Chapter 3:
Review of Literature

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3.1. Psycho physiological changes in humans visiting Antarctica

Characteristics and determinants of human response to extreme environmental conditions prevailing in the Antarctic continent have interested psychologists and physiologists. The polar workgroups on expedition to Antarctica are confined to capsule environment with lesser availability of resources, adverse weather conditions and altered circadian rhythm. Scientific studies and observations conducted earlier on humans travelling to Antarctica has revealed several changes in human physiology during the stay and also after returning back from Antarctica. These changes range from behavioural changes like aggression, mood swings to psychiatric problems like depression. Common problems reported in Antarctica include cognitive impairment, anxiety, irritability, hormonal fluctuations, stress and maladaptive difficulties. However, the most common perceived challenges by the members include impaired sleep, indigestion, constipation, and fatigue. Also, in-depth studies have shown decreased immune responsiveness accompanied with an increase in circulating insulin, thyroid hormones, testosterone, cortisol and pro-inflammatory cytokines (Hassi, Sikkilä, Ruokonen, & Leppäluoto, 2001; Muller, Lugg, Ursin, Quinn, & Donovan, 1995; Pagel & Choukèr, 2016).

Living in Antarctic isolated capsular environments requires multiple novel forms of adaptation. The living area is small with less personal space or privacy. Studies conducted on confined Antarctic environments have recommendations to enhance better quality of life in stations by having different locations of rooms for different purposes i.e., active or passive recreation, private or public socialising(Carrère, Evans, & Stokols, 1999) accommodating noisy and quiet times, formal and informal interactions etc.,. Carrere's study on stress levels in Antarctica, points the importance of solitude – where 60% of people's waking time was spent alone – which essentially should not inappropriately suggest wanting to stay alone as a symptom of unhappiness or maladjustment in the confined environment. Studies suggest that feeling comfort being alone is associated with lesser scores of depression, fewer physical symptoms and greater satisfaction with life(Larson & Lee, 1996; Storr, 1988)

Environment building and Social interactions are vital to any individual. As compared to the normal environment, in confined environments, the same people serving as both occupational colleagues and off-time companions affect the role contributions and the guidelines for one's behaviour and ability to predict other's behaviours, creating newer sources of stress(Harrison, Clearwater, & McKay, 1991)

An earlier study by Palinkas et.al., suggested that psychosocial adaptation to confined environments exhibit four distinct characteristics contributing to changes in behaviour (Lawrence A Palinkas, 2003).

a. Seasonal – mood changes associated with diurnal rhythms & psychological segmentation of the mission
b. Situational – personality, interpersonal needs, and coping styles
c. Social – low social coherence leads to depression, anxiety and anger
d. Salutogenic – perception of the situation and individual's response

Zimmer et al., in their review mention that, the influence of polar environment can range from the interference of general psychological health to psychiatric disturbances. Despite significant improvements in designing the research stations, mood and cognitive dysfunctions attributed to environment and cold climate have not been completely addressed (Zimmer, Cabral, Borges, Côco, & Hameister, 2013). Also, a decreased sense of satisfaction in work, diminished productivity, low morale and optimism and decreased well-being are reported. Interestingly, salutogenic effects – depending on the individual characteristics – to overcome the stressors are also documented (P Suedfeld & Weiss, 2000; Peter Suedfeld & Steel, 2000). The salutogenic effects vary based on the individual characteristics to social and professional support. The salutogenic effects are promoted by improved emotion and mood and decrease in the factors that affect psychological functioning. Physiological responses to extreme environmental conditions of Antarctica include changes in circadian rhythm due to light related changes(Broadway & Arendt, 1988; Kennaway & Van Dorp, 1991), peripheral vasoconstriction and impaired nerve conduction(Harinath et al., 2005; O'Brien & Frykman, 2003), hypothermia and frost bite (Cattermole, 1999; Hassi & Mäkinen, 2000; Steine et al., 2003), suppression of immune system (Muller, Lugg, & Quinn, 1995; Muller, Lugg, Ursin, et al., 1995; Shearer et al., 2002) and changes in hormonal levels (Leppäluoto, Pääkkönen, Korhonen, & Hassi, 2005; Sawhney et al., 1998; Steine et al., 2003)

3.1.1. Sleep in Antarctica

Difficulty in falling asleep or maintaining sleep has been reported in Antarctica. Reduction in slow wave and rapid eye movement phases of sleep are documented (Natani, Shurley, Pierce, & Brooks, 1970; Paterson, 1975). A study conducted on seven consecutive Antarctic expeditions reported that in winter, decline in local sunshine lead to longer time in bed, decreased sleep efficiency and delayed sleep onset (Steinach et al., 2016). Coller et.al., reported that sleep in Antarctic summer was highly fragmented and recorded higher night-time energy expenditure in summer than in winter(Collet et al., 2015). However, earlier records suggest a greater sleep fragmentation in Antarctic winters than in summers, the reason for which remains unexplored – (Bhattacharyya, Pal, Sharma, & Majumdar, 2008; Natani et al., 1970; Shurley, Pierce, Natani, & Brooks, 1970). This increased fragmentation in summer is attributed to the circadian desynchronization induced by melatonin secretion delay in constant day light (Ph, Hassi, Ph, Ika, & Ph, 2012) and cold exposure (Angus, Pearce, Buguet, & Olsen, 1979).

