

*REVIEW ARTICLE*

YOGIC EXERCISES AND HEALTH – A PSYCHO-NEURO  
IMMUNOLOGICAL APPROACH

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**Abstract :** Relaxation potential of yogic exercises seems to play a vital role in establishing psycho-physical health in reversing the psycho-immunology of emotions under stress based on breath and body awareness. However, mechanism of yogic exercises for restoring health and fitness components operating through psycho-neuro-immunological pathways is unknown. Therefore, a hybrid model of human information processing-psycho-neuroendocrine (HIP-PNE) network has been proposed to reveal the importance of yogic information processing. This study focuses on two major pathways of information processing involving cortical and hypothalamo-pituitary-adrenal axis (HP A) interactions with a deep reach molecular action on cellular, neuro-humoral and immune system in reversing stress mediated diseases. Further, the proposed HIP-PNE model has ample of experimental potential for objective evaluation of yogic view of health and fitness.

**Key words :** yogic exercise                      human information processing  
psycho-neuro-endocrine network  
hypothalamic-pituitary-adrenal axis

INTRODUCTION

In today's era of stress the restoration of health appears to be a problem. According to World Health Organization (WHO), the health in total includes physical, mental, social and spiritual dimensions (1). However, in spite of having an effective immune system endowed by the nature, human is unable to overcome the negative effects of environment leading to "stress". The stress

effects declines immune efficiency and fail to protect the health of all vital systems. Therefore, we propose an operational definition of health as "a state of dynamic equilibrium and stability against the changing environment accompanied -with constant attacks from external world (bacteria, virus, pollutants etc.) and internal psychological disturbances like fear anxiety, depression, neuroticism etc." Although one can treat these malfunctions employing the

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advanced medical remedies to restore the defense mechanism of the body, the root cause of the infections arising out of imbalanced neuro-humeral functions triggered by the disturbed mental state remains unaffected. Such illness of psycho-physical origin cannot be treated merely at organic level. Therefore, there is a need of some solution to set right the psycho-physical imbalance and in turn restoring neuro-humeral balance is the need of the hour.

However, the scanty reports reveal the role of positive psychological reinforcement in improving psycho-physical health (2)) that serves as buffer between stress and host response (3), which has been useful in coping stress mediated immune diseases (SMID). Here we propose yoga as a total solution for achieving psycho-physical health. This is the basis for investigating the effectiveness of yoga in restoring psycho-neuro-immunological aspects of health.

#### **Psycho-neuro-immunology of stress**

The resistive action of the immune system against foreign substances determines the capacity of the immune system. Therefore, the vulnerable effects of immune system solely depend on the nature of the transmission of foreign substances such as bacteria, virus, etc. (that triggers several diseases) to the host through the agents like wind, temperature, plants and animals etc. The diseases that are originated by the induction of bacteria, virus, etc., are said to be *Communicable Diseases* (CD) and diseases that are not triggered by external agents but by internal factors referred to as *Non Communicable Diseases* (NCD) like diabetes, hypertension, etc. These NCDs' may

facilitate an early onset of infection or highly susceptible to the infections in enhancing communicable diseases.

Apart from the environmental agents, psychosocial factors play an important role in deteriorating the immune system to such an extent that it loses the recognition and distinction between antigen and the body organs (4). This results in mistaken attack on healthy tissues or organs similar to antigens. This is referred to as autoimmune disease (A.I.D.).

#### ***Immunity in stress***

A few studies reveal major stress effects suppressing immune response that affect health (5). The stress on one's psychological state alters neuro-humoral action and immune system in various stress mediated symptoms such as emotional factors with shifting pain and inhibited impulse, rarity of coincidence of schizophrenia in Rheumatoid Arthritis (6), extreme low coincidence of rheumatoid arthritis in Schizophrenia (7) etc. The specific effects of stress components such as work pressure, worry, marital disharmony, threaten or loss of relatives leads to exclusive depression, overt neurotic symptoms and as well as orthosomatic problems, particularly in hyperthyroidism, are associated with the lack of ego strength, adienation, isolation and anxiety (8). The influence of psychic symptoms, in case of ethnocentric dependency involving high degree of energy in ego defensiveness with vicious cycle (9), elevation of Gamaglobulin with mental illness in psychotic state (10), IgM elevation in acute functional mental illness showing abnormal shaped globulin curve (11), increased gamma globulin and IgA

in disorganized level of anxiety (12, 13), confirms psychological mediated stress related immune changes.

