adverse Health Effects Due to Zero-G and Micro-Gravity Environment

Ageing Biomarker Condition	Description of cause	Āsana	Prānāyāma + Mudrā	Correct(s) Condition by
Muscle Atrophy	Muscle protein breakdown (sarcopenia). Muscles and bones work against gravity to keep us erect. Without this resistance, muscle protein breaks down (sarcopenia) at the rate of 1% per month in zero-G, in contrast to 1% per year on earth.	Four grounding <i>Āsana_s</i>		Building muscle tone
			<i>Kapālbhati-p</i> + <i>Shakti-m</i>	Increasing metabolic power + Building muscle tissue and Improving neuromuscular transmission
Bone Loss (osteoporosis)	A bone loss of about 1% per month occurs in weight-bearing bones due to imbalance between osteoblast (Calcium adding) and osteoclast (Ca-removing) cells		<i>Anulom-vilom-p</i> + <i>Dhyāna-m</i>	Bringing balance between left and right hemispheres of the brain, and hence between the two sets of cells. ⁴
			<i>Bhramri-p</i>	Calming the mind by harmonic resonance, and, releasing more than normal NO (nitric oxide) due to longer nasal-breathing, both of which help the function of osteoplast (putting in Ca).
		Shoulder-stand pose, and plough pose	<i>Ujjayi-p</i>	Each stimulating the thyroid and parathyroid glands, that secreting the hormone calcitonin that improves the function of osteoblast.
Back Pain	Due to loss of tone of para-spinal muscles	Four back-bending poses: cobra, locust, bow, and boat	<i>Anulom-vilom-p</i> + <i>Vāyu-m</i>	Bringing back the tone to para-spinal muscles
Connective Tissue Ageing or Loss			<i>Kapālbhati-p</i> + <i>Shakti-m</i>	Improving the metabolic function + Building the connective tissues

Central Nervous System problems				
Imbalance and Lack of Coordination		Two balancing <i>Āsana_s</i> : tree and dancer		Improving the balance of the physical body
			<i>Anulom-vilom-p</i> + <i>Dhyāna-m</i>	Improving the balance of the two halves of the brain, which in turn balances the body.
			<i>Brahma-m</i>	Relaxing the head and neck area and also improving blood supply through vertebral artery to cerebellum and basal ganglion, both of which are responsible for vestibular balance, and coordination of the body
Sleep Loss	In space, the sun rises and sets approximately every 90 minutes, depending on the orbit, resulting in lack of sleep due to breakdown of Circadian rhythm.	<i>Supta baddha kon-āsana</i>		Lying down in a restorative position to induce sleep
			<i>Bhramri-p</i>	Calming the mind to induce sleep
			Meditate in <i>Dhyāna-m</i>	Activating the Pineal gland, which releases more melatonin to induce sleep.
Increased Stress			Daily practice of all seven <i>Prānāyāma_s</i>	Reducing stress of the mind
Diminished Hypothalamic Function	The problem is due to the disappearance of body temperature regulation or rhythm	Daily practice of all <i>Āsana_s</i>	Daily practice of <i>Prānāyāma_s</i>	Acting through the limbic system of the brain to stimulate hypothalamus in order to correct its diminished function.
Reduction of Taste and Smell Senses			Daily practice of <i>Prānāyāma_s</i>	Improving the senses of taste and smell
Increased Sensitivity and Tenderness of Feet Soles		Stretch toes apart by putting fingers in-between them or wearing Yoga-Toes shoes: up to 15 min daily		Bringing to normal the sensitivity and tenderness of the soles

Cardio-Vascular System Problems				
Loss of Functional Capacity	Due to reduction of heart size, viz., 14% reduction of left ventricular mass occurs during space flight. On the ground, the heart works against gravity to pump blood to the head. In space, the fluids shift from lower body to the head, causing swelling of face and neck, causing a feeling similar to that of getting a head cold.	Do the two sitting-down, grounding <i>Āsana_s</i> : <i>Padamāsana</i> and <i>Vajrāsana</i>		Preventing this condition from happening
			<i>Bhastrikā -p</i>	Exercising the lungs and heart in order to restore the loss
Reduced Plasma Volume	Due to diuresis and natriuresis from carotid-cardiac baro-receptor by the upper body volume expansion due to fluid shift (see item 6.1).		<i>Kapālbhati-p</i> + <i>Varun-m</i>	Increasing metabolism + maintaining water balance, to build the plasma
Orthostatic Hypotension	Due to volume change induced by baro-receptor, not by autonomic imbalance.		<i>Kapālbhati-p</i> + <i>Varun-m</i>	Bringing balance
Arterial Wall Stiffness, Leading to Atherosclerosis	Due to insulin-induced release of protein kinase C-enzyme		<i>Kapālbhati-p</i> + <i>Hridaya-m</i>	
Reduced Aerobic Exercise Capacity			Doing all seven <i>Prānāyāma_s</i>	Increasing aerobic exercising capacity
Depressed Immune Response	Due to stress		Doing all seven <i>Prānāyāma_s</i>	Improving immunity

Metabolism Problems				
Truncal Adiposopathy (metabolic syndrome)			1. <i>Bhramri-p</i>	Reducing this condition
			<i>Ujjayi-p</i>	
			<i>Kapālbhati-p</i> + <i>Dhyāna-m</i>	
Less absorption of G.I. tract			<i>Kapālbhati-p</i> + <i>Apanā-m</i>	Increasing the <i>agni</i> (internal fire power), within the body, in order to prevent this condition
Increased calcium excretion through kidney and stone formation			<i>Kapālbhati-p</i> + <i>Apanā-m</i>	

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