3.1.2. Pituitary responses in Antarctica

Humans are tropical mammals with a thermoneutral zone on 25-27^{0}C. On exposure to cold, heat has to be produced for convenience and also survival. Heat is produced by two major ways: Obligatory thermogenesis, which is the basal metabolism at resting state where the temperature is produced in a thermoneutral zone and the second way of generating heat is in unacclimated animals where heat is initially produced through shivering, and is later replaced by non-shivering thermogenesis (Chemical / Hormonal thermogenesis) (Erikson, Eirog, Andersen, & Scholander, 1956).

Thyroid hormones play a vital role in response to cold exposure. Initial studies on short cold exposure to cold air or consuming crushed ice resulting in reduction of core body temperature by 0.4-0.9^{0}C did not produce an increase in serum Thyroid Stimulating Hormone (TSH) (Ducommun, Sakiz, & Defmrtment, 1966). Whereas, immersing the adults in cold water at 12^{0}C for 10 minutes followed by 28^{0}C for 20 minutes produced a two fold increase in plasma TSH for 90 minutes (Leppluoto, Korhonen, Huttunen, & Hassi, 1988).

In Indian expeditioners to Antarctica, one earlier study reported that there was no change in Total T_4, Free T_4 and Free T_3. But, serum free T_3 levels decreased. It is observed in Antarctica, that the TSH levels are the highest at early winter (April) and serum total T_3 was at its lowest in Spring (March). It is speculated that the decrease in T_3 during summer could be due to increased peripheral utilisation of the hormone than decreased production by the gland (DIPAS, n.d.). The increased production of TSH appears to be associated with the duration of light (Hassi et al., 2001). An increase in Insulin and testosterone might be important in maintaining the basal metabolic rate as an adaptation to the extreme cold climatic condition (DIPAS, n.d.).

3.1.3. Immune system regulation in Antarctica

Perceived anxiety in isolated environment and stress factors are responsible for decreased immunological responsiveness in Antarctica. Earlier studies on 9 month stay in Antarctica have documented alterations in T cell function, including depression of cutaneous delayed-type hypersensitivity responses and a peak 48.9% reduction of T cell proliferation to the mitogen phytohemagglutinin (Muller, Lugg, & Quinn, 1995). Also, the T cell dysfunction was mediated by a shift of cytokine production towards inflammation. Prolonged Antarctic isolation was also associated with altered latent herpes virus homeostasis, including increased herpes virus shedding and expansion of poly-clonal latent Epstein-Barr Virus infected B Cell population. Interestingly, report suggest that the T cell proliferation was maintained in the early phase of isolation, which was reduced in prolonged isolation. The T cell proliferation was directly correlated with IL-1ra (Interleukin 1 receptor antagonist) levels. A reduction in IL-10 and an increase in IL-2, 24-hour urinary catecholamine excretion, haemoglobin, platelets and plasma adenosine were observed during isolation (Pagel & Choukèr, 2016).

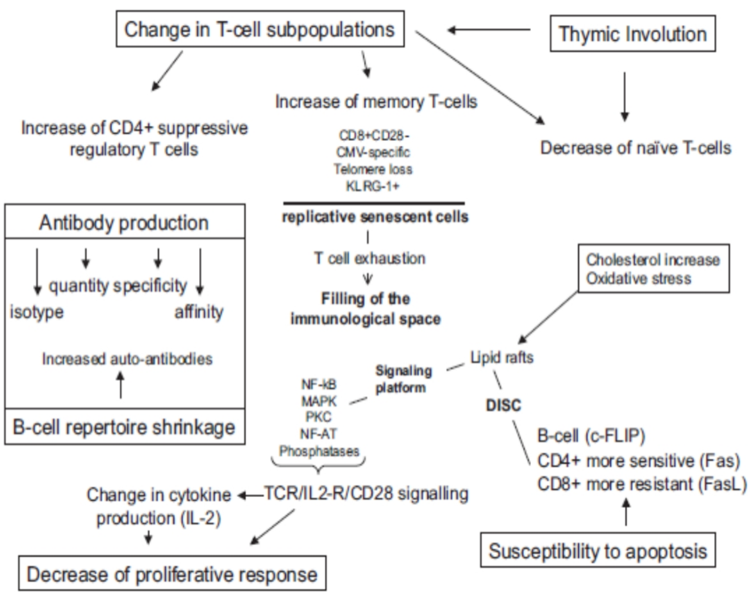

Fig 3.1. Immune System regulation Image Source: (Fülöp et al., 2007a)