Besides, combination of more than one autoimmune disease such as schizophrenia, rheumatoid arthritis etc is correlated with systemic lupus erythromatosus (14). This indicates role of distorted psychobiological factors mediating the stress effects in manifesting various types of autoimmune diseases. The other non-immunological stress effects are *age related rheumatoid arthritis, essential hypertension, rise in cortisol, blood glucose, triglyceride and total cholesterol* (15) that may be conducive to stress mediated immune diseases. These immunological abnormalities suggest the role of stress components on psycho-physiological and immunological aspects of different disease patterns.

The above reviews open the way on the complete control of stress over Neuro-endocrine and Hypothalamus functions that affect immune modulation and immune homeostasis (16). This relation suggests the chaotic picture of psychobiological effects of stress that operates within the frame of human information processing pattern in contrast to expected orderliness of the same contributing health in a state of relaxation (17). This may serve as basis for stress management through yoga, which could be proposed for verifying yoga effects based on psycho-neuro-endocrine effects of immune system in reversing autoimmune diseases.

#### **Role of stressors in psycho-neuro-endocrine (PNE) network**

The role of stress in facilitating antigenic

attack on immune system through various stressors of psycho-somatic origin inducing *immune mediated diseases* have been reported (18, 19). These stressors may manifest through genetic expressions on psychological, physiological and biochemical domains (20, 21). These changes are supposed to be regulated by hypothalamic-pituitary-neuro endocrine systems. Therefore, co-relating the stress effects of immune response in the frame of Pituitary-Neuro-Endocrine (PNE) network may serve as the basis for comprehensive understanding in most of the immune diseases.

The extensive review of literature on PNE network reveals that stress has been evolved through the processes of emotions and immune function (16). This directs to formulate several conceptual issues for understanding the effects of yogic exercise on immune functions. It is, therefore, necessary to have brief review about the role of *stressors* (psychosocial, physiological and biochemical) in affecting the immunity.

Literature amply supports the role of *psychosocial stressors* (as a co-factor) on immune system such as reduction in natural killer (NK) cell activity during sustained depression predicting the possibility of breast cancer (22), uncontrollable stress decreasing immune competence in behavioral depression (23) and depression in general (24). The behavioral stress alters hormonal function and modifies hypothalamic neurons (25). Further, these stressors lead to depression and cognitive deficits that enhances adreno-cortical secretion (26) and Hypothalamic-Pituitary-Adrenal activity (27). The impact of psychological stressors of

emotional and behavioral types modulates immune responses (28, 29). The psychological stressor effects on cellular and molecular level is evident from the earlier studies such as blunt and reduced immune response to the stimulation of Phytoheme agglutinins (PHA), Concalvin A (Con A) and Poke weed mitogen among depressed patients resulting in reduction of the cell-mediated immunity leading to melancholia (30) and reduction of mitogen induced lymphocyte proliferation with immunoglobulin secretion (31,32), which confirm the cellular and molecular effects of psychological stress.

Physiologically, although high level of maximal oxygen uptake ( $VO_2$  max) enhances immune response (33)); however, its low level works as a *respiratory stressor*, which modulates immune variables in deteriorating immune response. Further, *metabolic stressor* decreases Di-hydroxy phenyl glycol (2-DPG) and intra neuronal metabolism (34). Such metabolic stressors increase ACTH, Cortisol (35) and enhance Epinephrine and nor-epinephrine secretion in mood states as confirmed by 2- DPG estimation method (36). Similar effects in other auto-immune diseases like stiff man syndrome (37) confirm overall metabolic stress effects.

Therefore, the above review provides global view of overall stress-effects and interactions at psycho-neuro-endocrine systems. This suggests specific connectivity among stress, emotion and extent of immunity, which forms the entire basis for the role of PNE network in auto-immunity.