Few studies conducted earlier in hermetically sealed environments were unable to observe any changes with T cell proliferation in periods less than 120 days of confinement (Morukov et al., 2013; D A Schmitt et al., 1995a, 1995b; Didier A Schmitt & Schaffar, 1992). The reason for no change being observed was attributed to the lack of perceived isolation by the participating subjects. But, despite being enthusiastic and committed to the expedition, personnel at the Antarctic research stations experience isolation and confinement stress (Mullin, 1960). Other diverse environmental settings including hypoxia (Meehan et al., 1988; Taylor & Colgan, 2017), academic stress (Glaser & Kiecolt-Glaser, 2005; Segerstrom & Miller, 2004), sleep deprivation (Fülöp et al., 2007b; Irwin et al., 1996) and hostile environment training have all reported changes in T cell proliferation. The decreased T cell proliferation at Antarctica and latent virus shedding of Ebstein-Barr virus indicate possible EBV related disorders and health risks including cancer (Muller, Lugg, & Quinn, 1995). Summary of common symptoms experienced in Antarctica is mentioned in *table 3.1.*

3.1.4. Cognition and negative affect in Antarctica

Expeditioners to Antarctica have reported impaired memory, difficulty in concentration, reduced alertness and increased response time in standard tests (Angus et al., 1979; Mullin, 1960; Reed et al., 2001). Studies also suggested increased susceptibility to hypnosis, suggestions and spontaneous fugue states in winter period (Mullin, 1960). These symptoms are attributed to fatigue (Mullin, 1960), absence of environmental stimulation (Lawrence A Palinkas, 1989) and neurobehavioral effects of exposure to cold (Angus et al., 1979).

Expeditioners in earlier studies reported feeling depressed and feeling more irritated than usual in the winter period (L A Palinkas, 1992). This negative affect is attributed to poor sleep (Reed et al., 2001), psychosocial stress (L A Palinkas, 1992; Lawrence A Palinkas, 1989; Palmai, 1963) and a behavioural effect of long term exposure to cold and darkness (Bhargava, Mukerji,

& Sachdeva, 2000; L A Palinkas, Houseal, & Rosenthal, 1996; Lawrence A Palinkas et al., 2001; Reed et al., 2001). Depressed effect, anxiety and irritability are the most common symptoms in expeditioners (Mear, Swan, & Fulcher, 1987; Steger & Schurke, 1987). However, there are other expeditions that have reported no incidence of depression or anxiety in the expeditioners (Peri, Scarlata, & Barbarito, 2000; Weiss, Suedfeld, Steel, & Tanaka, 2000).

The psychosocial stress experienced in Antarctica can also be attributed to the conflict and social comparisons in the newly formed groups apart from the isolation and climatic conditions (Natani & Shurley, 1974; L A Palinkas, 1992). Studies suggest that tensions and conflicts in an expedition group can be due to members not adhering to the group norms (Johnson, Boster, & Palinkas, 2003; Natani & Shurley, 1974; L A Palinkas, 1992), heterogeneous nature of the group & gender (Leon, 2005; E Rosnet, Le Scanff, & Sagal, 2000; Elisabeth Rosnet, Jurion, Cazes, & Bachelard, 2004), ineffective leadership (Johnson et al., 2003; Jack Stuster, 2011; Wood et al., 2005) or competition between the leader and the members (Mear et al., 1987). It appears that the intensity of these symptoms are associated with the dynamics of the entire group (Leon, 1991).

3.1.5. Positive affect

Personal growth and a satisfactory professional performance within the Antarctic environment are associated with social compatibility, skill in performing tasks and emotional stability. Better performances have been reported to depend on an individual’s perception about self. High motivational levels, low need for social support, low levels of extroversion, neuroticism, interpersonal relationship and assertiveness are identified as individual traits that predict good performance (E Rosnet et al., 2000). Other predictive traits for better performance include tolerance to boredom, openness to new experience, shared problem solving and decision making.

	Symptoms experienced	References
Somatic Symptoms		
	Fatigue	(Ikegawa, Kimura, Makita, & Itokawa, 1998; Mullin, 1960)
	Weight gain	(L A Palinkas, 1992)
	Digestive complaints	(Law, 1960)
	Aches and Pains	(Guenter, Joern, Shurley, & Pierce, 1970; Law, 1960; Mullin, 1960; Nardini, Herrmann, & Rasmussen, 1962)
Sleep Impairment		
	Disturbed sleep	(Bhargava et al., 2000; Gander, Macdonald, Montgomery, & Paulin, 1991; Guenter et al., 1970; Nilssen et al., 1997; Usui et al., 2000)
	Loss of slow wave sleep	(Shurley et al., 1970)
	Loss of REM sleep	(Natani et al., 1970; Paterson, 1975)
Cognitive impairment		
	Reduced accuracy and increased response time for cognitive tasks of memory, vigilance, attention and reasoning	(Angus et al., 1979; Law, 1960; Mullin, 1960; L A Palinkas, 1992; Palmai, 1963; Reed et al., 2001)
	Intellectual inertia	(L A Palinkas, 1992)
Negative affect		
	Depressed mood, Anger and Irritability	(Gunderson, 1963; Law, 1960; L A Palinkas, 1992; Palmai, 1963)
	Anxiety	(Gunderson, 1963; Law, 1960)
Interpersonal tension and conflict		(Gunderson, 1963; L A Palinkas, 1992; Lawrence A Palinkas, 2003; J Stuster, Bachelard, & Suedfeld, 2000)

Table 3.1: Summary of Symptoms experienced in Antarctica

3.2. Yoga

Yoga is an ancient Indian science well known presently over the world for its potential physical and mental health benefits. Physical postures (Asana), voluntarily regulated breathing (Pranayama) and meditation are very commonly practiced in India over thousands of years to attain functional harmony between body and mind. Yoga practices, despite individual having associated pathology of Obesity(Jain, Uppal, Bhatnagar, & Talukdar, 1993), Hypertension (Gokal, Shillito, & Maharaj, 2007; Patel & North, 1975), Diabetes Mellitus (Bijlani, Vempati, & Yadav, 2005) or Cancer (Banerjee et al., 2007; Cramer, Lange, Klose, Paul, & Dobos, 2012; Culos-Reed, Carlson, Daroux, & Hately-Aldous, 2006) have been documented to aid in relief with underlying mechanism of action yet to be clearly understood.

Yoga practices have shown that even short term practice is helpful in promoting weight loss, reducing IL-6, TNF-α and increasing adiponectin levels in the plasma (Packard et al., 2011). And, regular practice of Yoga have shown to improve overall anti-oxidant status and maintain anti-oxidant defence system in normal healthy volunteers (Sinha, Singh, Monga, & Ray, 2007). Negative Emotions, which are the cause for worry, a contributor to perseveration and anxiety, has been shown to reduce within a week's span of yoga practice (Narasimhan, Nagarathna, & Nagendra, 2011) contributing towards coping mechanisms towards adaptation. Insulin resistance, a common factor of all the Metabolic Syndrome, has been shown to be overcome with Yoga practices, (Chaya et al., 2008).

A meditation technique that involves aligning breath, body movement and awareness for exercise has been shown to regulate immunity, metabolic rate and cell death by regulating transcription (Li, Li, Garcia, Johnson, & Feng, 2005). Another study on *Sudharshana Kriya* practitioners have shown better levels of Glutathione peroxidase suggesting better free radical scavenging activity and also, greater expressions of glutathione S transferase enzyme. Also, Sudharshan Kriya practices have shown to possess influence over Antiapoptotic Cox-2, HSP-70 and human telomerase reverse transcriptase activities (Sharma et al., 2008).

Yoga practices in a long run is shown to reduce inflammatory biomarkers TNFα, CRP, IL6 and cortisol below levels predicted by key risk factors as age, abdominal adiposity, cardiorespiratory fitness and depressive symptoms (Kiecolt-Glaser et al., 2010). Also, studies have shown better inflammatory status in experienced Yoga practitioners when compared to novices (Kiecolt-Glaser et al., 2010). The relation between sympathetic arousal and the immediate effect of yoga practices over the inflammatory biomarkers and immune expression is still unclear necessitating a need for scientific understanding of the beneficial effects. Hypothalamus and Limbic system which are intimately concerned with emotional expressions of fear, rage, and aggressiveness, which are affected in aging process, is inhibited with yoga practices (Arora & Bhattacharjee, 2008). Breath regulation which promotes diaphragmatic breathing correlates with reduced serum cortisol levels and lower oxidative stress levels (Martarelli, Cocchioni, Scuri, & Pompei, 2011) and similar effect of reduced free radicals, malondialdehyde and increased glutathione (Hegde et al., 2011) and increased Super oxide dismutase (Bhattacharya, Pandey, & Verma, 2002) have been documented with yoga practices. all of the above have a role in combating Insulin resistance and maintaining better pancreatic Beta cell functioning. Yoga practices apart from regulating the inflammation and promoting stress resistance, is also proven to enhance memory, attention and cognitive abilities (Gothe & McAuley, 2015)

In summary, Yogic practices are understood to provide potential health benefits by reducing inflammation, insulin resistance, developing stress resistance, improving immunity, enhancing memory, attention, cognitive abilities, sleep and over-all quality of life.