#### **Stressor-immune system in PNE network**

To comprehend the effects of stress in

immune modulation, it is necessary to consider mutual effects arising due to the interactions of Stressors with *psycho neuro endocrine* system targeting immune system and its components. This may help us to understand the molecular aspects of information exchange between psychological and immunological domains. The initial stage of *Stressor-PNE network-immune response* includes various stress-effects on nervous system like sympathetic stimulation altering blood leukocyte numbers (38), immunomodulation in a sympathetic stimulation (39, 40) etc., suggests that the sympathetic nervous system provide a vital link between psychological state and immune responses (41). The association of Natural Killer (NK) cell activity with psychological and pharmacological interventions leads to reduced sympathetic activity (42). The examination stress, causing physiological imbalance such as deregulated HPA axis (Hypothalamic pituitary adrenal axis) as a result of cognitive stress response, leads to cortisol awakening response and short circadian rhythm as inferred from salivary cortisol profile (43). This suggests vital links among psycho-neuro-humoral-immune system that serve as the basis for PNE network in regulating stress mediated immune responses.

#### **CNS-psycho-immunological relationship**

The above relation suggests that the Central Nervous System (CNS) forms the hub of PNE network. The CNS neurotransmitters integrate the PNE effects followed by both discrete and remote molecular changes that occur within neural circuits along with endocrine systems in different psychological states and peripheral

immune system. This is evident from the relation between host defense mechanism of mood states and physical illness (31, 44). Besides, neuro-chemical effects of neuropeptides such as enkephalins inhibits sensory autonomic reflex arcs via pre-ganglionic sympathetic fiber (45) and substance P modulates sympathetic ganglia (46) as well as immune system, provoke both endocrine and nervous system (47). This infers a close circuit between neuro-endocrine system and the immune response through various sensory and psychological states.

The chemical imprints of these *psychological mediated stress related immune effects* are evident from the presence of endorphin and neuro transmitter like 5-HT tryptophan in lymphocyte among chronic fatigue syndrome patients (48, 49). Besides, major neuro-chemical synaptic pathways such as serotonergic pathways with serotonin (5-HT)] action reduces brain antibodies leading to decreased primary and secondary immune response (50, 51). The dopamine secretion through dopaminergic pathways exerts its net stimulation on immune system (16) and reduces Nor-epinephrine level in the spleen (52) as well as catecholamines, which are considered as “good indicators of *age related decreased number of macrophages* (53). These are few ways to link the CNS a neurotransmitter with peripheral immune system and autonomic nervous system with immunity different psychological states.

The other neuropeptides like substance P with its vasodialating property (54) along with Ig.E act as potent factor to release histamine from the bone marrow in T-cell macrophage that are responsible for delayed skin hyper sensitivity of immune reaction

(55, 56). The Vaso-Intestinal Peptides in secreting thymic or monocyte peptides along with the action of Autonomic Nervous System (ANS) on enhanced immune functions (57) confirm triggering of immune organelles through the neuro-humoral processes involving both CNS and ANS functions.

The affective and neuroendocrine abnormalities associated with inflammatory diseases in multiple sclerosis suggest immunological basis of neurological dysfunction (58). This reveals that CNS mediated stress affects the HPA axis altered by psychological disorders.

#### **Yoga for psycho-immunological aspects of health**

The cortical region of CNS is the seat of awareness, consciousness and all voluntary psycho-physiological functions including control of breath, which results in modulation of neuro-humoral response as well as monitors the homeostasis of all the physiological systems for optimum health. However, ill-effects of stress causing the cortical dysfunction may jeopardize the overall homeostasis leading to various disorders.

Here we can propose Yoga – as it has breath-awareness component to modulate the cortical activities of the brain. This could be the pivotal point for enriching overall homeostasis.

The stress is known to be the root cause of all non communicative diseases (NCD) and the yogic exercises are considered as the best tool to manage stress. So also, the prevention of stress mediated diseases like

Rheumatoid Arthritis, Thyrodoitis, A.I.D.S (Acquired Immune Deficiency Syndrome), acquired immune haemolytic anemia etc seems plausible. As “*stress*” is the probable means to trigger autoimmune diseases that can be well managed through yoga exercises in bringing psychological, physiological and biochemical homeostasis such as reduction of hypertension, diabetes, etc (59,60). Although, it is known that the meditation manages stress through modulating PNE network (61) that modulates immune system considering a kind of network (62). However, so far, no reports are available regarding working mechanism of Yogic exercises in modifying PNE network functions for reversing stress mediated immune diseases. Moreover, the role of PNE mechanism through yogic exercise in maintaining ideal health has not been attempted so far. It was, therefore, thought desirable to propose the working concept of PNE network in relation to Yoga and Health.

However, effectiveness of yogic exercises on various aspects of mento-physical health are evident from the earlier studies such as enhancement in the immediate memory (63), improvement in psychomotor stability (64), restoration of emotional stability (65), management of stress (66), attentional resource conservation (67) as well as improvement in anti-oxidant status (68, 69) suggest a complex interaction of attention with the breathing activity and unique aspect of attention to set right the metabolic imbalance monitored by the conscious information processing. Therefore, based on the above interactions we propose the operational definition of Yogic exercises as “*The science of synchronizing attention directed breathing activity regulated by the*

*major functions of cerebral cortex to monitor body awareness and well directed homeostasis on all aspects of body functions*”.

The effectiveness of yogic exercises on CNS depends on the innate nature of yogic instruction component to play a vital role on PNE network that modulates immune system. Therefore, main features of instruction of yogic exercises include monitoring and filtering of information content concerned with several components of body awareness like stress detection, stimulus content and rejection of the post detection process that results in muscle relaxation (70). This suggests diminution of associated stress. However, conceiving the possibility of enhancing immunity by yogic relaxation technique could be a fruitful model than the existing psychotherapy model of West working on the principle of disclosing negative thoughts and feelings in a cognitive domain (71, 72) such as the positive role of psycho-social elements to enhance immune response (2, 3). However, the psychotherapy model seems to be limited to operate within field dependent environment as compared to the expected yoga effects in *field independent* situation.

This amply suggests that the idea of application of yogic exercises to overcome stress by the virtue of body-oriented-awareness including muscular stretching as well as relaxation potential to maintain one's health seems viable (73). This indicates that perhaps yogic exercises influence CNS, which is the hub of generating relaxation potential, in sensing and monitoring immune system (3). Further, immune system is considered as internal sensory organ that recognizes non cognitive stimuli like bacteria, virus, etc



(13) at par with nervous system. This, in fact, confirms the relation between CNS and PNS (Peripheral Nervous System) with immune system (74, 75). Therefore, based on the possibility of the dual role of CNS on relaxation and immunity, the effect of yogic exercises has been proposed.

**Yoga on nervous system – A dual role in relaxation and immunity**

The ultimate effect of yogic exercises is to achieve bliss and remain relaxed. Perhaps this is reflected from behavioral outcome such as remaining in happy mood, positive feelings etc. Such similar psychological state are attributed to the endorphin secretion and the parasympathetic actions of ANS on neuro-muscular functions. These endorphins are known to conserve bodily resources and energy (76), which appears to have similar effects of yogic exercises in resource conservation (67). This first line of action suggests the possible role of CNS in secreting endorphin through yogic exercises.

The second line of action is endorphin secretion according to reflex hypothesis of Gordienko (77) produces antibodies through CNS. This hypothesis is confirmed based on the endorphin presence in the lymphocytes and also the internalization of beta-endorphin in thymic cells (78, 79). Therefore, the dual-effect of yogic exercises on nervous system seems plausible in modulating immunity and relaxation. We, thus, suggest the further possibility of investigating the role of yoga on Gordienko's reflex hypothesis to understand the functions of PNE network in immunity and relaxation.

Thus, the basis of the application of PNE

network through yoga on one's health needs thorough understanding of cortical functions related to psychological processes that trigger PNE network routed through the percolating effects of the limbic system and hypothalamus of the brain. Such an understanding about the role of cortical function of yogic exercises on PNE network can be explored using the concept of Human Information Processing (HIP).

Since HIP is the cross road mechanism for translating the effectiveness of *abstract content of yoga instructions* to the yoga practitioners, it may be a suitable method to investigate the psycho-physiological effects of yogic exercises through neuro-endocrine interactions of signals transmission, particularly, in reversing the *Stress mediated immune disease* (SMID).

Thus, the comprehensive understanding of psycho-neuro-immunological effects of yoga is possible only by integrating the PNE network with the cortical information processing aspect of yogic instructions through HIP.

**What is HIP ?**

The Human Information Processing (HIP) is defined as a methodology of neuro-psychology to understand the cortical aspects of *stimulus information processing*. HIP consists of five steps viz, *detection of stimulus, decision, memory* (updating of information) *and reaction time or motor response*, which describes the processing of cognitive stimuli with a meaningful motor output operated on certain mode of attention function, such as control or automatic functions (80, 81). This concept represents

anatomico-physiological substrate such as sensory neuron for stimulus detection, brain stem plus Reticular Activating System for arousal to sustain attention flow, thalamus to relay signal and noise contents, pre-frontal cortex to discriminate and extract stimulus features such as cues, shape, form, etc., frontal cortex for decision making and parietal cortex for updating the information (short-term memory), cerebella and pre-motor cortex for response execution.

#### **HIP-PNE network through cortex-HPA axis**

The stress arises as a result of the withdrawal of attention and reduces attention sensitivity due to increase in task difficulty (82), its influence on emotion is detrimental to health. However, as the *limbic system* is the seat of emotions, any unaware effects of stress would divert the cortical aspects of attention process that results in chaotic (affective) response. Therefore, the psychophysiological aspects of stress response arising from the brain functions are supposed to reflect on the functions of HPA axis. Since most of the motor commands are routed through HPA axis and other endocrine functions, initially, the ripple effects of motor commands may be propagated via brain stem and R.A.S (Reticular Activating System) to HPA axis. Thus, the stress related effects of HPA working in unconscious mode might modulate neuro-endocrine axis that in turn affects immune system.

The HIP approach would be integrated by continuing the cortical information processing from the conscious mode towards the molecular level on HPA axis in a unconscious mode. It seems that the process of stress formation is unconscious in nature

whereas its effects are obviously conscious. This in fact is the basis of almost all the stress related psychosomatic disorders.

It is, however, interesting to note that the *limbic system* acts as a *switch cum converter* to relay the neural language of the conscious content of stress-message towards HPA axis in the unconscious mode. This path-way is the basis for translating the stress effects. Such interaction of HPA axis with the immune system may reveal non-cognitive perceptual mode of immune modulation in an HPA mediated immune system in all pathological conditions and particularly in the cases of stress mediated immune diseases.

Although the subconscious mode of neural content of stress message is reflected through *theta waves*, a kind of electro-cortical response, however, registering the unconscious effects of the immune system on the cortical or sub-cortical level has never been investigated.

#### **HIP of yogic exercises on PNE network**

Conventionally, the HIP concept applies to the conscious information processing dealing with the cognitive stimuli and a meaningful motor output; however, adopting HIP principles in understanding immune system slightly differs. In fact, immune system is a kind of internal sensory organ to recognize non-cognitive stimuli like bacteria, virus etc (13) and the "*Stress*" is a kind of mental state characterized by the withdrawal of attention as a result of increasing task difficulty that reduces the attention sensitivity (82). Therefore, the link between the stressful mental state and the



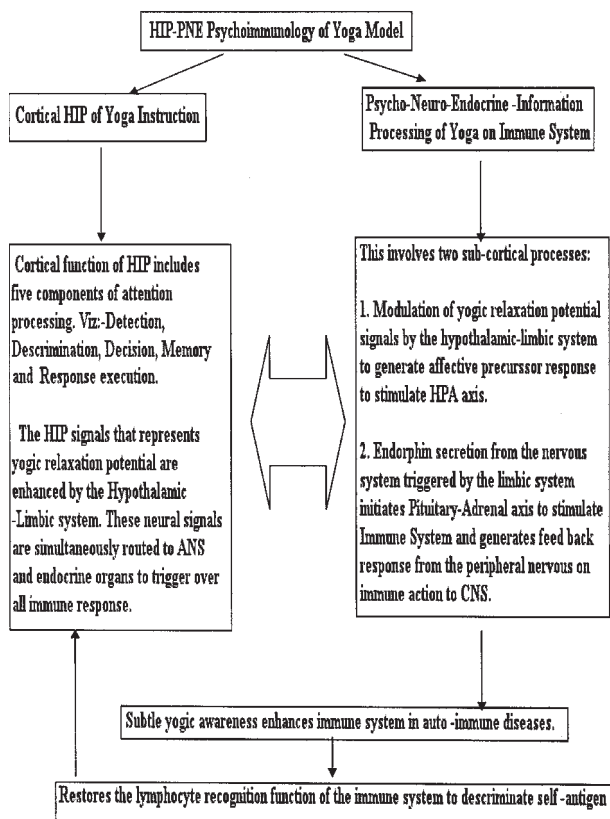


Fig. 1 : An integrated model of HIP-PNE network for yogic exercise effects on immunity.

immunity could be established based on a subject experiencing Strain or Emotional distress on the immune system via CNS (83). This suggests a common role of CNS in attention mechanism and immune chemistry.

The stress related disorders such as hypertension, diabetes etc., could be due to the prolonged effects of the interference of conflicting nature of attention that may result in delayed cognition (84) and delayed CNV (Contingent Negative Variation) – a kind of electro-cortical activity – which is also evident in the patients suffering from chronic pain (85). Similarly, opposite effect of PNE in managing the stress (86) confirms

HIP links. Perhaps Yoga establishes such links that helps to manage stress mediated immune diseases. However, the HIP-PNE model of yoga through HPA axis pathways has been depicted below.

The hub of PNE network is Hypothalamic – Pituitary – Adrenal Axis. There are only few studies that reflect the role of PNE using HPA axis in managing stress through meditation (61).

However, the regulation of PNE through cortical functions can be inferred from the effects of brain lesions on antibody production (87), increased antibody formation through parasympathetic agents (88) and hypothalamic control over gamaglobulin levels (89) suggests that the awareness and relaxation capacity of yoga exercises may have a vital role to play in altering pre-attentive aspects of neural processing in modulating the immune system. But the yoga effect on PNE network and immune system within HIP framework has not been attempted so far.

Since the hypothalamus is the seat of emotion and only a part of the brain that has recognition ability of cognitive function, alongwith similar functions of the “T” recognition cells in immune system form the main components of HIP-PNE network to link emotion with immune responses. This PNE network in turn modulates consciously recognized information content into immune response in unconscious mode. This relation between emotional response and immune system is evident from various studies indicating alteration of IgM (due to the disposition of some Personality factors) showing high incidence of Rheumatoid

Arthritis (90), synchronization of the mood with the symptoms of Rheumatoid Arthritis (44, 91), Thyrodoitis, AIDS, acquired immune haemolytic anemia, Systemic Lupus Erythromatosus, Myasthenia gravis, Poly arthritis nodosa, Polymites, etc (44). Conversely, suppression of pre-disposing factor in an adaptive response situation due to positive attitude, confidence building, remaining in relaxed state and mental state free from tension with an attitude of least state of subjective uncertainty etc, through yoga exercises may enhance immune response. After all, immunity is proposed as an information exchange rather than transaction of energy content (3). This suggests that the HIP of yogic exercises is essential for understanding the information processing aspect of psychology in tune with the molecular information exchange processes occurring at PNE level and immune system.

#### Conclusion

The study summarizes that the comprehensive understanding of the mechanism of health and fitness through yogic exercises based on proposed HIP-PNE model seems to operate on two routes

of information processing viz, cortical aspects of HIP of yogic instruction through HPA axis of PNE Network and subsequently with the HIP components of PNE network in modulating immune system through hypothalamo-limbic-pituitary-adrenal functions.

This proposed model seems to be feasible for experimental testing and to explore various aspects of psycho-immunological effects of yogic exercises. Further, this study would help to evaluate efficacy of yoga on psycho-physiological and biochemical (molecular) modes of information processing, which may guide to design suitable yogic exercise modules in improving immune sensitivity.

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